ROSS ISLAND SAND & GRAVEL CO.

Ross Island Reclamation Plan

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EXECUTIVE SUMMARY

Ross Island Sand & Gravel Company (RIS&G) is proposing a Reclamation Plan for the island complex that is markedly different from – and much improved upon – the plan that has been in place for the last two decades. The product of 14 months of review by an independent advisory committee, the plan described in this document is based on better science, more thorough analysis and broader public input then the 1979 plan.

This Reclamation Plan is based on a more current and complete scientific understanding of the river, the island complex, and surrounding habitat. The strategies prepared in this updated plan reinforce existing public policies, using clean fill to achieve substantial reclamation and diverse habitat development on an accelerated basis.

This Reclamation Plan is more practicable than the 1979 plan. It is built upon an assessment of the economic, availability and logistics of reclamation fill. And while RIS&G's commitment to the plan will require a substantial investment in the reclamation of Ross Island to yield substantial public benefits, this updated plan will accommodate the continued operation of RIS&G's processing facility at the island. In this way the new strategy strikes a balance between preserving jobs and protecting the environment – public values shared by many of the region's citizens.

PLANNING PROCESS. This document is the culmination of a 14-month inclusive public process to review the existing 1979 Reclamation Plan for Ross Island. Ross Island is located about a mile upstream from downtown Portland at approximately river mile 15.0 of the Willamette River. Since the 1920s, the RIS&G has actively mined the island and the Ross Island lagoon for commercial aggregate. For the past two decades, RIS&G also has conducted reclamation activities at the island, in accordance with the provisions of a reclamation plan adopted in 1979. The Ross Island facility site includes Ross Island, Hardtack Island, and the Ross Island lagoon.

To assist in the review of the 1979 Plan, RIS&G convened a six member advisory committee (Ross Island Reclamation Plan Advisory Committee – [RIRPAC]). The purpose of the committee was to advise RIS&G regarding any revisions to the 1979 plan needed to reflect current knowledge about the natural and man-made environment of the lower Willamette River, to protect the long-term interest in reclamation of the island following mining, and to develop reclamation goals.

The RIRPAC met ten times between June 2001 and September 2002. All meetings were open to the public and the media. Two technical workshops, a hydrology study, and two public outreach meetings were also conducted to aid in preparing the Reclamation Plan. Additionally, RIS&G described operational issues/constraints related to reclamation and evaluated the costs associated with implementing reclamation activities with fill from different sources and of different quality to ensure that the reclamation plan could be practicably implemented. Geotechnical engineers, habitat restoration specialists, and other experts were retained to analyze options and develop detailed strategies for achieving desired reclamation outcomes.

Based on the results of the above activities, RIS&G proposes to revise the 1979 reclamation plan. RIS&G believes that better fish and wildlife habitat outcomes will be achieved under a revised plan than under the existing 1979 plan. Accordingly, RIS&G proposes that the 1979 plan be replaced by a new plan based on better science, current regulatory requirements and a changing role for Ross Island in the lower Willamette River.

RECLAMATION GOALS AND APPROACH. This final Reclamation Plan describes the proposed new approach to reclamation. The new approach supports the following reclamation goals established by RIRPAC:

- Protect and enhance the fish and wildlife values of the islands;
- Protect surface water and groundwater resources;
- Protect the structural integrity of the islands as needed to prevent catastrophic erosion and scouring events; and
- Preserve options for future public ownership and benefit.

The proposed 2002 reclamation plan will meet these goals. The 2002 plan is supported by sound science and based on current knowledge of river processes and habitat restoration. When fully implemented, the 2002 Plan will produce total habitat acreage comparable to the 1979 plan. It will result in the creation of a greater diversity of habitat types than the 1979 plan, including riparian, emergent wetland and shallow water habitat considered important to threatened fish species. Only "Class A" Fill, as defined by the Oregon Department of Environmental Quality (DEQ) will be used to accomplish reclamation goals. DEQ has determined that Class A fill does not pose an unacceptable risk to human health and the environment and is protective of surface water and groundwater resources. Placement of fill in selected areas to accomplish reclamation will protect the structural integrity of the islands. Diverse vegetation plantings and naturally established vegetation will create an aesthetically pleasing environment.

The proposed approach to reclamation compares favorably to both the condition of the island in 1979 and the projected conditions of the island assuming full implementation of the 1979 reclamation plan. Important benefits of the proposed approach compared to the 1979 plan include the following:

The proposed 2002 plan will result in development of 118 acres of upland forest, 22 acres of riparian/emergent wetland habitat on the south end of the lagoon and 14 acres of shallow water habitat at the north, west, and south portions of the lagoon (Figure 1). A far greater diversity of plants and animals can be established at Ross Island with these habitat types than with the predominantly upland habitat emphasized in the 1979 plan. The details regarding the development of these diverse habitats are contained in the Ross Island Wetland and Riparian Habitat Reclamation Plan (Appendix A).

The size of the lagoon (131 acres) will be approximately the same size as under the 1979 plan. The lagoon will have a variety of depths, including deep holes. Independent scientists have advised RIS&G that the deep holes created by mining do no ecological harm. Sediment from the Willamette River is projected to accumulate in the lagoon at the rate of 5 to 6 inches per year.

The plan proposes that the described habitat be developed over a 10-year period. This implementation timeline is significantly shorter than the reclamation period proposed in the 1979 plan, which allowed up to 20 years for full implementation.

The 1979 reclamation plan would have resulted in creation of approximately 135 acres of upland forest (approximately 10 more acres of forested upland than existed in the 1979 baseline condition of the island). No wetland habitat would have been created under the 1979 plan. The lagoon area, post reclamation, would have consisted of 138 acres of open water with a relatively uniform average depth of –20 feet (Figure 2). The lagoon would be less than ideal salmonid habitat due to temperature and predator concerns.

In addition to these benefits, the proposed plan contains clear reclamation goals and strategies (the 1979 plan contains no state goals) and a detailed monitoring program (the 1979 plan does not include a monitoring program).

For purposes of comparison, the 1979 island (which consisted of 132 acres of forest habitat) is shown on Figure 3. The variety of depths in the lagoon ranged from –130 to a small amount of shallow water habitat (depth undefined).

The proposed approach also varies from the 1979 plan with respect to the quality and amount of fill to be placed in support of reclamation goals. It is estimated that full implementation of the 1979 plan would require importing approximately 20 million yd^3 of fill. The 1979 Plan contains no specific direction regarding the source or quality of reclamation fill; however, when the 1979 Plan was developed the adequate and acceptable sources of fill were believed to be available. At that time, the sources and quality of material used as reclamation fill were subject to far less regulatory scrutiny than is the case today. Standards for fill quality did not exist, other than in a broad and qualitative sense.

Since 1979, far more stringent and specific standards for fill quality have been developed. These more stringent standards limit the quantity of clean fill available in the Portland metropolitan area thus creating greater competition for the limited volume available. In this context, the 1979 plan could not be implemented in a cost-effective manner or within a reasonable time frame. The proposed 2002 reclamation plan will involve placement of less total fill (approximately 4.0 to 4.6 million yd^3) than would have been placed if the 1979 reclamation plan had been fully implemented. The new plan proposes that all of this fill meet DEQ "Class A" fill standards. The plan also identifies prospective sources of the fill material. Using clean fill preserves options for future public ownership and benefit.

The 2002 reclamation plan represents an approach that can be implemented to reclaim Ross Island. A diversity of habitats is proposed for creation in a 10-year period. The plan as proposed will create the highest quality habitat in the fastest feasible timeframe.

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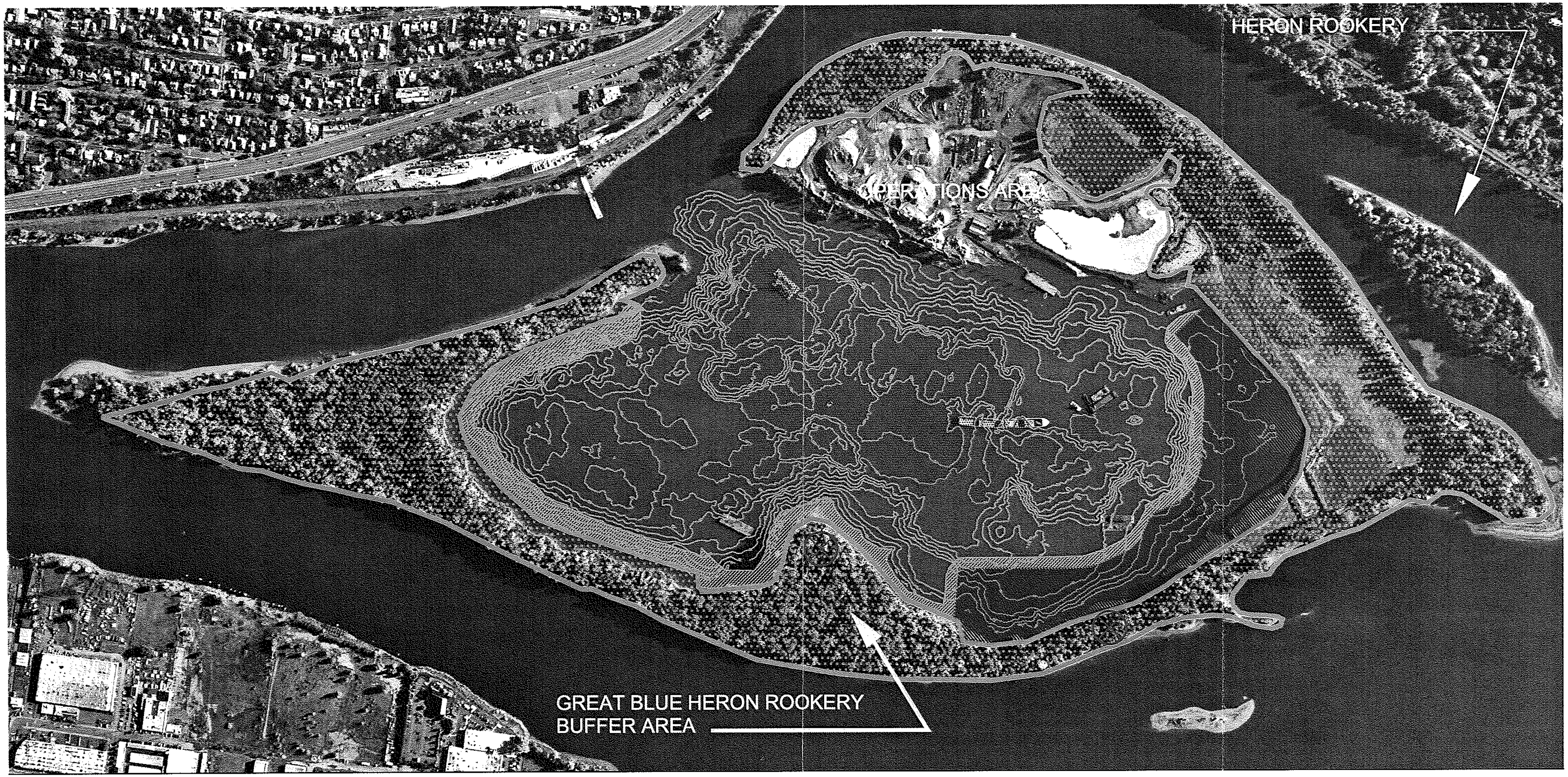
1.0 INTRODUCTION

In May 2000, the Oregon Division of State Lands (DSL) authorized continued mining and reclamation activities by RIS&G through a five-year extension of the company's Removal-Fill permit. Among the conditions included in the permit was a requirement that RIS&G review the current reclamation plan for the island, originally adopted in 1979. The permit condition further directed the company to convene a stakeholder group to assist in the review and to make recommendations regarding potential revisions to the existing plan.

As a result of that review, RIS&G proposes to replace the 1979 plan with a new approach to reclamation. This document describes the new approach and provides a rationale for replacing the 1979 plan. The document has nine sections. The first several sections are devoted to background information on Ross Island and its surroundings. Sections 4.0 and 5.0 discuss the goals of reclamation goals and proposed approach to reclamation. The final sections of the plan focus on the details of implementing the proposed approach, including fill placement, monitoring and management, and evaluation. Details regarding the plan review process, re-vegetation, habitat development and other technical issues are contained in various appendices to the plan.

RIS&G wishes to thank the members of the Ross Island Reclamation Plan Advisory Committee, their staff, and other agency representatives and members of the public who participated in the review process. The company also wishes to express its appreciation to the independent experts who participated in the reclamation planning workshops held last fall. Both the planning process and the plan benefited greatly from their involvement.



PROPOSED HABITAT TYPES

SHALLOW WATER HABITAT

RIPARIAN/EMERGENT WETLAND

UPLAND FOREST

DEEP WATER AREAS
(greater than and equal to -100 feet RID)

EAGLE NEST

0 250 500 1000
SCALE IN FEET

ROSS ISLAND
2002 PROPOSED RECLAMATION

FIGURE 1

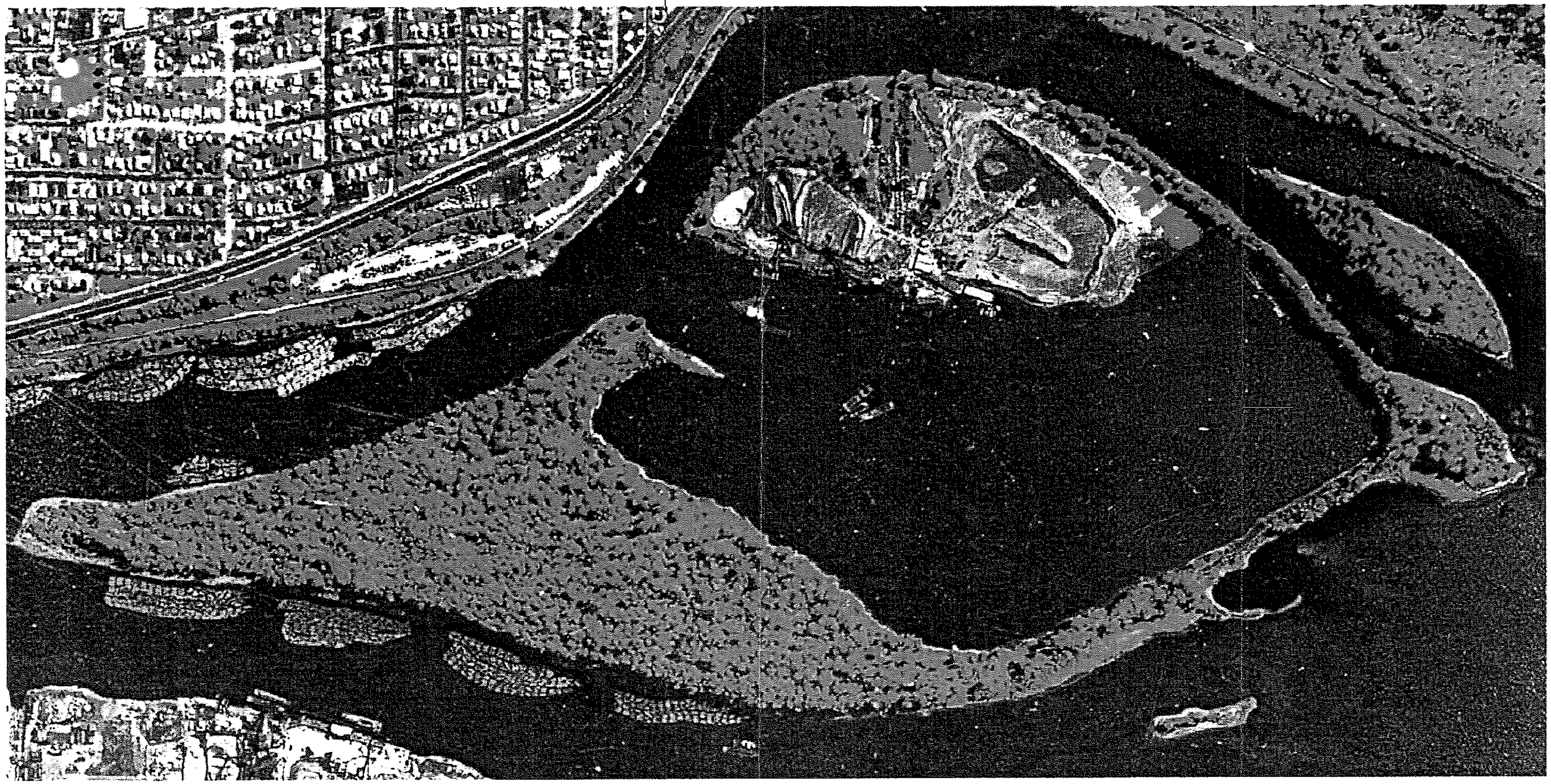
UPLAND FOREST

LAGOON (average depth -20 ft.)

ROSS ISLAND
1979 PROPOSED RECLAMATION PLAN
AS REQUIRED BY THE DIVISION OF STATE LANDS

0 250 500 1000
SCALE IN FEET

FIGURE 2



0 250 500 1000

SCALE IN FEET

ROSS ISLAND 1979

FIGURE 3

2.0 BACKGROUND

2.1 HISTORY OF MINING AND RECLAMATION AT ROSS ISLAND

RIS&G has removed and processed sand and gravel at Ross Island for 75 years. For most of that time, filling at the island was limited to the return of noncommercial sand and silt material separated from commercial grade material during processing by RIS&G. A 1979 Conditional Use Permit from the City of Portland (City) (see Section 2.2) specified areas that could be mined and required that RIS&G reclaim both upland and in-water mined areas to certain dimensions on a specific timetable. To meet the plan requirements, RIS&G began importing fill material from other sources. Reclamation fill material used at Ross Island from the early 1980s through 1998 is documented to have come from three sources - noncommercial material from onsite aggregate processing; dredging-related fill material from sites along the Willamette and Columbia rivers; and other imported fill material.

Some of the fill material used to reclaim the lagoon was placed in surface depressions that were subsequently capped because the fill material was judged to be chemically unsuitable for unconfined open water disposal under the regulatory guidance in place at the time. (US Environmental Protection Agency/US Army Corps of Engineers (EPA/USACE) 1991.) This disposal method, known as confined aquatic disposal, had been used to safely dispose of contaminated material at several other sites in the country. The placement of fill material in Ross Island lagoon, including the confined aquatic disposal areas, was approved by the appropriate regulatory agencies, including the DEQ.

RIS&G concluded mining operations in the Ross Island lagoon in the fall of 2001 – three and a half years prior to the expiration of its current permits. The company will continue reclamation filling and other reclamation activities as described in this plan. In addition, processing of aggregate material from other sources, primarily upland sites on the Yakama Nation Reservation in Washington, is expected to continue indefinitely at Hardtack Island.

The company hopes to transfer ownership of Ross Island and part of Hardtack Island to the City of Portland in the near future. The timing and exact boundaries of the land to be transferred have not been finalized. State and federal permit requirements will remain in effect after any such transfer. Reclamation of mined areas will continue as required under any state and federal permits in force at the time. The removal fill permit must be officially transferred to a new permittee and is a separate action than transfer of ownership of the island.

2.2 REGULATORY CONTEXT

Mining and reclamation operations at Ross Island are subject to the following state and federal laws:

- Oregon's Removal-Fill Law, the legislatively declared policy of which is to preserve the use of the waters of the state for navigation, fishing and public recreation. DSL administers the Removal-Fill Law. The DEQ is charged with issuing the water quality certification required in conjunction with state and federal removal and fill permits.
- Section 404 of the Federal Clean Water Act, administered by the USACE, which regulates discharges of dredged or fill material into the waters of the United States. The USACE generally issues permits under Section 404 in conjunction with the state's review and issuance of permits under the Removal-Fill Law.
- The Federal Endangered Species Act (ESA), the purpose of which is to protect fish, wildlife and plants that have been determined by the federal government to be threatened or

endangered by extinction. Fish species found in the lower Willamette River that have been listed under the ESA include lower Columbia River steelhead, lower Columbia River Chinook salmon, upper Willamette River steelhead and upper Willamette River Chinook salmon.

The ESA affects regulation of mining and reclamation activities at Ross Island as follows:

- Section 7 of the ESA directs all federal agencies to conserve threatened and endangered species and, in consultation with the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), ensure that agencies' actions do not jeopardize listed species or destroy or adversely modify their critical habitat. In the case of RIS&G, the federal action requiring consultation is the issuance of the Section 404 permit.
- The Oregon Removal-Fill Law requires that before issuing a permit, the director of DSL must make a number of findings, including that the project would not adversely affect rare, threatened or endangered species or cause significant degradation of aquatic life and habitats.

RIS&G was issued its first permit for removal of material from state-owned waters in October 1967, following passage of the Oregon Removal-Fill Law. The removal statutes were amended in 1971 to include regulation of fill, and subsequent renewals of RIS&G's state permit (#RF-26) have covered both removal and filling activities. The first dredge and fill permit from the USACE was issued in 1976.

Also in 1976, DSL added provisions to the company's Removal-Fill Permit prohibiting RIS&G from removing any additional upland portions of the islands until the company filed a "Total Management Plan" for the island interior with DSL. A task force was convened by then-governor Robert Straub to develop a plan that was acceptable to all parties. Based on the work of the task force, in 1979 a reclamation plan for the island was adopted and incorporated into the company's state permit. The following year, the City of Portland issued a conditional use permit (CU-106-79) with more detailed guidelines for grading and re-vegetation of upland areas created by fill.

In 1985, operating under new administrative rules authorizing the issuance of multi-year permits, DSL issued a three-year permit renewal to RIS&G. The permit was renewed for five-year increments in 1988 and 1993. In 1998, RIS&G applied for another five-year renewal of permit #RF-26. In May 2000, DSL issued the renewed permit, which authorizes mining to continue at the island until 2005, and filling related to reclamation to continue through 2020.

2.3 MAY 2000 PERMIT REQUIREMENT TO REVIEW THE 1979 RECLAMATION PLAN

The DSL renewal permit issued in May 2000 incorporates by reference the "Material Removal and Reclamation Program", commonly referred to as "the 1979 reclamation plan". The permit includes a provision requiring RIS&G to convene a stakeholder committee to assist in reviewing the plan, determining whether changes are needed to reflect current knowledge and issues, and, if necessary, revising the plan.

In response to this permit requirement, in May 2001 RIS&G convened the Ross Island Reclamation Plan Advisory Committee (RIRPAC). The purpose of the committee was to review the 1979 Reclamation Plan and advise RIS&G regarding any revisions needed to 1) reflect current knowledge about the natural and man-made environment of the lower Willamette River; and 2) protect the long-term public interest in reclamation of the island following mining. Additional information regarding the RIRPAC and the reclamation plan review process can be found in the RIRPAC's "Report to the Community", a separate document.

The May 2000 permit further requires that the revised plan include the following:

- A description of the planned beneficial use of the island following mining;
- A legally enforceable time schedule for completing reclamation;
- Plan and profile drawings;
- Final slope configurations and how they will be stabilized;
- Procedures and timelines for the removal of all equipment, refuse, structures and foundations from the permit area;
- A re-vegetation plan;
- Location of soil storage and stockpile areas;
- Access roads;
- Stormwater management and de-watering structures;
- Proposed types and sources of fill material;
- Proposed methods of fill placement;
- Other information required by DSL to accurately describe the proposed reclamation; and
- A bond or other security instrument to ensure reclamation is completed.

The permit calls for revisions to the 1979 plan to be submitted to DSL by July 1, 2002. In June 2002, an extension was requested and granted by DSL to extend the submittal date to October 1, 2002.

The following section describes the physical characteristics and natural resources of Ross Island and the surrounding environment.

3.0 DESCRIPTION OF THE ISLANDS

3.1 LOCATION

The Ross Island complex is located about a mile upstream from downtown Portland at approximately river mile 15.0 of the Willamette River. The RIS&G facility site includes Ross Island, Hardtack Island, and the Ross Island lagoon. (See Figure 3-1 and Figure 3-2)

3.2 GEOLOGY

The Ross Island complex is situated within a geologic formation known as the Portland Basin, a northwest trending basin characterized by thick accumulations of sediment and topographic lineations, faults and folds trending to the northeast and northwest. Distinct geologic associations located near the site include ancient basin-fill sediments over sedimentary and volcanic bedrock. Primary geologic formations within the Portland Basin include the Columbia River Basalt Group, Sandy River Mudstone and Troutdale Formation, catastrophic flood deposits and native alluvium.

The presence of native alluvium is of special significance. The alluvium of the Portland Basin consists of river and stream deposits of silt, sand and gravel largely confined to the Willamette River channel and the valley bottoms of tributary streams. Much of the sand and gravel material mined and processed in the Portland area originates from this material.

3.3 UPLAND RESOURCES

3.3.1 VEGETATION

Like most urban landscapes, Ross Island looks and functions much differently today than it did in the early days of Oregon statehood. A General Land Office survey conducted in 1852 characterized the island as being comprised of "brushy bottoms" and "land bottoms, soil first rate alluvial". Plant species noted in the survey included black cottonwood with 14" diameters, white oak with 12-18" diameters, willow and white ash approximately 6-12' in diameter, Douglas spiraea and trailing blackberry.

The island's topographic features at the time of the survey likely bore a strong resemblance to features of other islands and floodplains in the lower Willamette and Columbia rivers. The Oregon Natural Heritage Program has characterized such islands as having well-drained soils and exhibiting shallow linear troughs and low ridges running parallel to the river. Remnants of these troughs, relics of high-energy flood events that occurred prior to flood control, can be seen in older aerial photographs of Ross Island. Shallow overflow ponds may also have been part of the island's original topography.

Today, the terrestrial environment at Ross Island is a mixture of established riparian habitat and - as a result of ongoing reclamation activities and continued mining of native material - newly reclaimed and successional areas. At the river's edge are both steep and moderately steep banks, with low-lying shrubs, overhanging trees, and shallow sandy beaches. Woody debris, log piles, and exposed roots are present along most of the shoreline, which is generally devoid of herbaceous vegetation. The islands are subject to occasional flooding.

Landau conducted reconnaissance-level terrestrial surveys in fall 1999 and spring 2000 at both Ross and Hardtack islands. The purpose of these surveys was to qualitatively evaluate site-specific terrestrial organisms, habitat types, and habitat areas as baseline information for a remedial investigation of site contamination. Terrestrial habitat, including vegetation and vertebrates, was documented at 15 survey stations and classified into the following representative categories:

- Bare shoreline – Unvegetated.
- Riparian deciduous hardwood forest – The canopy in this habitat is dominated by black cottonwood and Oregon ash. Himalayan blackberry, red-osier dogwood, and snowberry make up a dense shrub layer, with willow becoming an important cover near the edges of the islands. Dominant herbs include stinging nettles, trailing blackberry, and horsetail.
- Riparian shrub thicket - This habitat is dominated by dense Himalayan blackberry, red-osier dogwood, and willow. The herb layer is quite sparse and variable. Nearshore plant species observed include tumbleweed amaranth, hornwort, peavine, white sweet clover, and black cottonwood seedlings.
- Re-vegetation forest (sapling stage) - The re-vegetation forest (sapling stage) is a reclaimed area containing black cottonwoods less than 6 feet high and an abundance of red-osier dogwood. A small amount of Himalayan blackberry is present. Herbs consisted mainly of alfalfa and reed canarygrass.

3.3.2 WILDLIFE

Numerous birds have been observed at Ross Island, including song/perching birds, bald eagle, Great Basin Canada goose, great blue heron, and mallard. Past studies have indicated that nearly 100 species visit or reside at Oaks Bottom, a natural area located just across Holgate Slough from Ross Island.

Until late 1999, a great blue heron rookery occupied part of Ross Island. By the time of Landau's spring 2000 survey, the heron rookery had moved to East Island. Rookery movement is not uncommon and could have occurred due to several factors, including disease or parasites that may have heightened nestling mortality; the presence of bald eagles; boating on the adjacent Willamette River; disturbance from people on the island, and/or dredging activity in the lagoon. The bald eagle nest on the island also relocated between the fall and spring surveys to a site within the mapped heron rookery.

Signs of mammalian activity have been observed across much of the island, including those of beaver (e.g., slides, trails, chewed trees, and tracks) and raccoon (tracks). Burrows attributed to nutria were noted along many of the "high bank" areas of the island, particularly on the Willamette River. Canine tracks and feces were also noted, but the species was not determined (likely species include domestic dog, coyote or fox). Deer mice were the only mammals trapped at the site during recent ecological studies.

A 1976 Portland State University student conducted a survey of small mammals on islands in the Columbia and Willamette Rivers, including Ross and Hardtack islands. According to this survey, vagrant shrews, Townsend's moles, eastern cottontail rabbits, beaver, black-tailed deer (not currently resident on the island) and northern flying squirrels could all be found on the islands at that time. Regional experts consulted during development of the reclamation plan reported that the common ground squirrel, nutria, river otter, raccoons, bats and long-tailed weasels make use of islands similar to Ross Island in the Willamette/Columbia system.

No signs of reptiles or amphibians were noted during the reconnaissance ecological surveys conducted by Landau. However, frogs have been heard during other site investigations and likely inhabit the shorelines and wet areas of the island. According to experts consulted during the course of preparing the plan, even prior to mining Ross Island is unlikely to have been inhabited by large populations of amphibians.

3.4 AQUATIC RESOURCES

3.4.1 BENTHIC ORGANISMS

Landau also conducted a qualitative evaluation of the nearshore aquatic and benthic environment of Ross Island Lagoon, Holgate Slough, and the Willamette River near the RIS&G facility. The evaluation showed that benthic invertebrates are present in nearshore sediments at Ross Island as well as in deeper water sediments in the lagoon. Oligochaetes (aquatic worms) were the most abundant benthic invertebrates at the site, followed by diptera (true flies) and amphipods ("scuds"). Diptera evaluated at the site have been almost entirely of the family Chironomidae (non-biting midges). Other benthic organisms present at the site include flatworms, Asian clams, nematodes, aquatic moths, and caddisflies.

3.4.2 SALMONIDS

Salmonid use of the lagoon and adjacent river during the 1999 sampling periods consisted of temporary use by out-migrating juveniles. In general, the salmonid abundance outside the lagoon was greater than inside. Hatchery and wild Chinook, hatchery coho salmon, and hatchery steelhead were captured at all sampling stations. Hatchery Chinook salmon dominated the catch at all stations, with wild Chinook the second most abundant salmonid. A significantly greater number of hatchery salmon were captured relative to wild salmon. The least abundant salmonid observed in the local area was wild cutthroat trout. None were captured anywhere in the study area.

3.4.3 OTHER FISH SPECIES

The Willamette River supports a number of non-salmonid fish species. These include native species such as Pacific lamprey, white sturgeon, northern pike minnow, large-scale sucker, and sculpins, as well as introduced species such as crappie, yellow perch, walleye, American shad, and largemouth and smallmouth bass. Many of these introduced species (e.g., crappie, yellow perch, largemouth and smallmouth bass and walleye) were captured in Ross Island Lagoon during the 1999 surveys.

3.5 RARE, THREATENED, OR ENDANGERED SPECIES

Several federally listed, proposed, and candidate species are known or suspected to occur within the RIS&G facility area, including Chinook salmon, steelhead and bull trout, and bald eagle (CH2M Hill 1999b). Resident bald eagles have nested on Ross Island since 1996. Due to successful recovery efforts, USFWS proposed a rule in 1999 that the bald eagle be removed from the federal list of endangered and threatened wildlife in the lower 48 states under the Endangered Species Act.

3.6 GENERAL CHARACTERIZATION OF GROUND AND SURFACE WATER HYDROLOGY

3.6.1 GROUNDWATER

Ross and Hardtack islands are located in the southern portion of the Portland Basin. Groundwater discharge in the Portland Basin is primarily to springs, streams and rivers. The Willamette River acts as a primary regional discharge area.

The predominant groundwater flow at the site is upward from the Troutdale Formation into native alluvium. From there, groundwater continues to flow upward into Ross Island lagoon and the Willamette River.

Within the upland fill at the site, groundwater flow is downward and outward to the lagoon and the river. The dominant flow component in this water-bearing unit is horizontal. During some months of each year, the vertical gradients between the fill and the native alluvium reverse and the flow gradient is upward.

3.6.2 Surface Water

Elevations of the Willamette River and Ross Island Lagoon fluctuate on a daily basis in response to tidal changes, the stage of the Columbia River, and discharges from upstream reservoirs. Willamette River flow data are monitored by the US Geological Service (USGS); the closest observation station to the RIS&G facility is located at RM 12.8 (USGS 2001). For years with complete streamflow data (January 1994 through August 2001), the annual average flow ranges from 28,418 cubic ft per second (cfs) to 57,787 cfs.

Annual peak flows for the period from January 1994 through August 2001 generally occurred from December through February. Unusually high discharge rates were recorded in late 1995/early 1996 and again in late 1996/early 1997. The maximum river gauge height at the USGS station during this period was 26.19 ft (RID) in February 1996. In recent years, river elevations at Ross Island have ranged from 5 to 12 ft (RID) with an average elevation of 3.3 ft (RID).

Mining within the Ross Island lagoon has created a deep basin, with depths to –130 ft RID. The lagoon is hydraulically controlled by a shallow sill at about –20 ft RID at the entrance to Holgate Slough. Holgate Slough depths just outside the lagoon are at about –30 ft RID. The surface of the bottom of the lagoon continues to change each year due to mining and reclamation activities.

Surface water in the Ross Island lagoon demonstrates temperature and dissolved oxygen gradients in the late summer months at approximately 30 to 50 ft (CH2M Hill 1999a). Because of continuous river flow and tidal influence, the lagoon water is likely to be somewhat well mixed during most months of the year. During the warmer summer months, the lagoon sill and the thermal gradients probably prevent the deeper water layer from mixing significantly with surface water and then may "turn over" in the early fall as air temperatures cool.

3.7 MINING FACILITIES

Primary processing of material mined at Ross Island occurs at RIS&G facilities on Hardtack Island. These facilities include an office building, processing plant, two settling ponds for processing water and ancillary access roads and facilities. The facility employs 650 people, and is a major supplier of aggregate in the Portland area.

Aggregate materials removed from the Ross Island lagoon and shoreline are loaded onto barges and taken to the unloading facility and processing plant at the northwest end of Hardtack Island. A clamshell crane is used to remove material from the barges to the processing plant, which consists of six crushers, seven vibrator screens and seven crushed material hoppers. Finished aggregate is washed, and the wash water discharged to the primary settling pond. Accumulated silts and sands from the washing process are removed from the ponds periodically and used for upland reclamation purposes.

3.8 ENVIRONMENTAL HEALTH

Since 1999 RIS&G has been working on a remedial investigation (RI) required under a consent order between RIS&G and DEQ. The purpose of the RI is to evaluate whether RIS&G site operations, or the fill accepted at the facility for reclamation in the past, contain contaminants that pose a threat to human

health or the environment. The environmental media of interest in the RI and related studies include all media that could be affected by releases of potential contaminants from imported fill or through spills, including upland soil and surface water, lagoon sediments and surface water, and groundwater.
Key findings of the RI include the following:

- More than 96 percent of the data points collected from the directly accessible environmental media at the site (surface soil, surface water, and surface sediments) do not contain contamination (defined as levels of contaminants that would pose unacceptable levels of risk to human health or the environment).
- In the few areas in which contamination was found, it generally is not expected to migrate significantly or is readily amenable to removal and/or capping to prevent unacceptable exposures to human health and the environment.
- No unacceptable risks are predicted for threatened or endangered species (e.g., salmon and bald eagle).
- Human health risks predicted for typical site workers and recreational visitors are no greater (and in some cases, less than) those that would be predicted for naturally occurring, or otherwise ambient, levels of chemicals in the Willamette River upstream between Ross Island and Wilsonville.

3.9 LAND USE DESIGNATIONS

The City of Portland's Comprehensive Plan Goals and Policies (City of Portland 1980) and comprehensive plan map show the type, location, and density of land development and redevelopment permitted in the area. With only minor exceptions, land use designations shown on the comprehensive map within the locality of the facility are in agreement with current zoning.

Current zoning corresponds closely to the comprehensive plan. Zoning within the locality of the facility and adjacent areas consists of a combination of open space, residential, commercial, and industrial uses.

3.10 SURROUNDING ENVIRONMENT

Ross Island's natural resource values have long been recognized. Throughout the process of reviewing the 1979 plan and developing a new approach to reclamation, RIS&G was urged to place these values in the broader geographic and planning context of the segment of the Willamette River lying between the Sellwood and Marquam bridges. This segment of the river is characterized by a variety of land uses, including commercial and residential development, surface transportation systems, and older industrial areas planned for redevelopment. At the same time, this area contains significant greenspace and natural area resources, among them the river itself, the Oaks Bottom wildlife refuge, the Willamette Greenway and the Springwater Trail. These natural features, and other "context issues" considered during the course of developing the revised reclamation plan, are described below.

3.10.1 THE WILLAMETTE RIVER

Ross Island's relationship with the Willamette River is complex – the river has been the major force forming and changing the island over time, and will continue to affect the island in the future. The river, too, has changed, from a broad, braided watercourse loaded with sand and gravel brought down from the Cascades to a more narrow, more incised river carrying the finer sediments of erosion from developed urban and agricultural lands.

Not surprisingly, the location of Ross Island in the middle of the Willamette has had a significant impact on the direction of the reclamation plan. There are few (and perhaps no) other locations in Oregon where mined land reclamation is being attempted in a river/island setting. This setting presents a series of unique challenges to the reclamation planning effort. First, the reclamation plan must address river resources, from threatened and endangered fish and wildlife to water quality. Second, the reclamation plan must somehow take into account the dynamics of the river and the potential impacts of those dynamics on the island. What did the island look like before mining, and before flood control and other changes in the river system? Given those changes, how is the river likely to affect the island over time, regardless of reclamation activities? Could an approach to reclamation be developed that accommodates, or even take advantage of, the forces of the river?

In addition to affecting the approach of the reclamation plan, the location of the RIS&G facility in and adjacent to the river means that reclamation must consider navigation and other uniquely river-related issues. Finally, the river's proximity to the island means that thousands of citizens will have the opportunity to view and visit the site as reclamation proceeds. The importance of understanding their interests and issues has been an on-going consideration.

3.10.2 Oaks Bottom

Oaks Bottom is a 160-acre wildlife refuge located in southeast Portland just across Holgate Slough to the east of the Ross Island complex. The refuge is recognized as important urban wildlife habitat characterized by a diverse array of upland and wetland plant communities and wildlife.

Oaks Bottom is owned by the City of Portland and managed for both wildlife habitat and passive recreational values. Over the past few years, the City has examined the potential for developing off-channel salmon habitat at Oaks Bottom. In general, the City's evaluation has concluded that current conditions at Oaks Bottom are less than optimal for salmonids, and that the creation of more favorable conditions would conflict with other long-standing management objectives for the refuge. The evaluation also suggested that the "enhancement and management of the Ross Island Complex as an extension of the Oaks Bottom Refuge" could assist with the objective of providing off-channel salmonid rearing habitat.

3.10.3 Willamette Greenway

The Willamette River Greenway runs along both sides of the river in the vicinity of Ross Island. The Greenway was established in response to legislation originally enacted in 1967 and statewide planning goal 15, the purposes of which are to "protect, conserve, enhance and maintain the natural, scenic, historical, agricultural and economic and recreational qualities" of lands along the Willamette River. Portland's Willamette Greenway Plan was adopted in 1988. Current Greenway regulations require a setback of development at least 25 feet from top of bank on either side of the river.

On the west bank of the Willamette, the Greenway runs through Willamette Park and between the river and a number of commercial properties. On the east side, a segment of the Springwater Trail parallels the railroad right-of-way between the river's edge and McLoughlin Boulevard.

3.10.4 PLANNING AND REGULATORY CONSIDERATIONS

Ross Island's location – and the relevance of its reclamation – have grown in importance in light of recent planning and regulatory efforts affecting the lower Willamette River. A driving force in all these efforts is the federal Endangered Species Act, under which several species of anadromous fish found in the river are protected. The City of Portland is currently in the process of developing a response to the listing of these fish species, which include steelhead trout and Chinook salmon. Any activity that may affect fish habitat – including the immediate and long-range impacts of reclamation efforts – will be subject to increased interest and scrutiny as a result.

Partly in response to the ESA, and partly in recognition of the significance of the Willamette River to the history and future of Portland, the City has also initiated River Renaissance. River Renaissance is a "partnership for the revitalization of the Willamette River" that will "align city efforts, build strong public and private partners, leverage resources for implementation, and involve the public in a long-term strategy for river management".

Other planning projects in the vicinity include the North Macadam project and the planned southward extension of the Eastbank Esplanade.

4.0 RECLAMATION GOALS AND STRATEGIES

4.1 RECLAMATION GOALS

Reclamation goals for Ross Island are as follows:

1. Protect and enhance anadromous fish and wildlife habitat values of the islands;
2. Protect surface water and groundwater resources;
3. Protect the structural integrity of the islands; and
4. Preserve options for future public ownership and benefit.

General strategies for achieving the goals are outlined below. Details regarding implementation are provided in Section 6.0 and technical appendices to the plan.

4.2 STRATEGIES FOR ACHIEVING RECLAMATION GOALS

4.2.1 PROTECT AND ENHANCE ANADROMOUS FISH AND WILDLIFE HABITAT VALUES

- Establish riparian floodplain conditions along portions of the interior lagoon shoreline, as defined by bank slope, vegetation types, and frequency of inundation;
- Establish an emergent wetland to provide diverse habitat for a wide range of fish and wildlife, including juvenile salmonids;
- Provide for diverse aquatic conditions, including a range of lagoon depths;
- Plant and maintain native species of plants in upland areas in order to provide a healthy, diverse vegetation pattern; and
- Provide for continued protection for the heron rookery and bald eagle nests.

Employing these strategies to achieve the goal of protecting and enhancing fish and wildlife habitat values will require that the desired end physical state of the island complex (depth to lagoon bottom, slopes from lagoon shore to lagoon bottom, etc) be revised from the 1979 plan. Continued protection of the heron rookery and bald eagle nests will require that provisions of the original plan be included in the revised plan.

4.2.2 PROTECT SURFACE WATER AND GROUNDWATER RESOURCES

- Minimize soil erosion from reclaimed areas;
- Protect shorelines from bank erosion to the maximum extent practicable;
- Create stable interior berm slopes;
- Prevent scouring of existing fill to avoid exposing contaminated sediments; and
- Use only "Class A" (as that term is defined in the DEQ draft Fill Evaluation Scope of Work dated April 25, 2002) fill for reclamation purposes.

Provisions for accomplishing most of these plan elements are already in place to satisfy requirements of the various regulatory programs under which the Ross Island facility currently operates.

4.2.3 Protect the Structural Integrity of the Islands

- Maintain current elevation of berm connecting Ross and Hardtack islands to prevent scouring of existing fill on the lagoon bottom and protect newly reclaimed areas, including created wetlands.
- Monitor structural integrity during reclamation period (e.g., Stability of in-water slopes and shorelines)

Over time, natural river forces will change the physical characteristics of the islands - including their size and shape – regardless of the approach to reclamation. At the same time, taking steps to protect the structural stability of the islands will help ensure that the primary goal of providing improved fish and wildlife habitat is not jeopardized.

4.2.4 Preserve Options For Future Public Ownership And Benefit

- Enhance the environmental qualities of the islands through habitat preservation and restoration.
- Use Only DEQ-defined Class A fill for reclamation purposes.
- Place fill in locations and in a manner that enhances and reinforces existing capping of contaminated sediments.

5.0 RECLAMATION ALTERNATIVES

Theoretically, there are many possible approaches to reclaiming Ross Island. One approach is represented by the 1979 plan, which envisions a relatively high elevation, steep sloped, forested island surrounding a lagoon with an average depth of –20 ft. Other alternatives could emphasize fish habitat, enhance conditions for terrestrial species, or improve public recreational opportunities. A variety of alternatives could be created by placing various quantities of reclamation fill in different locations.

In reality, however, reclamation options are constrained by several factors, including the end use of the island, reclamation goals, public environmental concerns, the hydrology of the Willamette River, and "practicability" issues – that is, operational considerations, cost and other factors that determine whether reclamation can be implemented as proposed. The impact of each of these constraints on potential reclamation alternatives is described below.

End use of the island – RIRPAC has recommended, and RIS&G concurs, that following reclamation the primary use of Ross Island should be as a natural area focused on providing fish and wildlife habitat. Use as a natural area is consistent with the interests of multiple public agencies, complements management goals of the Oaks Bottom Urban Wildlife Refuge, and preserves options for future ownership and use of Ross Island by the City of Portland. With appropriate management, use as a natural area is also consistent with continued aggregate processing on Hardtack Island, as currently anticipated by RIS&G.

Reclamation goals – Reclamation alternatives must also support the reclamation goals and strategies set forth in Section 4.0.

Public Environmental concerns – Major environmental goals affecting the reclamation plan include providing habitat for threatened anadromous fish species, protecting existing wildlife resources (including bald eagles and great blue heron) and protecting surface and groundwater quality. These concerns influence the type of habitat to be emphasized in the reclamation plan, the type of fill material to be used and the timing and location of filling activities.

The high priority placed by regulatory agencies on the protection and recovery of threatened fish species – and the unique potential of the Ross Island lagoon to serve as needed off-channel habitat for juvenile salmonids – are especially important. To assist in evaluating how reclamation could affect and be affected by fish and wildlife considerations, RIS&G convened two technical workshops in the fall of 2001 focused on aquatic and upland resource issues. Independent experts in the fields of fish and wildlife biology, Willamette Valley vegetation and hydrology participated in the workshops. The consensus of workshop participants was that reclamation of Ross Island could result in significant benefits to fish and wildlife, achieved relatively quickly, if reclamation focused on the development of emergent wetland and riparian floodplain habitat. (A summary of major themes of the two workshops can be found in Appendix B.)

The focus on emergent wetlands narrowed the range of reclamation alternatives in other ways as well. First, it contributed to the decision to use uncontaminated material for reclamation fill in order to avoid exposure of fish and wildlife to contaminated sediments. The wetland focus and the desire to develop this type of habitat quickly also helped determine the most desirable locations for fill placement. Creating emergent wetlands at Ross Island entails establishment of a very shallow-gradient transition from the island perimeter into the lagoon. The quantity of fill required to develop such an area, provide sufficient acreage to ensure wetland function and the desire to create this habitat focused attention on shallower areas of the lagoon.

Hydrology of the Willamette River – A Hydrology study was conducted to better understand the possible effects of the river on various fill placement locations, as well as the potential role of river sediments in filling the Ross Island lagoon over time. A report describing the modeling work is included as Appendix C to this plan. The primary findings of the report are summarized as follows:

- Up to 5 inches of sediment per year will accumulate in most areas of the lagoon. Some areas of the lagoon will receive up to 10 inches of sediment per year.
- Under baseline conditions (no additional placement of fill), little erosion of interior shorelines or scouring of subsurface fill areas is likely to occur, even at higher than average river flows.
- Lowering the dike that bridges Hardtack and Ross islands will not appreciably increase sediment deposition in the lagoon, and may increase the possibility of land erosion on the interior shoreline of Ross Island in the northern lagoon.
- No areas of existing uplands or present in-water fill are in danger of erosion, even under conditions of high water.

These findings dictated that imported fill would be needed to attain reclamation goals and that the fill could be placed primarily to develop desired habitats.

Practicability – The practicability of a reclamation plan – that is, its ability to be fully implemented – is as important as the plan's purported benefits. Reclamation filling is subject to a number of practical operational considerations, include the availability and accessibility of fill material, the number and size of barges available to transport large quantities of fill material, and the timing and mechanics of fill placement. Also, state regulations regarding the seasonal "window" during which fill may be placed (to protect sensitive fish stocks from turbidity) affect the amount of reclamation fill which can be placed in any given year.

The economics of reclamation – the balance of revenues generated and expenses incurred – must also be considered. RIS&G evaluated costs of various fill scenarios as part of the planning process. This evaluation was used, together with operational and regulatory considerations, to estimate the amount of fill that could be placed annually, the total amount of fill that could be imported for reclamation, and the total number of years reclamation.

Taken together, these factors limit the number of practicable alternatives to the 1979 plan and define the basic parameters of a new approach to reclamation. Recommendation of the island's end use as a natural area and identification of emergent wetland habitat as an important component of reclamation determine the quality and potential locations of reclamation fill. Factors relating to the practicability of reclamation served to determine the fill quantity and specific placement locations. The "range of alternatives" is narrowed to two options – the proposed alternative, and the 1979 plan.

The next section describes key features of the 1979 reclamation plan, followed by additional description of the proposed approach.

5.1 THE 1979 PLAN

The 1979 Ross Island Reclamation Plan reflects a philosophy of mined land reclamation in keeping with the regulatory framework and scientific understanding of that time. The 1979 plan contains no stated goals, but the structural integrity of the island appears to have been an important consideration. Major elements of the 1979 plan can be described as follows:

Island perimeter – The 1979 plan calls for RIS&G to expand the perimeter of the leave berm into the lagoon until a top width of 400 ft, more or less, is attained. Drawings related to the re-vegetation element of the plan show flat, wooded areas interspersed with swales and seasonally wet areas in the upland portions of the island.

Elevations – The elevation of the completed berm varies from between +24 to +30 ft. m.s.l. in the 1979 plan.

Vegetation – Under the terms of the 1979 plan, RIS&G is required to re-vegetate the berm in accordance with permits in force at the time. A re-vegetation supplement to the 1979 plan (required under the City of Portland's 1981 conditional use permit) specifies that native plants are to be used in the plantings, including black cottonwood, red willow, big leaf maple, Oregon ash, elderberry, snowberry and others.
A created wetland appears at the north end of the lagoon on re-vegetation maps depicting the final stages of reclamation (2010-2020). However, the planned elevation of that area is too high to allow inundation or even saturation on a regular basis. This design would have resulted in conditions unsuitable for wetland plants.

Additionally, invasive species such as reed canarygrass, blackberries, and Scot's broom were also specified in the 1979 plan. These species are now on the City of Portland's Plant List as prohibited species.

Lagoon – The 1979 plan calls for the Ross Island lagoon to be filled to an average depth of –20 ft m.s.l. and its shoreline contoured to a slope not steeper than 3:1. With this approach, water temperatures in the lagoon would become elevated above river temperatures and would have a detrimental effect on salmonids. Many non-native predators (largemouth bass, yellow perch, bluegill, crappie) of the lower Willamette River also prefer warmer backwaters, such as the lagoon. The lagoon would be less than ideal salmonid habitat due to temperature and predator concerns.

Source of fill – The plan calls for RIS&G to use waste sand from its processing plant operations, suitable dredge spoils, and/or other similar materials approved by the DSL as reclamation fill material.

Great blue heron rookery – Under the provisions of the 1979 plan, the company may not to excavate any uplands or operate in the lagoon within 300 feet of the great blue heron rookery between February 1 and July 1 of each year.

Implementation of the 1979 plan would have resulted in 135 acres of upland forest and a 138-acre lagoon. Based on a more thorough analysis of daily and seasonal river level fluctuations, the referenced swales and wetlands would not have been successfully established. The plan would provide only limited benefits to fish and wildlife – primarily by protecting the bald eagle nesting area and heron rookery. The transition zone from upland to aquatic areas is too steep and narrow, and the in-water fill area offers little of the near shore complexity and diversity favored by juvenile salmonids. The finished upland elevations are significantly higher than they would have been under historic conditions and provide little topographic or habitat diversity. At such elevations the long-term viability of black cottonwood habitat is questionable.
Finally, and most significantly, the 1979 plan simply is not "practicable" due to the large volume of fill required compared with the amount of suitable fill currently available (Class A fill). Even if practicable from a cost and availability standpoint, given the regulatory and operational constraints discussed previously the volume of fill required could not have been placed within the timeframe set forth in the 1979 plan.

5.2 PROPOSED ALTERNATIVE APPROACH TO RECLAMATION

The approach to reclamation proposed in this plan reflects the past history and current conditions of the islands as well as current scientific understanding regarding reclamation and habitat restoration. The proposed plan envisions a less static, less engineered island complex than implied by the 1979 plan. This approach to reclamation requires tools and actions that "set the stage" for more interaction between the river and island. Key components include:

- Grading to create more diversity in upland elevations and make the current shoreline more irregular;
- Providing for a gradual, shallow transition from upland to water to support emergent vegetation species;
- Creating a mosaic of habitats including forest, emergent wetland, riparian, and shallow water; and
- Allowing natural deposition of sediments over time in the lagoon, potentially assisted in the future by lowering the berm between Ross and Hardtack islands to allow entry of flow from the main channel of the Willamette.

As noted, the factors discussed in Section 5.0 determined the specific location and extent of reclamation under the proposed approach. Further details are provided in Appendix A, which describes the emergent wetland and re-vegetation components of reclamation plan. To summarize, the proposed approach results in 118 acres of upland forest and 22 acres of riparian/emergent wetlands. The lagoon size is 131 acres with a variety of depths down to + 36 to –130. The lagoon will include 14 acres of shallow water habitat (less than –20 feet) that is also created.

5.3 COMPARISON OF PROPOSED APPROACH WITH 1979 PLAN

The primary differences between the 1979 plan and the proposed approach are as follows:

Upland – Under the current plan, RIS&G is required to expand the upland perimeter to a width of 400 feet to ensure the structural stability of the island(s). Finished elevations are at 24-34 feet m.s.l. Under the proposed alternative, the width of upland will be determined by what is needed to ensure island stability while meeting habitat diversity goals. Finished elevations of previously reclaimed areas will remain at heights established under the current plan. However, newly reclaimed wetlands will be graded from a finished elevation of 10.5 feet m.s.l. to an elevation of –0.5 feet m.s.l. This area will be contoured to form a gentle slope ranging from 5% flood elevation to the 95% flood exceedance elevation mimicking tidal wetlands along the lower Willamette and Columbia rivers.

Lagoon – Under the current plan, the lagoon is to be filled to an average depth of –20 ft. m.s.l. Under the proposed alternative, the lagoon depth would vary. Some areas would be much shallower to allow for the creation of emergent wetland conditions and shallow water habitat; others would be deeper. Some very deep holes (- 100 feet and deeper) would remain.

Emergent Wetland/Riparian Area – A key difference between the 1979 plan and the proposed approach is the description of the transition zone between the upland portion of Ross Island and the lagoon. Under the current plan, in some areas this zone is described as a "swale or seasonally wet area", to be reclaimed to a slope of 3:1 (shallower in some areas) and planted with a variety of grasses and other forbs. Only in the final stages of reclamation (2010-2020) is a shallower "wetland" area proposed for part of the lagoon. As previously discussed, the planned elevations in the 1979 plan would not have supported wetland hydrology or vegetation.

Under the proposed approach to reclamation, the transition from the upland to the lagoon in the areas subject to reclamation will be more gradual. An attempt will be made to create an emergent wetland and riparian floodplain conditions similar to those found at several reference sites representing habitat types that were once widespread in the metropolitan area but that have been lost to urban development over time. These reference sites are described in Appendix A.

The proposed alternative provides for a greater diversity of habitat types than the 1979 plan. The mosaic of habitats in the proposed alternative includes forested habitat at the north and south ends of the lagoon, creation of emergent wetland and riparian habitat at the south end of the lagoon, and creation of shallow water habitat at the north and south ends of the lagoon. Figure 1 shows the location and extent of the various habitat types.

The following tables compare the lagoon depths and number of acres of each habitat type to the 1979 island, the 1979 plan, and the proposed alternative.

Table 5-1 Lagoon Depth Comparison for Three Scenarios

Lagoon Depths	**1979 Island (acres)**	**1979 Plan (acres)** **Implementation Target Date: 2026**	**2002 Plan (acres)** **Implementation Target Date: 2013**
Shallow (<20 feet)	Unknown	20	14
Medium	Based on historical recollections of facility personnel the average depth of the lagoon was around –60 feet	118	81
Deep Water (>100 feet)	Unknown	20	36
Lagoon size	132	138*	131**

*The 1979 Plan envisioned a lagoon with an average depth of –20 ft.
**The 2002 Plan envisions a lagoon with a variety of depths. 131 acres does not include riparian/emergent wetlands.

Table 5-2 Acreage Comparison for Three Scenarios

Habitat Type	1979 Island (acres)	1979 Plan (acres) Implementation Target Date: 2026	2002 Plan (acres) Implementation Target Date: 2013
Upland Forest	125	135	118
Riparian/Emergent Wetlands	0	Almost none	22
Acres	125	135	140

Implementation Timeframe – Under the 1979 plan, reclamation would not be fully implemented until 2025. Under the proposed approach, full implementation will occur within ten years.

Other Differences Between the 1979 Plan and the Proposed Approach – In addition to the above, the proposed approach contains improved monitoring and evaluation provisions and more detailed descriptions of the methodology for creating desired habitat outcomes than the 1979 plan. The 1979 Plan contained no monitoring requirements.

5.4 BENEFITS OF PROPOSED APPROACH

The proposed approach has the following benefits in comparison with the 1979 reclamation plan:

- The proposed approach is more in keeping with current scientific thinking about river and watershed restoration. After decades of employing more structured and engineered solutions to flood control and riverine habitat restoration, scientists now advocate a more "natural" approach in which only the most needed structural components of the system (i.e., isolation from the river scour and sedimentation, suitable elevation gradients, and a substrate with appropriate permeability) are provided in an effort to "jump start" natural processes. While results of the hydrology study indicate that the components of reclamation provided by natural processes may take many years to accrue, incorporating those processes in the reclamation plan will allow more resources to be focused on productive wetland and riparian habitats.
- The proposed approach to reclamation will produce beneficial habitat results far sooner that the 1979 plan would have. Substantial wetland and floodplain habitat will be developed in the ten years following approval of this plan.
- The habitat being proposed in the alternative is a type once abundant but now scarce in the metropolitan area. It will supply off-channel rearing habitat for juvenile salmonids migrating downstream and improved conditions for numerous other fish and wildlife species.
- The proposed approach will create shallow water immediately adjacent to the proposed emergent wetland/riparian area (southern end of lagoon) This area will be particularly valuable to salmonids due to increased invertebrate production and refuge that emergent and riparian plants will afford. At the northern end of the lagoon shallow water habitat will also be created that includes large woody material along a 140-wide foot undulating bench. The woody material will provide structural complexity and refuge that is not currently present in the lagoon.

- The proposed approach responds to local and regional concerns regarding the needs of listed fish. Under the 1979 plan, the lagoon would have been filled to an average depth of –20 feet m.s.l. While it is difficult to predict the impact on fish and wildlife of the lagoon as envisioned in the 1979 plan, agency and other experts consulted during the development of this plan agreed that the proposed emphasis on shallower, more complex nearshore areas would lead to better habitat results.

- Establishing a mosaic of habitats and conditions within the island complex will improve the diversity of plant and animal species. A greater diversity of habitats - will also significantly benefit fish and wildlife.

- The approach creates significant opportunities for long-term education and research. Middle schools, high schools and others in the community could become involved in monitoring and documenting changes at the island. These important lessons could be applied elsewhere to benefit agencies, landowners and the general public.

- The proposed approach to reclamation will not adversely affect river navigation. In response to feedback received at the technical workshops, RIS&G considered adjusting the level of the berm between Ross and Hardtack islands as a means of recruiting additional river-borne sediments for deposit on the floor of the lagoon. Results of the hydrology study indicated that little would be gained by lowering the berm. Under the proposed approach, therefore, the height of the berm will not be changed.

6.0 IMPLEMENTATION

6.1 INTRODUCTION

This section describes specific actions planned to achieve the goals of reclamation outlined in Section 4.0 and implement the proposed approach to reclamation discussed in Section 5.0. Planned components of the reclamation process include:

- a description of the quantity and likely sources of reclamation fill materials;
- locations for fill placement and placement methods;
- schedule and sequencing of fill placement;
- engineering and landscaping specifications in fill placement relative to habitat restoration and enhancement;
- fill improvement for planting;
- types of plant species that will be introduced and proposed schedules;
- controls that will be implemented during reclamation to mitigate potential impacts on groundwater, surface water, and fish and wildlife resources; and
- other activities, such as development of short-term staging areas for fill stockpiling and removal of these areas post-reclamation, removal of equipment, and removal of access roads.

These planned components of reclamation are described in detail in Sections 6.2 – 6.6.

6.2 FILL

6.2.1 FILL QUANTITY AND SOURCES

As noted previously, RIS&G conducted an analysis of potential fill sources, fill amounts and fill quality in conjunction with this plan. The company's analysis indicated that the amount of fill that can be placed in a given year is constrained by regulatory requirements and operational considerations. The regulatory constraints include "in-water work windows" to protect fish and wildlife resources and increasing scrutiny of contaminants contained in dredged material. Operational constraints include the physical limitations of the quantity of fill that can be dredged, transported, and placed in a year due to equipment and personnel resources.

Dredging in the Columbia River is restricted to four months of the year (November 1 to February 28). On a yearly basis, half of the material (200,000 yd^3) that is dredged and to be used in reclamation activities must be obtained in these 4 months. Dredging on the Willamette River is restricted to six months of the year (July 1 to October 31 and December 1 to January 31) and will provide 50,00 yd^3 per year. These materials can be placed in the lagoon year round below –40 feet but can only be placed above –40 feet during the "in-water work window" of February 15 and June 30 and November 1 to November 30 (as stipulated by permit).

The concept that only a portion of dredged material and upland excavation material generated in the metropolitan region is acceptable for use as fill by RIS&G has reduced the amount of material available for reclamation activities.

Based on these constraints, this plan proposes to place approximately 4,500,000 yd^3 of reclamation fill at Ross Island in order to achieve identified goals within the established ten-year time frame. Reclamation fill for the island complex has historically come from three major sources:

- Dredge material from the Columbia and Willamette rivers, typically used as in-water fill.
- Soil from excavations in the greater metropolitan Portland area, typically used as upland fill.
- By-product material from aggregate production (non-commercial grade sand dredged from the facility settling pond), used in the past for in-water fill capping and beach construction.

The same major sources of material will be used for reclamation fill during the period covered by the plan. These sources and the "natural fill" from the Willamette River comprise the 450,000 yd^3 of fill to be placed yearly over the 10-year reclamation period.

The purposes of continued reclamation filling at the island complex are to further stabilize the slopes within the lagoon, enhance existing fish and wildlife habitat, and create new habitat. Results of the hydrology study described in Section 5.0 were used to determine which areas of the lagoon required filling to ensure long-term slope stability. Technical workshop results, current understanding up of upland topography and in-water bathymetry and operational constraints were used to identify the locations and dimensions of the floodplain/wetland/riparian and upland areas proposed to be constructed in the lagoon.

Specific types of fill, identified locations for placement and a proposed placement schedule are discussed in the following sections. The necessary physical characteristics of the fill required to achieve the placement goals are identified by reclamation area.

Consistent with the adaptive management approach, placement of fill has been specifically scoped for a period of ten years after plan acceptance. Review of fill placement and factors that impact fill placement (such as availability of reclamation fill, contribution of natural sedimentation to the reclamation process, and the results of monitoring in place fill) will be reviewed near the end of the five year period. Findings that enhance or adversely impact the achievement of the reclamation goals will be evaluated. This evaluation will inform potential changes in fill placement at the island complex in subsequent years.

6.2.2 LOCATIONS AND METHODS OF FILL PLACEMENT

To meet the goals of reclamation and address other environmental issues, fill will be placed in-water in the lagoon to meet four objectives:

- Ensure slope stability to preserve the integrity of the island uplands;
- Enhance the stability of existing fill;
- Mitigate isolated surface sediment contaminant issues; and
- Create riparian floodplain and emergent wetland conditions along portions of the interior lagoon shoreline.

Based on the four described objectives, three areas of proposed fill have been identified and are shown as Area A, Area B, and Area C/D on Figure 6-1. Figure 6-1 also illustrates where cross sectional diagrams have been developed to show both the current conditions and projected post-fill conditions in these areas. The total volume of fill needed to meet the objectives in these areas is 4.0 to 4.6 million yd^3. In addition, a slope stability analysis has been conducted to evaluate whether proposed fill regimes will meet acceptable stability criteria using the type of material assumed to constitute future reclamation fill in these areas. Results of these analyses are provided in Appendix D.

In Area A, the existing post-mining slope averages 1.75H:1V (1.75 ft. horizontal to 1.0 ft. vertical). No reclamation activities have been conducted in this area to date. The purpose of placing fill in this area is to widen the existing upland area of Ross Island and create approximately 4.67 acres of upland and 6 acres of shallow water habitat. The newly created upland and bank will be planted with native tree and shrub species (see Appendix A table 2 for zone 1). A cross section of Area A showing current conditions and the reclamation goal is shown on Figure 6-2. The location of this cross section is shown on Figure 6-1. The fill volume required to meet this desired end state in Area A is estimated to be 2.0 to 2.3 million yd^3 including allowance for the method of deposition. The material that will be used as fill in Area A to achieve a 3:1 slope is assumed to be gravelly sand or fine to medium sand with silt.

Based on the results of a study conducted by the Port of Portland relative to their confined cells and verified through independent review, Area B (see Figure 6-1) was identified as a target area for fill placement to further buttress the area where the Port's confined disposal cells are located. The existing slope in this area varies from approximately 1.75 to 1 to 2 to 1. To achieve long-term stability of this fill area, additional fill will be placed in Area B to achieve an approximate 3 to 1 slope. Cross sections of Area B showing current conditions and the reclamation goal are shown on Figures 6-3, 6-4, and 6-5. The locations of these cross sections are shown on Figure 6-1. The fill volume required to achieve this desired end state in Area B is 500,000 to 600,000 yd^3. The material that will be used as fill in Area B to achieve the 3:1 slope is assumed to be gravelly sand or fine to medium sand with silt.

A stability analysis was conducted on the existing slopes between Areas A and C/D. A stability analysis was conducted on section E-E' located as shown on Figure 6-1. The cross-section of E-E' is shown on Figure 6-6. The safety factor of the assumed slope failure is 1.7.

Some limited areas of surface sediment contamination were identified during the course of the facility-wide Remedial Investigation (RI) Area C/D. If remedial action is determined to be necessary to address this sediment contamination, this action will be identified in the Feasibility Study (FS) to be conducted following completion of the RI.

Two types of remedy are most likely to be recommended: focused excavation of the contaminated sediment, or covering the sediment in place with clean fill. Based on contaminant fate and transport modeling in other parts of the lagoon, it is likely that capping will be considered the more acceptable remedy. Area C/D (see Figure 6-1) has been identified as the area where such capping is likely to occur. The capping will serve as a remedy from contaminated sediment and to build emergent wetland/riparian habitat.

Area C/D also has been identified as appropriate for development of riparian floodplain and emergent wetland habitat conditions. Current conditions in these areas with respect to depth and shore-to-bottom slope make them most amenable to rapid filling and completion of a marsh/wetland with a bordering riparian buffer area. These actions are consistent with remedial actions that may be required to address isolated areas of surface sediment contamination. Should results of the FS indicate otherwise, the fill regime may need to be modified.

To allow periodic inundation as required by emergent wetland plants, Area C/D will be filled to slopes ranging from 50:1 (2%) to 33:1(3 %). Beyond the wetland area, fill will be placed at angles ranging from 3:1 to 6:1, depending on the area. Approximately 1.5 to 1.7 million cy of fill will be required to fill Area C/D to the configuration shown in the figure cross sections. Cross sections of Area C/D and their respective reclamation goals are shown on Figures 6-2, 6-3, and 6-4. The locations of these cross sections are shown on Figure 6-1. Additional detail regarding creation of the wetland area is provided in Section 6.3.4 of this plan and the accompanying report by Pacific Habitat Services (Appendix A).

Fill placement is targeted for the northern and southern ends of the island. In the northern area, (Area A), fill will be placed to create approximately 4.7 acres of uplands, approximately 6 acres of shallow water habitat, and as buttressing slope to support the uplands and shallow water habitat. At the southern end (Area C/D), fill will be placed to create approximately 3.5 acres of shallow water habitat and approximately 22 acres of emergent wetland/riparian habitat. Fill will also be placed to create a buttressing slope for the created habitat in Area C/D and to support the existing cells in Area B.

The following table summarizes the amount of fill in each area.

Table 6-1 Fill Amounts For Each Area

Area	Amount of Fill (million yd^3)
Area A	2.0 to 2.3
Area B	0.5 to 0.6
Area C/D	1.5 to 1.7
Total	4.0 to 4.6

6.2.3 POTENTIAL SOURCES OF FILL

The revised reclamation plan depends on three broad categories of fill for reclamation: imported fill similar to that used in current reclamation efforts (dredge material from the Columbia and Willamette Rivers and soil from excavations in the greater metropolitan Portland area), and aggregate processing by-product material. Additional fill is sediment recruited from natural deposition by the Willamette River in Ross Island lagoon. The hydrology study conducted in conjunction with this plan showed that 5 to 10 inches of river sediment will be deposited annually in the lagoon. As a result, imported fill material will be required to buttress slopes and create additional uplands, cover isolated areas of contamination, and get a "head start" on building emergent wetland habitat will need to be imported. The following table summarizes potential sources, volumes and possible criteria for incoming imported fill.

Table 6-2 Potential Fill Sources for the Ten Years of Reclamation

Fill Source	Approximate Volume (yd^3)	Composition
Combined sewer overflow excavation	1,000,000	Soil
RIS&G aggregate processing by-product	500,000	Sand, soil
Columbia River dredge material	2,000,000	Sand, silt
Willamette River dredge material	500,000	Sand, silt
Natural fill	500,000	Sand, silt

6.2.4 SEQUENCE AND SCHEDULE OF FILL PLACEMENT

In general, the priority for fill placement will be in three areas: Area B, to buttress existing fill, Area C/D to create conditions for development of uplands, riparian floodplain and emergent wetland habitat, and Area A. The volume of reclamation fill that can be placed in these areas on an annual basis is constrained by several factors. First, the fill must be available for use within a fairly limited geographic area and represent a cost-effective acquisition to the company. The fill must be of appropriate quality (see Section 7.1.1 for further discussion on fill quality).

In addition, certain logistical issues must be addressed as fill is brought to the facility. The island complex has little space to stockpile incoming fill until it can be placed. An average flat top barge is approximately 1,500 to 2,000 ton capacity (1150 to 1500 yd^3, assuming that each yd^3 equals approximately 1.3 ton), and a dump barge is typically 3,000 ton capacity (2300 yd^3). If barge capacity averages 1,500 yd^3, approximately, a goal of 750,000 yd^3 per year means over 500 barge trips into the lagoon per year. If a work period for placement of in-water fill of 180 days per year is assumed, three barge loads per day would be required to meet this goal.

Larger barges (up to 10,000 yd^3) may be available for some projects, including dredging projects in the Columbia River. RIS&G's ability to meet this fill goal will be dependent on its ability to receive and unload this fill volume during its limited work window period for in-water filling.

6.2.5 HABITAT CREATION

6.2.5.1 Area A

Habitat development in Area A will include upland and shallow water habitat. The upland habitat will include planting of trees to create additional forested habitat. The northern end of the lagoon will be continuously graded from an elevation of 20 feet RID to an elevation –10 RID. This will allow for a linear slope varying from 4:1 to 7:1 in steepness. The area above 12 RID along the northern end of the lagoon will be planted with trees and shrubs such as black cottonwoods *(Populus balsamifera trichocarpa*), red elderberry (*Sambucus racemosa*) and scouler's willow (*Salix scouleriana*). Areas below elevation 12 feet RID will be planted with the same shrubs listed under Zones 2 and 3 (see Appendix A).

An area of shallow water habitat will also be created within Area A. The habitat will extend from an elevation of approximately +1 foot RID, which may support a fringe of emergent vegetation, to an undulating bench, which will be created with a maximum width of 140 feet at an elevation of approximately –10 feet RID. Numerous pieces of large wood material (whole trees with root wads and branches still intact) will be anchored on the bench to provide structural complexity that is currently lacking in the lagoon. The bench will provide a substrate for benthic macroinvertebrates, which will in turn provide food for juvenile salmonids. This bench will be supported by the buttressing slope, which will be created at an approximately 3:1 grade.

For further discussion of upland habitat and shallow water habitat see Appendix A.

6.2.5.2 Area C/D

Habitat development in area C/D will include emergent wetland/riparian habitat, new upland forest and the planting of already reclaimed lands. A very shallow slope (between 33:1 and 50:1 will be created in the southern end of the lagoon. This slope will be planted in zones corresponding to inundation regimes suitable for selected vegetation. These idealized zones are depicted on Figure 9 in Appendix A. The lowest elevation of the wetland (Zone 4) will be inundated for much of the year and emerge from the water for the first time after the summer solstice. The highest zone (Zone 1) will occasionally be inundated during flood events, but will likely be dry throughout the year. The idealized location and species proposed for each zone are in Table 2 of Appendix A.

The existing upland plantings will be monitored for 5 years to assure the continued survival of these plants. If the plant counts fall below the 75% survival level 3 years after installation, other trees and shrubs will be installed to bring the number to the requisite 75%.

Weekly spray irrigation will be provided for woody plants above an elevation of 8 feet RID. The irrigation system will deliver the equivalent of 1.5 inches of rainfall once a week between June 20 and September 20. For the second growing season, the irrigation system will be operated every two weeks through the same period. Irrigation beyond the second season should not be needed unless new plants have been installed.

6.2.5.3 Heron Rookery

The continued viability of the heron rookery will be ensured through the reclamation period. As specified in the facility permit, no filling shall occur within 650 feet of the surveyed boundary of the heron rookery between February 1 and July 15 with separate written permission from DSL.

6.2.6 SEISMIC CONSIDERATIONS

Seismic issues related were first raised during the Port of Portland's evaluation of its confined disposal cells in Ross Island lagoon, and examined more fully as part of the Remedial Investigation (RI) for the facility. As part of the RI, the DEQ requested input from technical staff at both DOGAMI and Oregon State University. As reflected in a letter to RIS&G dated December 19, 2001, DEQ and DOGAMI concluded the following:

- The current slopes north of the Port's confined cells in Ross Island lagoon represent a potential risk of failure as a result of shaking induced by a magnitude 6.0 seismic event. Placement of fill in the deep area of the lagoon adjacent to this area is occurring.
- The risk associated with a surface rupture at the facility has an estimated recurrence interval of 2,500 years or more. The rupture of the relevant strand of the Portland Hills Fault has a 5,000 to 10,000 year recurrence interval, according to DOGAMI. DEQ has determined that events with a recurrence interval of 2,500 years or more are outside the boundary of what reasonably needs to be considered in assessing risks relative to surface rupture. As such, the risk is considered very low and below levels warranting further evaluation.
- Long-term management controls to ensure that the existing caps over the confined disposal cells and lateral barriers to contaminant migration are maintained will be required.

The requirement that fill be placed to buttress the area containing the Port's confined cells is addressed as part of the reclamation plan. Long-term management controls have been identified and are described in the monitoring section of this reclamation plan.

6.3 VEGETATION

Four areas of reclamation will require re-vegetation:

- Upland areas currently reclaimed but not vegetated at elevations higher than the riparian zone;
- Uplands to be created under this plan;
- The riparian zone; and
- The scrub-shrub/emergent wetland area.

These areas will be planted as reclamation proceeds. In the case of currently reclaimed upland areas and the riparian zone area RIS&G will plant vegetation in "annual planting parcels" (but no less than 5 acres minimum) as such parcels become available through reclamation. Plant types that will be introduced into the existing uplands and riparian buffer zone are listed in Appendix A. The upland plantings will be installed in the early spring and the riparian zone and wetland plantings will be installed occur in the summer/fall during low water periods.

6.4 PROTECTION OF SURFACE WATER AND GROUNDWATER RESOURCES

Protection of surface and groundwater resources is an important goal of the reclamation process. This goal will be accomplished through several means: continued implementation of monitoring, protection and response programs already in place; use of future reclamation fill that has been appropriately screened and meets acceptance criteria as "Class A Fill", and proposed additional of the RI/FS process. Surface groundwater monitoring, protection and response programs already in place are discussed in this section. The other program elements are discussed in Section 7.0 of this plan.

RIS&G currently maintains two operation programs to protect surface water quality:

- The RIS&G Turbidity Monitoring and Management Program; and
- The RIS&G Sediment and Erosion Control Plan.

Both programs are part of existing DSL dredge and fill permits. Documents describing both programs are available on request. The Turbidity Monitoring and Management Program was developed as a condition for receipt of a Section 401 Water Quality Certification for operation of the facility. It establishes turbidity threshold levels, methods to be used to monitor turbidity, best management practices to be implemented by RIS&G to control turbidity, and additional measures that must be taken in the event that a threshold level is exceeded. The Sediment and Erosion Control Plan was established as a special condition of the DSL permit. It identifies areas of the island complex where specific erosion control measures will be implemented. No additions or revisions to these existing programs are proposed in the revised reclamation plan.

RIS&G currently conducts regular groundwater monitoring at the island complex under two programs. The first program is groundwater monitoring required as a condition for the facility's Water Pollution Control Facilities (WPCF) Permit. This permit allows RIS&G to use water from its settling pond to irrigate newly reclaimed areas. The monitoring wells included in this program are shown on Figure F-1. Monitoring parameters are summarized in Table F-1. A copy of the WPCF permit and the groundwater monitoring program are available on request. RIS&G has completed regular reports to document these monitoring activities, which are on file with the DEQ Water Quality Division. RIS&G will continue to [illegible]t monitoring as required by the WPCF permit under this reclamation plan.

[illegible]dwater monitoring at the facility as part of the ongoing [illegible] frequency and parameters are [illegible]f these wells

6.5 PROTECTION OF FISH AND WILDLIFE RESOURCES

Although mining in the lagoon has ceased prior to the expiration of the current DSL permit, aggregate processing will continue on Hardtack Island indefinitely using raw material barged from an upland aggregate mine in Avery, Washington. Reclamation filling will continue for a minimum period of ten years. Fish and wildlife resources will require protection from the potential impacts of such ongoing aggregate processing and reclamation activities as well as from increasing recreational use of the island complex.

To meet this objective, buffers established in the current DSL permit limiting activity in the lagoon near the former blue heron rookery and bald eagle nest will remain in effect. Specifically, from February 1 to July 15 there will be no disturbance, including filling or barge mooring, within 300 feet of the former and current eagle nest as surveyed. No filling or barge mooring will occur within 650 feet of the surveyed boundary of the heron rookery between February 1 and July 15 without separate written authorization from DSL. Similar buffers will be set to protect new bald eagle nests or heron rookeries established and inhabited during the period of this permit. Reclamation activities will adhere to these buffers to maintain the area's suitability as a heron rookery.

The buffers around the heron rookery and eagle nest are already permanently marked with upland monuments. Between February 1 and July 15, they will be marked with temporary buoys place in the lagoon to mark where barges may not be moored.

In addition to continued adherence to these buffer zones, in-water filling will be restricted to water depths greater than 40 ft. between February 15 and June 30 and between November 1 and November 30 to ensure that impacts from introduced turbidity on migrating salmonid are minimized. In addition to these fill timing restrictions, RIS&G will continue to adhere to its existing turbidity monitoring program, described in Section 6.4, to control impacts of turbidity on aquatic life.

Reclamation fill brought to the facility will be screened according to the draft Fill Evaluation Scope of Work for RIS&G developed by DEQ (dated 4/25/02 and subject to modification based on discussions with DEQ; this draft document is included as Appendix E) to ensure that it has been adequately tested for presence of contamination, meets the definition of Class A Fill and does not present a threat to human or ecological receptors. Ongoing monitoring will be conducted to ensure that fill already in place does not pose a potential threat to terrestrial or aquatic organisms. This monitoring is described in Appendix F of this plan.

A program for controlling invasive and/or exotic plants in the upland, riparian buffer zone, and emergent wetland areas that currently exist or will be constructed as part of future reclamation is discussed in Section 8.3.3 of this plan. This program will control and mitigate adverse impacts to fish and wildlife resources from loss of habitat to these invasive/exotic plants.

The RIRPAC has recommended that the island complex be reclaimed as a "natural" area, with emphasis on creation of terrestrial and aquatic organism habitat. In order to achieve this goal, areas of the island complex will require protection and restriction from public access both during reclamation and post-reclamation. Public use of areas undergoing reclamation will be restricted as discussed in Section 7.4 of this reclamation plan. No plan for restricting use of the public to areas of the island complex post-reclamation has yet been developed. Since ownership of Ross Island is likely to be transferred to the City of Portland, RIS&G will not develop a formal program for limiting impact on fish and wildlife resources by the public.

6.6 OTHER

6.6.1 PROCEDURES AND TIMELINES FOR EQUIPMENT, REFUSE, STRUCTURE, FOUNDATION REMOVAL

At the present time, an equipment storage yard on Hardtack Island is the only company-managed facility in the area proposed for transfer to the City of Portland. All equipment and refuse will be removed from this area and transferred to the active processing area within six months of a transfer to the City. The active processing area of Hardtack island, including the RIS&G processing plant and associated structures and storage areas, will continue in its current configuration for the entire remaining term of the existing DSL permit (i.e., for the next 25 years). Imported raw materials will be barged to the facility from sources up the Columbia River and processed into finished product at this facility for the foreseeable future. Therefore, no plan for dismantling the active processing area is presented at this time.

6.6.2 LOCATION OF SOIL STORAGE AND STOCKPILE AREAS

Imported reclamation fill may need to be stored on a temporary basis prior to placement. There is limited area on the island complex for stockpiling and storing large quantities of material that has not already been re-vegetated. Therefore, temporary storage of reclamation fill may occasionally occur in upland areas adjacent to the area where it will be placed. Storage will be short term, with the length of storage time keyed to the permitted in-water work period in that area. Stockpiles will be located in a manner such that surface water runoff from stockpiles will not be allowed to flow into the lagoon or Willamette River. Some reclamation fill material may be stored on moored barges for short periods of time (less than 30 days).

6.6.3 ACCESS ROADS

Only one road currently exists in that portion of the island complex proposed to transfer to the City. This is a temporary access road necessary for ongoing reclamation activities. Additional temporary roads may need to be constructed to support these activities. They will be constructed in a manner to prevent erosion or runoff into surrounding surface water. They will be abandoned, re-graded as appropriate, and re-vegetated according to this plan within 1 year of the time that they are no longer needed to support reclamation activities.

The active processing area of Hardtack Island, including the access roads, will continue to operate in its current configuration for the entire remaining term of the existing DSL permit (i.e., for the next 25 years). Therefore, no plan for dismantling the active processing area is presented at this time.

7.0 RECLAMATION FILLING/MONITORING AND MAINTENANCE

7.1 MONITORING PARAMETERS

The overall goal of the monitoring procedures described in this section is to track the progress of reclamation activities toward achieving the reclamation goals described in Section 4.0 and to ensure that the current quality of the environment is not impacted by future reclamation fill or other activities. Monitoring is essential to the effectiveness of adaptive management, which requires that the planned aspects of the reclamation program and changes in the island complex due to natural processes be regularly reviewed and, if necessary, changed to ensure that the overall goals of the reclamation plan are met.

In addition, monitoring provides a basis for establishing that no degradation is occurring in previously mined areas beyond the baseline conditions resulting from the RI/FS process and related action (if any). Specific monitoring parameters, objectives, and methods, and schedules (frequency) are presented in Appendix F for historic filling activities and proposed monitoring under the RI/FS process. Detailed sampling and analysis procedures, monitoring data evaluation techniques, and specific evaluation criteria related to the RI/FS process will be developed in subsequent monitoring plan documents.

In order to organize reclamation monitoring data in a manner that can be easily accessed and compared from year to year, RIS&G will have the facility 2002 bathymetric and topographic information loaded into a GIS database. This will serve as the base map against which future reclamation progress will be compared. As monitoring data is obtained, it will be loaded into the database as separate data layers, allowing monitoring parameters to be compared from year to year.

7.1.1 FILL SOURCES AND QUALITY

The requirements for monitoring of reclamation fill quality will be based largely on the originating source of the fill and the planned area of placement at the island complex. The areas identified for reclamation filling over the next ten years will include areas below the mean high water mark. The riparian buffer area lies in close proximity to mean high water. As a result, this fill will be required to meet contamination limits established based on continual contact with surface water.

At this time, DEQ is reviewing all reclamation fill that will be in contact with surface water on a case-by-case basis to determine if sufficient testing has been conducted. If DEQ determines that the fill has not been adequately characterized, additional testing is recommended. After required testing has been conducted, both DEQ and RIS&G review the data to determine if the fill can be imported to the island complex for use in reclamation. If the fill is accepted at the facility, a file on the fill source and associated data is established by RIS&G. Additional information is collected during fill placement, as discussed in the following sections, to document the location of the fill.

RIS&G intends to use DEQ's proposed draft Fill Evaluation Scope of Work (dated 4/25/02 and subject to modification based on discussions with DEQ) for future fill screening. RIS&G will continue to maintain records of each fill source and associated data, and track fill placement as discussed in the following sections. For reclamation activities, RIS&G will only use material meeting the definition of Class "A" fill. Therefore no specific media monitoring (sediment, surface water, or groundwater) related to placement of Class A fill is proposed.

7.1.2 UPLAND/IN-WATER FILL PLACEMENT AND SEDIMENT MONITORING

7.1.2.1 Upland Reclamation Filling

Placement of upland fill will be documented according to location placed using the technique that is currently in use, which consists of a survey of topographic conditions after each upland fill event occurs. Survey information will be compiled annually and imported into the GIS database for the purpose of developing a current map of the island that depicts the current status of upland reclamation. The results of the mapping exercise will be evaluated and compared to the upland reclamation goals.

Ongoing groundwater monitoring will be conducted to ensure that fill materials already in place do not present a threat to groundwater and surface water in the future, and to allow an extra measure of protection beyond incoming fill screening for future upland fill.

7.1.2.2 Sediment Filling and Accumulation

Monitoring for sediment accumulation and in-water reclamation filling will consist of bathymetric surveys of bottom (mudline) elevation conditions in Ross Island Lagoon. The objectives of this monitoring are to:

- Document changes in lagoon bottom conditions during reclamation activities and provide a means for evaluating whether reclamation elevation goals are being met;
- Provide a method for confirming the locations and approximate volumes of reclamation fill activities;
- Confirm that existing areas of potential concern regarding slope stability are being addressed by reclamation filling;
- Monitor areas of potential concern regarding slope stability, which could possibly develop during reclamation filling; and
- Monitor natural filling (sediment accumulation) or erosion (e.g., scouring) within the lagoon.

This monitoring will be accomplished through an annual bathymetric survey that will be conducted over the next 10-year period during which active reclamation filling will be occurring. The survey will cover the entire lagoon. This lagoon-wide survey will also monitor, to the extent possible, natural filling or erosion within the lagoon during the 5 year filling period.

After the 10-year filling period, annual bathymetric surveys will be discontinued. Additional surveys will only be performed after this period after an unusual event (e.g., severe flooding) has occurred indicating that additional lagoon-wide bathymetric information is warranted.

Estimates of the volume of reclamation filling events, the natural sediment accumulation rate, and erosion rates from bathymetric survey data will be limited to some extent by the accuracy and precision of the survey. Typically, survey mudline elevation measurements are accurate to within approximately 0.5 feet along survey track lines. Between track lines, where elevations are interpolated, there is typically lower accuracy. This is especially true in areas of significant bottom relief.

The bathymetric surveys will be performed using methods employed during previous surveys at Ross Island. A small vessel will be used that is equipped with standard bathymetric survey and differential global positioning system (DGPS) navigational equipment. The bathymetric survey information collected will be compiled annually and imported into the GIS database for the purpose of developing a map of the island that depicts the current status of lagoon reclamation. The results of the mapping exercise will be evaluated and compared to the in-water reclamation goals.

7.1.3 Slope Stability

Stability of inwater slopes will be monitored through use of bathymetry. Bathymetric surveys will be conducted as described previously in this section. Any slope failure observed will be reported to DSL and corrective action taken as appropriate.

7.2 MONITORING FREQUENCY AND SCHEDULE

The following table summarizes the aspects of reclamation discussed in this section that will be subject to regular monitoring, monitoring frequency, and the time of year (if dependent on season) the monitoring will be conducted.

Table 7-1 Reclamation Monitoring Frequency and Schedule

Reclamation Activities	Monitoring Activity	Monitoring Frequency
1. Evaluation of fill quality and placement		
- Upland	Phase 1 information and/or chemical data Topographic survey	As generated After each upland fill event
- In-water	Phase 1 information and/or chemical data Bathymetric survey	As generated Annually for 10 years
-Natural sedimentation/erosion	Bathymetric survey	Annually for 10 years and as-needed after "unusual" event such as severe flooding
2. Monitor In-Water Slopes	Bathymetric survey	Annually for 10 years and as needed after "unusual" event such as severe flooding

7.3 MONITORING REPORTING

Data collected from elements of the monitoring program will be compiled and evaluated as appropriate for inclusion in an annual monitoring report to DSL. The report will include any adaptive steps as may be required to redirect the reclamation activities. In addition, RIS&G will report the results of the monitoring of the ongoing reclamation to the community on an annual basis. The report will include results of ongoing monitoring and such adaptive steps as may be required to redirect the reclamation activities.

7.4 PUBLIC USE MANAGEMENT

RIS&G will continue its reclamation activities, as described herein, as long as it owns the island complex. During that time, the company will continue its present policy of discouraging public use of the islands and the lagoon. At the same time, the company recognizes that the lagoon is made up of "waters of the State" and therefore available to all watercraft.

To begin the process of developing a more detailed public use management strategy, RIS&G proposes to convene a "joint management group." The joint management group is envisioned as a public/private task force that will examine a series of management options to ensure the maximum flexibility for public access while providing protection of the resource. The group will also ensure that no decisions will be made that will inhibit or preclude future options. Management options that could be considered by the committee include signage, public education, development of designated public access areas, and management partnerships with other Willamette River stakeholders.

The committee should have broad community representation, and whatever process is employed should include extensive public outreach and involvement. The company proposes that the committee be chaired jointly by the City of Portland and RIS&G and staffed by RIS&G.

8.0 HABITAT SUCCESS CRITERIA/MONITORING AND MAINTENANCE

8.1 WETLAND/RIPARIAN HABITAT SUCCESS CRITERIA

The successful growth of native vegetation and the control of non-native vegetation will form the basis of a successful reclamation effort. Focusing on the success of the vegetation assumes that a fill slope will be created between 2% (50:1) and 3% (33:1); that the lower elevations of the slope will be approximately +1 feet RID; that an aquitard will be placed within the surface of the fill slope; and that each of the planting zones will be exposed to the hydrologic regimes described in the sections above. It is anticipated that variations to this idealized scenario are unavoidable given the large amount of fill that needs to be placed to create the slope and the fact the fill will be placed using a barge and, therefore, cannot be precisely located. For this reason, it is assumed that some alteration of the fill slope may be needed to correct situations that vary widely from the assumptions described above.

The wetland and riparian creation will be considered successful if (1) no more than 20% of the wetland and the planted riparian area below 10 feet RID is covered with reed canarygrass and no more than 20% of the area above 10 feet RID is covered with Scot's broom (*Cytisus scoparius*) or Himalayan blackberry, (2) if at least 75% of the woody plants installed above elevation 4 feet RID (in the wetland, riparian, and upland areas) are surviving 5 years after installation; and (3) that approximately 22 acres of wetland and riparian habitat will be created on the fill slope at the southern end of the lagoon and that a portion of the fill slope meets the definition of jurisdictional wetland as described in the U.S. Army Corps of Engineers, Environmental Laboratory, 1987. Corps of Engineers Wetland Delineation Manual. Technical Report Y-87-1 (1987 manual).

The exact area of wetland that will be created will primarily depend on the water level fluctuations within the lagoon (which are dependent on dam releases and precipitation). It is assumed that wetland will be created below an elevation of 5 feet RID if the fill slope is inundated or saturated to the surface for more than 12.5% of the growing season. Wetland may be created below an elevation of approximately 10 feet RID if the fill slope is inundated or saturated to the surface for more than 5% of the growing season. Based on these elevations, it is estimated that between 8 and 16 acres of the 22-acre wetland/riparian habitat area may satisfy the jurisdictional definition of wetland.

Given the uncertainty of establishing herbaceous vegetation at lower elevations, we feel that RIS&G should not be held to specific success criteria. However, an estimate of total cover within the lower zone (Zone 4) of the reclamation area will be assessed and photographs of the vegetative cover will be included in the annual monitoring reports.

8.2 UPLAND HABITAT SUCCESS CRITERIA

The reclamation of upland areas will be considered successful is at least 75% of the trees and shrubs are living and in good health five years after their installation. If the plant counts fall below the 75% survival level 3 years after installation, other trees and shrubs will be installed to increase the number to the requisite 75%. If necessary, healthy volunteer trees and shrubs of the same species or native species approved by DSL as an appropriate substitute can be counted as replacements in order to reach the 75% survival level.

8.3 MONITORING AND MAINTENANCE

The reclamation areas will be monitored and maintained annually to determine whether the effort is successful. Data collected during the monitoring period will be included in an annual monitoring report to be provided to interested parties and regulatory agencies. The report will include a discussion on the success of the reclamation effort, issues that may affect the success of the plants and proposed management options; and photographs illustrating the reclamation area.

After each phase of planting, the area planted will be mapped and added to RIS&G's Geographic Information System (GIS) database. Such areas will be subject to monitoring for a period of five years. Specific criteria of the vegetation monitoring program are described in Section 8.3.2 of this reclamation plan and in the wetland and riparian habitat creation plan that accompanies this document (Appendix A). If plant survival does not meet the criteria identified, monitoring will extend beyond the five-year monitoring period for each annual planting area impacted. Upland and riparian buffer zone areas that have been reclaimed will be irrigated, if necessary, until the plants have established themselves sufficiently as to not require further irrigation.

8.3.1 Hydrology Monitoring

The creation of jurisdictional wetland on the fill slope requires that the three required criteria of the 1987 Manual be satisfied: wetland hydrology, dominant hydrophytic vegetation and hydric soils. It is assumed that if the fill slope is graded correctly, it will be exposed to a hydrologic regime that satisfies the jurisdictional definition of wetland hydrology as included in the 1987 manual. It is also assumed that if wetland hydrology is created, hydrophytic vegetation will dominate and soils with redoximorphic features (i.e., hydric soils) will develop.

Areas that always meet the jurisdictional definition of wetland hydrology are those that are inundated or saturated at least 12.5% of the growing season. With supporting wetland characteristics (i.e., dominant hydrophytic vegetation or hydric soils) areas may be inundated only 5% of the growing season. The growing season is defined as the period of time between the last killing frost (defined as the last winter date with minimum temperature of 28° F for five years out of ten) to the first killing frost (the first winter date with minimum temperature of 28° F for five years out of ten). For Portland (during the years 1951-1976) the last killing frost was March 4 and the first killing frost was December 1. This gives a growing season of 272 days.

For the fill slope at the southern end of the lagoon, this means that soils saturated to the surface for less than 14 days (5%) between March 4 and December 1 do not satisfy the wetland hydrology criterion. Soils saturated to the surface for more than 34 days (12.5%) between March 4 and December 1 are definitely considered to have wetland hydrology. Soils with saturation regimes between these extremes require additional evidence to satisfy the wetland hydrology criteria.

The hydrology of the slope throughout the year can be determined by comparing the elevations of the fill slope with the river level fluctuations measured at the Corps of Engineers river gage on the Morrison Bridge. The fluctuations of the water level in the Ross Island lagoon is, of course, closely related to the water surface fluctuations at the Morrison Bridge.

An analysis of the Corps' data, indicates that the water surface elevation of the Ross Island lagoon (River Mile 15) is approximately 0.2 feet above the water surface at river mile 13 near the Morrison Bridge. Lower flows may have a slightly steeper gradient, but with no more than 0.5 feet in river surface elevation difference.

An as-built topographic survey of the fill slope will be prepared each year to establish the slope's elevations. This topographic survey will be compared with the corrected water levels within the lagoon and areas that satisfy the wetland hydrology criterion will be determined. As vegetation becomes established, it is anticipated that the wetland area may increase due to the dominance of wetland plant communities.

A wetland delineation, to be concurred with by the DSL, will be conducted at the end of the monitoring period to determine the final wetland boundaries.

8.3.2 VEGETATION MONITORING

To determine the success of the plants, monitoring will occur in the late summer using a belt transect placed at 50 feet intervals along the outer edge of the planted zone. Transects will extend 5 feet on each side of a straight line from a baseline established at the upper edge of Zone 1 and extending to the edge of the water. The transects will be broken into 20-foot plots starting furthest away from the lagoon. Areal cover of Himalayan blackberry (*Rubus discolor*), Scot's broom (*Cytisus scoparius*), and reed canarygrass (*Phalaris arundinacea*) and other invasives will be assessed by ocular estimate as a percent of each 10 foot x 20 foot plot. The presence and abundance of woody species will be established within each of the plots along each of the transects.

The transects will cover approximately 20% of the fill slope. The counts for each woody plant within each of the 10 x 20 plots will be used as a sample population for the entire woody plant population. With these samples, we will be able to make a statistical estimate of the plant populations to a given confidence level using the standard deviations and means of the samples.

This same method will also be used at the northern end of the lagoon to establish the success of vegetation within the upland area.

As discussed above, an as-built topographic survey of each new section of the fill slope will be conducted. This survey will aid in determining the optimal elevations for each of the species installed and the elevations at which new plants are colonizing.

8.3.3 INVASIVE/EXOTIC PLANT CONTROL PLAN

As part of the vegetation monitoring plan, all historical and newly reclaimed and re-vegetated areas will be surveyed annually for occurrence of invasive species such as blackberry, Scot's broom and reed canarygrass. Results will be summarized in the annual report to DSL, which is discussed in Section 7.3 of this plan. If more than 20% cover of invasive species is observed in reclaimed and re-vegetated areas, RIS&G will consult with DSL to identify appropriate corrective actions.

In addition to this monitoring and corrective action, as appropriate, RIS&G will continue to mechanically (no herbicides) remove ivy from the base of trees located on the western portion of Ross Island. Ivy removal will occur only between July 15 and January 31.

Blackberries (*Rubus discolor and Rubus ursinus*), Scot's broom, and reed canarygrass will be controlled during the initial plant establishment period to allow the desired plants to thrive. Semiannual mowing of the invading plants during the first two years (or as deemed necessary) following initial installation to control their growth will be conducted.

If more than 20% cover of reed canarygrass is within the wetland area, the grass growing above the water will be mowed three times during the growing season (the first of June, the middle of July, and the middle of October). Areas with more than 20% cover of Scot's broom and Himalayan blackberry will be treated following the recommendations of the Portland Parks and Recreation Pest Management Program and the Watershed Revegetation Program.

8.4 FISH AND WILDLIFE MONITORING

Regularly scheduled, quantitative monitoring of populations of fish and wildlife are not a component of the reclamation plan monitoring program. It is expected that further development of upland habitat, development of the riparian buffer and wetland areas, cessation of mining in the lagoon, and controlled recreational access to the island complex will result in greater use of habitat by fish and wildlife. Monitoring usage patterns may be identified at a later time as useful information that could be gathered as part of ongoing environmental education programs at the primary, secondary and university level.

Qualitative monitoring will be conducted as part of ongoing reclamation activities to ensure that these activities are not adversely impacting ecological receptors. This will include reporting to DSL in the annual report any unusual response by fish/wildlife, such as additional movement of the heron rookery or bald eagle nest or unusually high or low levels of migrant bird use of the island.

8.5 MONITORING FREQUENCY AND SCHEDULE

The following table summarizes the aspects of habitat creation in this section that will be subject to regular monitoring, monitoring frequency, and the time of year (if dependent on season) the monitoring will be conducted.

Table 8-1 Habitat Monitoring Frequency and Schedule

Habitat Activities	Monitoring Activity	Monitoring Frequency
1. Plant growth and survival	Vegetation monitoring	Annually for 5 years following the planting of each "annual planting area"
2. Determination of jurisdictional wetland	Hydrology monitoring	Annually for 5 years following the completion of the as-built topography survey of each reclaimed area
3. Vegetative Composition, Cover and Production	Vegetation monitoring	Annually for 5 years following the planting of each "annual planting area"
4. Diversity and Density of Fish and Wildlife Populations	Qualitative Monitoring	Reporting of unusual response by fish/wildlife

8.6 REPORTING

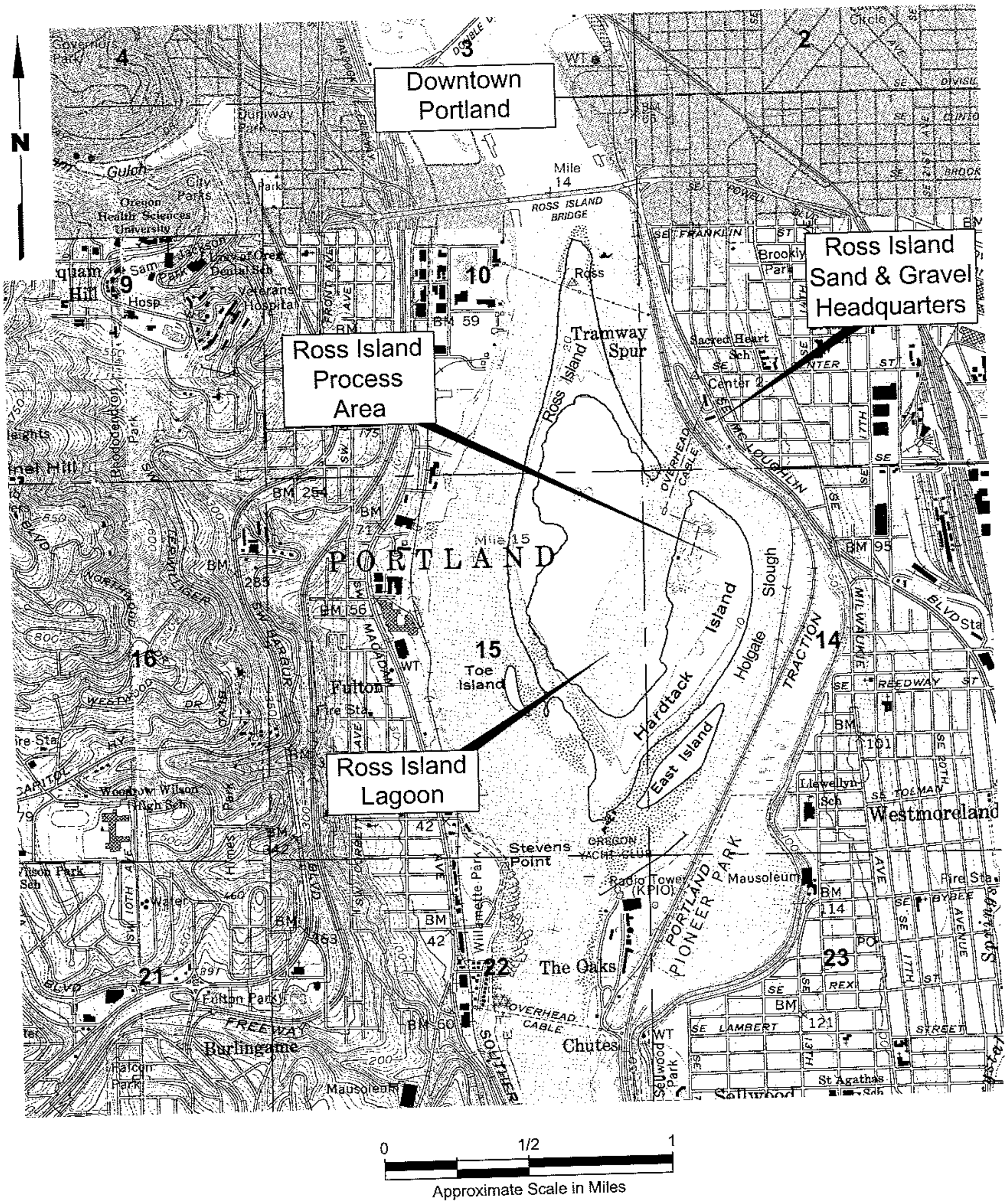
Monitoring of plant survival in the wetland, riparian and upland habitat areas will be conducted once during each growing season between the summer solstice (June 20) and the autumn equinox (September 20). Transects will be run at low tide to allow a count of all woody plants within each transect. The hydrology monitoring of the created wetland area will occur after the as-built survey of the wetland/riparian area has been received and comparisons can be made with the hydrology data collected from the gage at the Morrison Bridge.

Data collected from elements of the monitoring program will be compiled and evaluated as appropriate for inclusion in an annual monitoring report to DSL. The report will include any adaptive steps as may be required to redirect the reclamation activities. In addition, RIS&G will report the results of the monitoring of the ongoing reclamation to the community on an annual basis. The report will include results of ongoing monitoring and such adaptive steps as may be required to redirect the reclamation activities.

9.0 EVALUATION/ADAPTIVE MANAGEMENT

Due to the array of variables that can affect plant growth, it will be necessary to adaptively manage the reclamation effort. Issues that may require changes in how the reclamation area is managed include, but are not limited to: competition from non-natives not considered by this study (e.g., purple loosestrife (*Lythrum salicaria*); predation from herbivores (e.g., geese, beaver, nutria); long-term and short-term instability of the fill slope; plant mortality from annual creation of the fill slope (e.g., smothering newly planted species with fill material); creation of potential fish entrapment sites as the slope is filled; and elevations or angle of slope not conducive to the proposed range of hydrologic regimes.

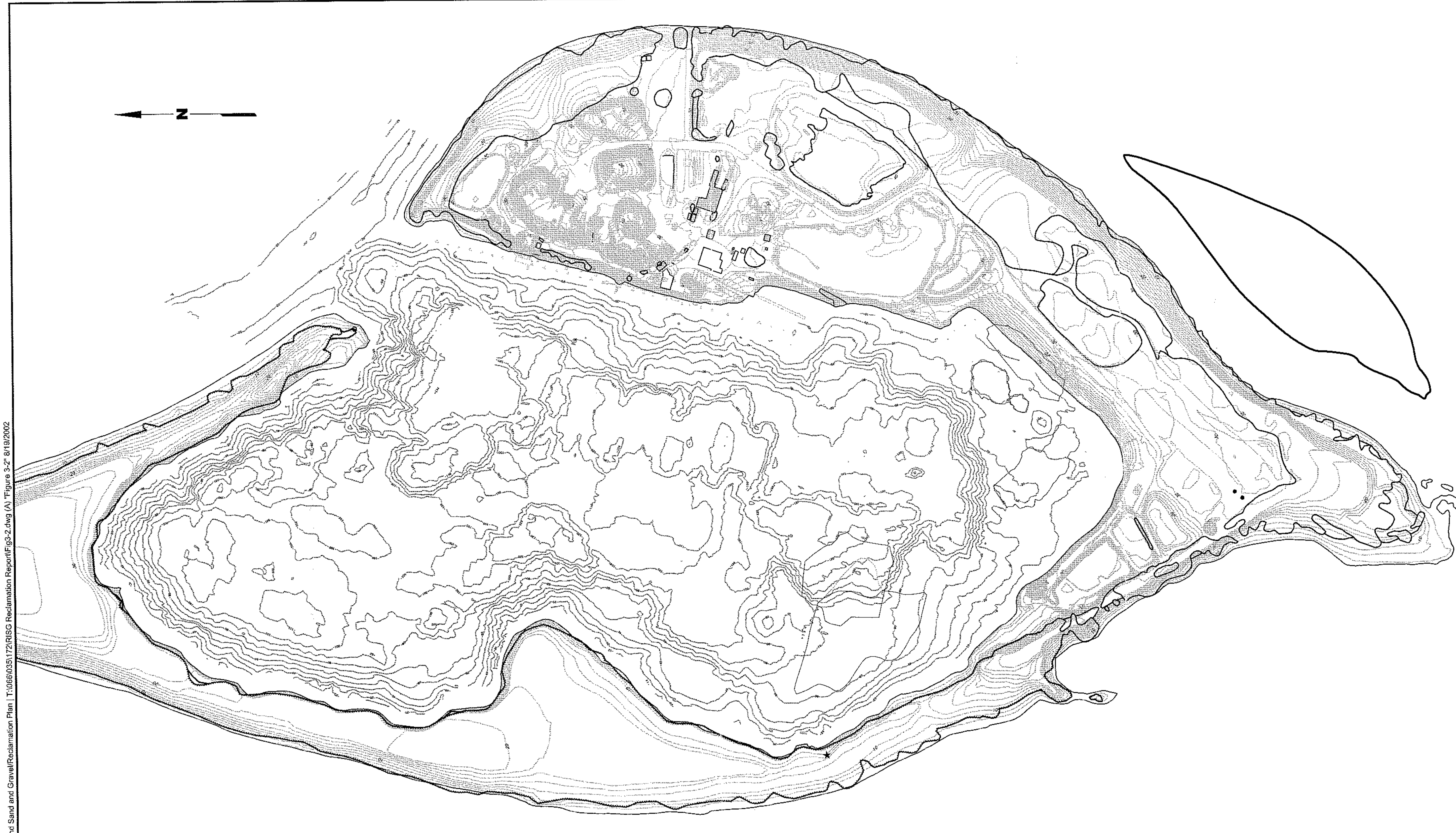
The annual report will describe any physical changes that may be required to the reclamation area and any changes in management strategies. These changes will be discussed with the agencies prior to implementation the following year.



Note: Basemap prepared from the USGS 7.5-minute quadrangles of Portland and Lake Oswego, Oregon (1975 Photo). Contour interval is 10 feet.

Ross Island Sand and Gravel/Reclamation Plan | T:\066\035\172\RISG Reclamation Report\Fig3-1.dwg (A) "Figure 3-1" 4/25/2002

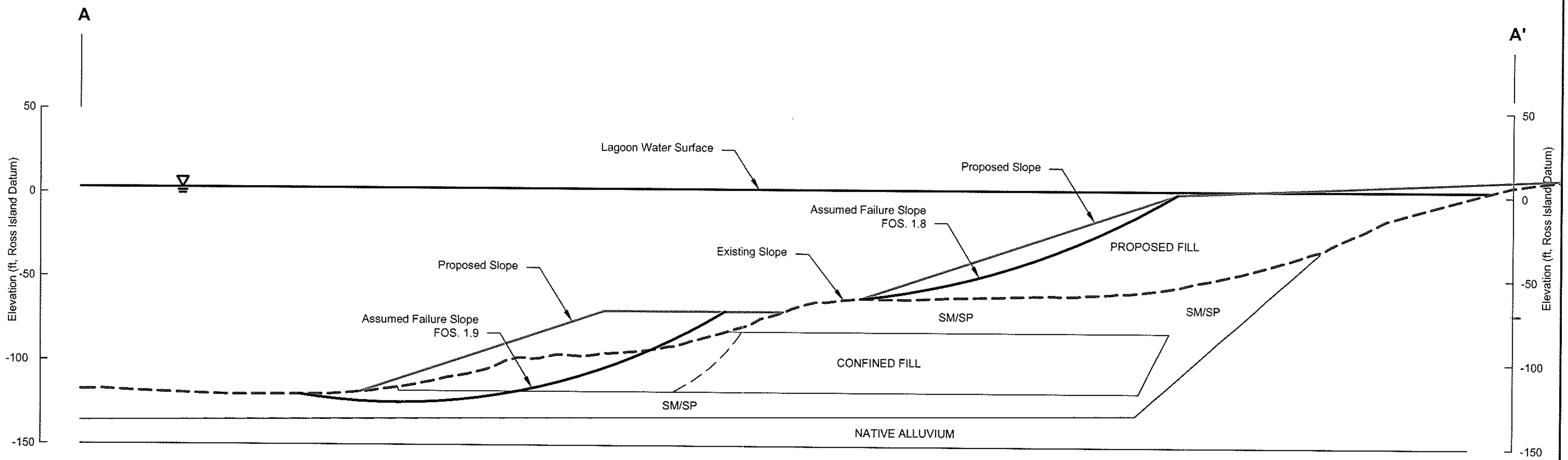
Landau Associates	Ross Island Sand & Gravel Portland, Oregon	Vicinity Map	Figure 3-1



Ross Island Sand and Gravel/Reclamation Plan | T:\066\035\172\RISG Reclamation Report\Fig3-2.dwg (A) "Figure 3-2" 8/19/2002

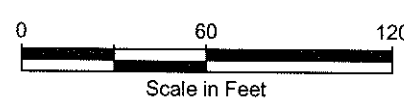
Landau Associates

Ross Island Sand & Gravel Portland, Oregon	**Map of Ross Island**	Figure 3-2



Legend

GM/GP	Sandy GRAVEL with Sand (Loose)
ML/CL	SILT with Fine Sand and Clayey SILT
SM/SP	Fine SAND, Fine SAND with Silt Silty Fin SAND
	Confined Port Fill
	Native Alluvium Dense Sandy Gravel
	Dense Native Gravel
	Barge Placed Fine Sand With Silt

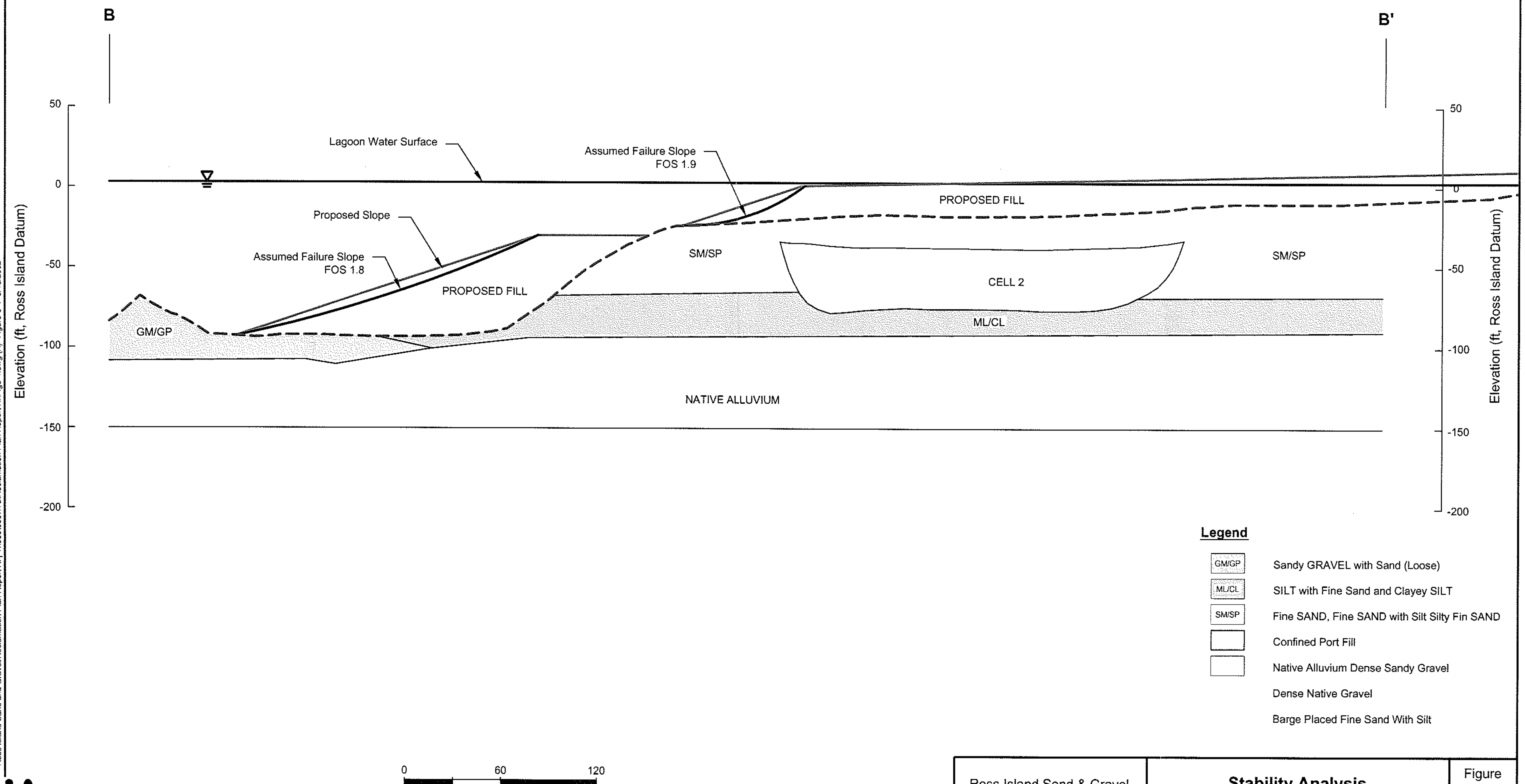


LANDAU ASSOCIATES

Ross Island Sand & Gravel
Portland, Oregon

**Stability Analysis
Cross-Section A-A'
Extended Slope**

Figure
6-3



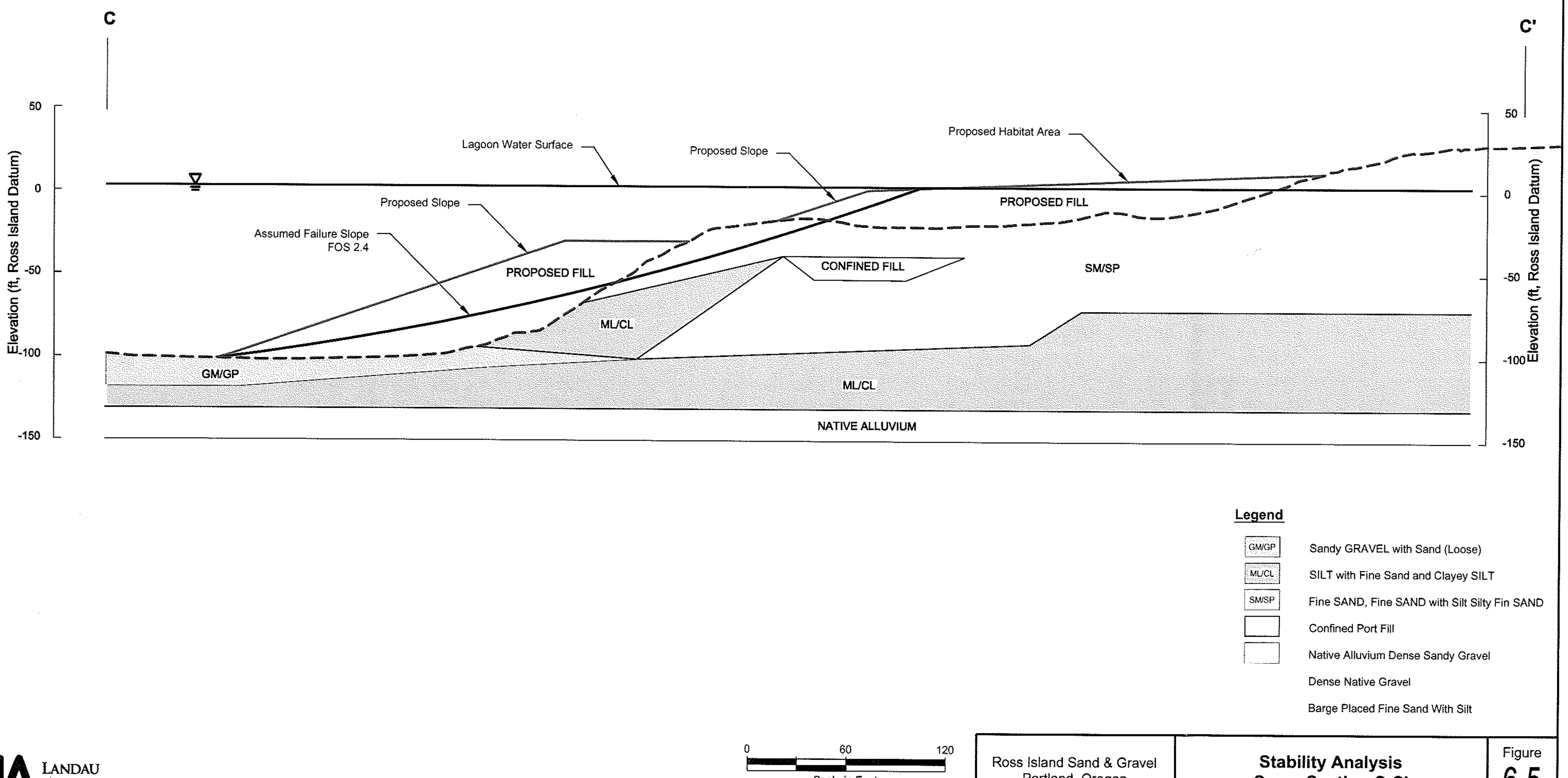
Ross Island Sand and Gravel/Reclamation Plan Report XI | T:\066\035\172\Reclamation Plan Report XI\Fig6-4.dwg (A) "Figure 6-4" 9/16/2002

LANDAU ASSOCIATES

Ross Island Sand & Gravel
Portland, Oregon

Stability Analysis
Cross-Section B-B'

Figure
6-4



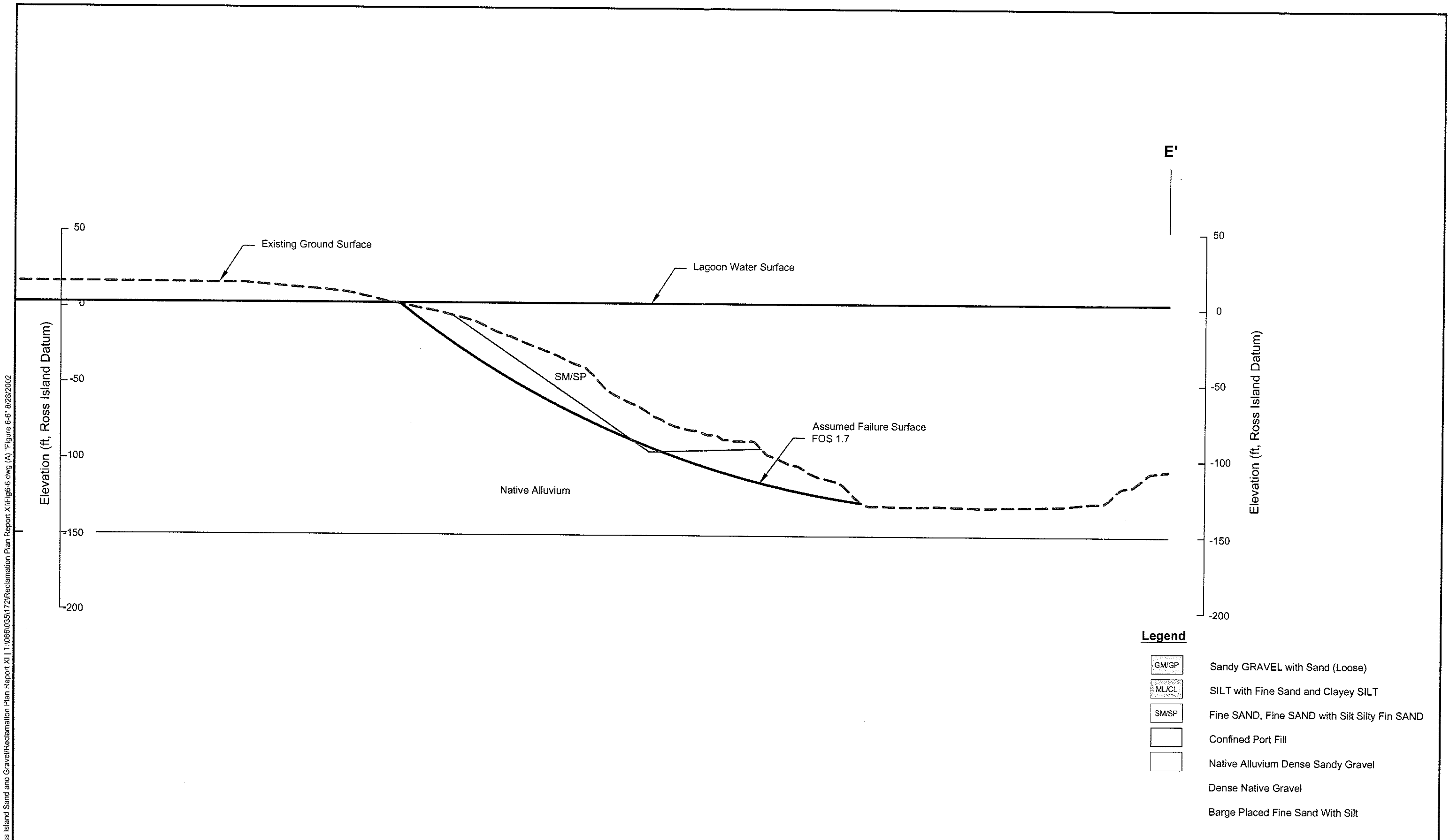
Ross Island Sand and Gravel\Reclamation Plan Report XI | T:\066\035\172\Reclamation Plan Report XI\Fig6-5.dwg (A) "Figure 6-5" 9/16/2002

LANDAU ASSOCIATES

Ross Island Sand & Gravel
Portland, Oregon

Stability Analysis
Cross Section C-C'

Figure
6-5



Ross Island Sand and Gravel\Reclamation Plan Report XI | T:\066\035\172\Reclamation Plan Report XI\Fig6-6.dwg (A) "Figure 6-6" 8/28/2002

LANDAU ASSOCIATES

Ross Island Sand & Gravel
Portland, Oregon

Stability Analysis
Cross-Section E-E'

Figure
6-6

APPENDIX A

Ross Island
Wetland and Riparian Habitat
Reclamation Plan

Ross Island
Wetland and Riparian Habitat Reclamation Plan

Prepared for

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7800 SW Durham Road, Suite 500
Tigard, Oregon 97224

Prepared by

Pacific Habitat Services, Inc.
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(503) 570-0800

September 19, 2002

Ross Island

Wetland and Riparian Habitat Reclamation Plan

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September 19, 2002

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1.0 INTRODUCTION

Overview

This report discusses the feasibility of creating shallow emergent and scrub-shrub wetland, riparian and upland habitat, and shallow water habitat within the Ross Island Lagoon. The Ross Island Lagoon is bordered to the south by an earthen dike, which was constructed between two islands: Ross Island and Hardtack Island in 1926-1927. Ross Island, which is located to the west of Hardtack Island, is bordered on its west side by the mainstem of the Willamette River. Holgate Slough borders Hardtack Island on its east side. Both islands are located at approximately river mile 15 of the Willamette River within the City of Portland, Oregon (T1S, R1E, Sections 10, 11, 14, 15). Figure 1 illustrates the location of Ross Island and its lagoon.

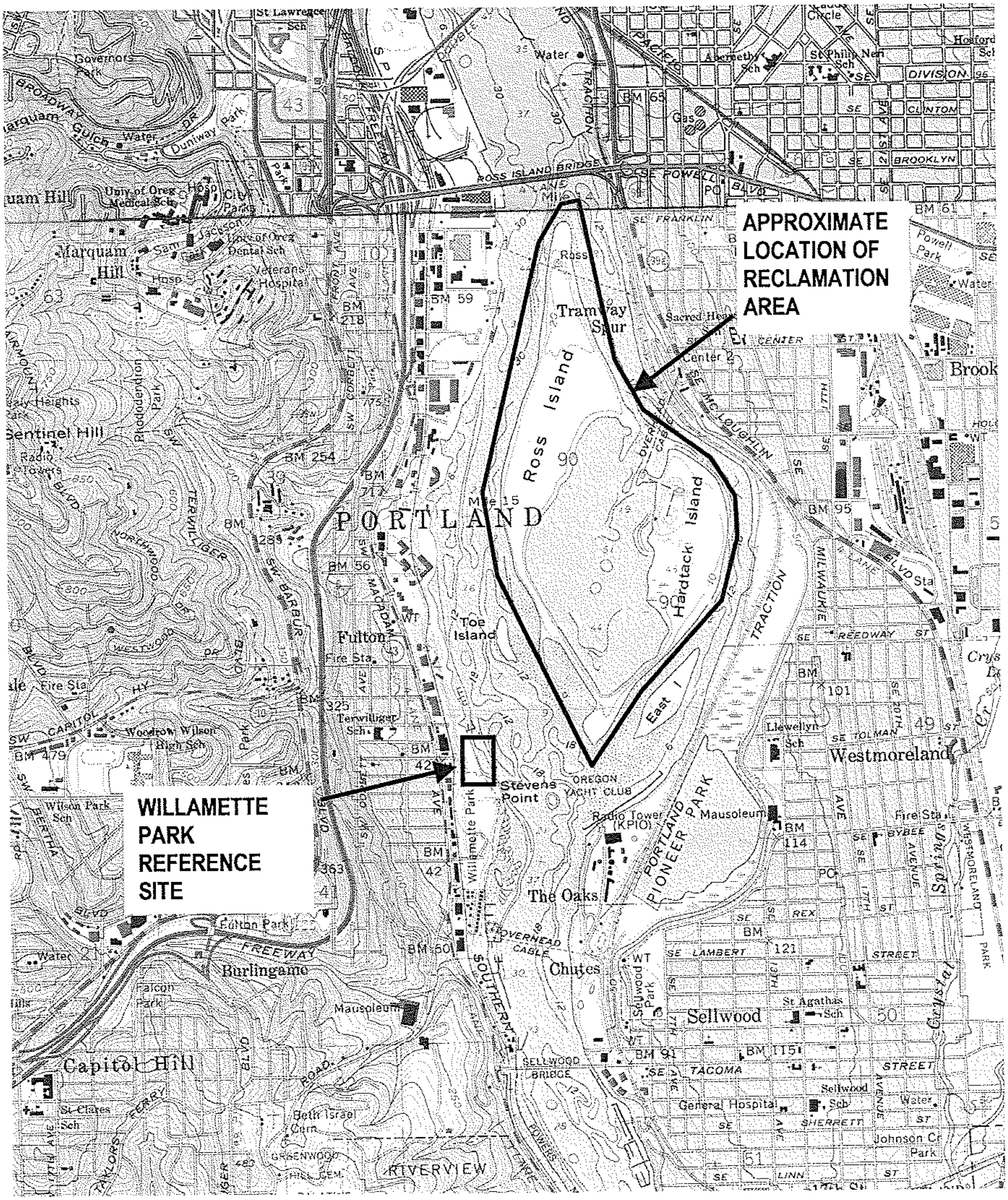
Ross Island Sand and Gravel, Inc. (RIS&G) holds permits from the US Army Corps of Engineers and the Oregon Division of State Lands allowing extraction of sand and gravel from the lagoon and its environs. These permits also provide for the reclamation of the island. The original concepts for reclaiming the island were described in a 1979 plan, which RIS&G and the agencies have agreed to review. The objectives for the new reclamation plan are to improve the quality of habitat within the island complex. This study is a component of this comprehensive review.

Report Summary

The goals of the study include characterizing the existing conditions at Ross Island; locating an area that is subject to a similar hydrologic regime as Ross Island and that contains similar habitats to those proposed within the lagoon; determining whether the conditions at the reference area can be replicated as part of the reclamation process; and establishing a strategy to successfully implement and provide long-term management of the reclamation area.

The habitats proposed as part of this study include expansion of the upland/riparian habitat primarily dominated by black cottonwood (*Populus trichocarpa*) and Oregon ash (*Fraxinus latifolia*) within the higher elevations of the island (i.e. above an elevation of 12 feet Ross Island Datum (RID)); a scrub shrub wetland, subject to periodic inundation and primarily dominated by Pacific willow (*Salix lasiandra*) and Columbia River willow (*S. fluviatilis*); an emergent wetland, which is subject to more frequent inundation and is dominated by herbaceous species such as Columbia sedge (*Carex aperta*), softstem bulrush (*Scirpus tabernaemontani*), northern mudwort (*Limosella aquatica*) and short-seed waterwort (*Elatine brachysperma*).

Our investigation determined that creating the habitats described above is possible, though it will likely be difficult. The reclamation plan needs to be carefully implemented to ensure that conditions conducive to the growth of native plants are achieved. Issues that need to be addressed include: creating a fill slope that allows a hydrologic regime suitable for native plants; ensuring the substrate of the fill slope possesses hydraulic and physical qualities that will facilitate plant growth; and reducing invasive plant competition. The biggest challenge will be to create a slope that not only persists, but that possess a hydrologic regime that causes



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Location and general topography for Ross Island, Portland, Oregon (USGS, Portland, OR-WA quadrangle, 1961, photorevised 1970 and 1977, and Lake Oswego, Oregon quadrangle, 1961, photorevised 1984).

FIGURE 1

—Pacific Habitat Services, Inc.

minimal stress on the plants. Plants will be stressed not only by the annual water level fluctuation of up to 16 feet, but also by the daily tidal fluctuations of 2 to 3 feet. Unlike plants found within estuarine or saltwater environments, relatively few freshwater plants are adapted to this daily fluctuation.

The investigation also determined that the best opportunity for creating wetland is within the southern end of the lagoon. Due to the shallower depths, filling this portion of the lagoon creates the largest wetland area in the shortest period of time. To successfully establish wetland in the lagoon, we feel it is necessary to create a gentle slope ranging between approximately 2% (50:1) to 3% (33:1). This gradual slope will not only provide hydrologic conditions conducive to the growth of wetland plants, but at lower elevations will benefit juvenile salmonids. Juvenile salmonids have been documented using the shallow waters of the lagoon during their outmigration: the lagoon provides off-channel habitat that is lacking within the lower Willamette River. Juvenile salmonids have been documented as using the shallow water beach areas with a gentle slope, some cover, and a substrate of sand/silt or gravel (Beak 2000). Juvenile salmonids will also benefit from the increased production of invertebrates within the created wetland and adjacent riparian area.

Establishing the gentle slope within the southern portion of the lagoon will create a total of approximately 22 acres of wetland and riparian area. A portion of the area will be created each year given the assumption that approximately 4,500,000 cubic yards of fill material will be available. Fill for the wetland/riparian creation and shallow water habitat will be placed within the lagoon during the in-water work periods of July 1 through October 31st and December 1st through January 31st over the 10-year reclamation period. Deep water filling below 40 feet from the water surface may occur year-round.

To improve vegetation success, we recommend placing an aquitard (a relatively impermeable layer) beneath or at the surface of the fill slope to change the drainage within the substrate from mainly vertical to more horizontal. The ideal aquitard is probably a silty clay loam, though any substrate with saturated hydraulic conductivity of less than 0.5 inch per hour will likely suffice. We feel the aquitard is necessary to ensure the substrate responds in a hydraulically steady manner. In other words, water movement through the substrate should be restricted (or dampened) through the daily tidal cycles, which at the lagoon can fluctuate between two and three feet. Generally, plant growth in coarse alluvium (i.e. sand) within a tidal regime, such as that present at Ross Island, is limited by rapid soil-water pressure fluctuations.

We recommend creating the fill slope from an elevation of approximately +12 feet RID at the upper edge to approximately +1 feet RID at the lower edge. A slope approximately 400 feet to 500 feet long appears to be possible within the lagoon.

We recommend initially installing plants in zones according to the hydrologic regime projected along the length of the finished slope. An idealized slope would contain an upper zone above an elevation of +12 feet RID that will be able to support trees and shrubs such as bigleaf maple (*Acer macrophyllum)*, blue elderberry (*Sambucus mexicana*), and black cottonwood (*Populus trichocarpa balsamifera*). These plantings will expand the width of the riparian area within the interior of the lagoon. As the elevations decrease, the slope will be more frequently inundated and inundated for longer periods. Scrub shrub vegetation dominated by several species of willows will likely dominate the higher elevations (+6 to +10 feet RID) of these zones. The lower elevations (i.e. between +2 and +4 feet RID) will likely be dominated by perennial herbaceous plants.

The lowest zone closest to +1 foot RID should be able to support annual emergent plants that are only exposed during mid summer to early fall. Due to the uncertainty of establishing plants within this zone, it is preferred that plants not be installed, but be allowed to naturally colonize this area. Elevations below the bottom of the slope will be used as shallow water habitat by salmonids. The slope in this area (Area C/D) will be 3:1.

Although the plants will initially be installed in zones, its is assumed that plants will soon start thriving in areas where they are best adapted. Over time, the distinction between the zones will be less well defined.

We recommend planting trees at a density of 10 per 1000 square feet and shrubs at a density of 15 per 1000 square feet. Trees and shrubs should be bare root or cuttings. To increase the likelihood of success, perennial emergents should be planted as plugs and not seeds.

In addition to the wetland/riparian habitat and shallow water habitat proposed for the southern end of the lagoon, we recommend creating shallow water habitat for salmonids within the northern portion of the lagoon. The ability to create wetland in this area is restricted by the relatively narrow width available to create a fill slope. Creating a wide and shallow slope (i.e. 33:1 to 50:1) suitable for wetland conditions would require a large amount of fill material and would probably take many years to create given the amount of annual fill likely available to RIS&G. Although creating suitable wetland habitat appears to not be possible, it appears that shallow water habitat with an average water depth of 15 feet is possible.

We propose that the northern end of the lagoon would be graded from an elevation of +20 feet RID to an elevation –10 feet RID. The area above 12 feet RID along the north end of the lagoon would be planted as upland forest with black cottonwoods (*Populus balsamifera trichocarpa*), red elderberry (*Sambucus racemosa*), and Scouler's willow (*Salix scouleriana*). The plantings between elevation 12 feet RID and 1 feet RID would be planted the same zonation as Area C. The upper portion of this area will support riparian habitat. The portion of the linear slope below +1 feet RID would serve as shallow-water habitat for fish. Between +1 foot RID and –10 feet RID, an undulating bench would be created with a maximum width of 140 feet. Fill will be placed on the bench unevenly to add complexity and diversity to the habitat. To augment the effectiveness of this area as habitat for fish, we propose that whole trees with root wads and branches still intact be anchored in place to provide shelter for juveniles. The National Marine Fisheries Service and the Oregon Department of Fish and Wildlife will be consulted on the number of trees.

We recommend that ongoing maintenance and monitoring of the reclamation area be adaptive to respond to changes in the factors that will shape the wetland. It is likely the reclamation plan will have to be modified to respond to changes in the hydrology, substrate and competition from invasive species within the first few years of creation. Annual reports for 5 years after the initial construction will document the success of the reclamation efforts and will recommend management options for the following year.

Our reclamation recommendations were supported by a preliminary analysis of two reference sites along the shores of Vancouver Lake and the Columbia River. Vancouver Lake, which is located to the east of the Columbia River in Clark County, is generally subject to the same tidal fluctuations as the Ross Island lagoon. Portions of the shoreline of Vancouver Lake have shallow slopes (less than 3%) and wetland plant communities that generally grow in the zones proposed for the reclamation project. The substrate along the margin of the lake is primarily silt, which restricts the vertical movement of water. Another reference site (Frenchman's Bar) is located along the Columbia River to the west of Vancouver Lake. This reference site is also subject to a similar hydrologic regime as the Ross Island lagoon, is dominated by scrub shrub wetland community and has a silty substrate.

Other reference areas include an area of aggrading bank within the Willamette Park along the west bank of the river. This wetland is to the north of the boat launch ramp for the park. This area, which has been aggrading for 10 years, supports a dominant stand of willows growing in fine substrate.

2.0 DESCRIPTION OF EXISTING CONDITIONS WITHIN ROSS ISLAND

2.1 Hydrology

The construction of the earthen dike at the southern end of the island and the later additions of fill to portions of Hardtack Island have created a relatively quiet lagoon that is generally isolated from the scour of the open Willamette River. Water levels in the lagoon, however, are subject to daily tidal fluctuations and from the annual discharges from dams.

An analysis of tidal fluctuations throughout the year was conducted by reviewing data from a US Army Corps of Engineers gauging station located approximately two miles downstream at the Morrison Bridge. This gauge records surface elevations every 15 minutes. The data show a daily irregular 2 to 3-foot tidal fluctuation. The data also show that water levels in the lagoon fluctuate approximately 15 feet annually. Gauging records at the I-5 Bridge near Vancouver, Washington, show a similar water level fluctuation regime with little difference in surface elevation or in tidal timing from the Morrison Bridge. Figures 2, 3, and 4 depict the annual fluctuations

The discharges from the Bonneville dam on the Columbia River are highly regulated by power production requirements, fish migration conditions and to a certain extent by flood control of spring snowmelts. The major fluctuations in water level at Ross Island, however, are likely the result of flood control releases from dams on the upper Willamette River. Since the late 1990's the Army Corps of Engineers have been assisting the outmigration of young salmonids by reservoir releases at the appropriate season. The full effect of the endangered species declaration for several anadromous species was in effect by 1999. The water level records for 1998 and 1999 show a large peak in water level to 12 feet RID for about 10 days in mid-April. Another longer rise in river stage occurs from the last week in May through mid-June. The drought and power shortages of the years 2000 and 2001 have altered the Corps reservoir management to a certain extent, but in the spring of 2002 the same April peak and the longer rise in late May-early June were again noted. These rises in river stage can probably be expected to occur every year.

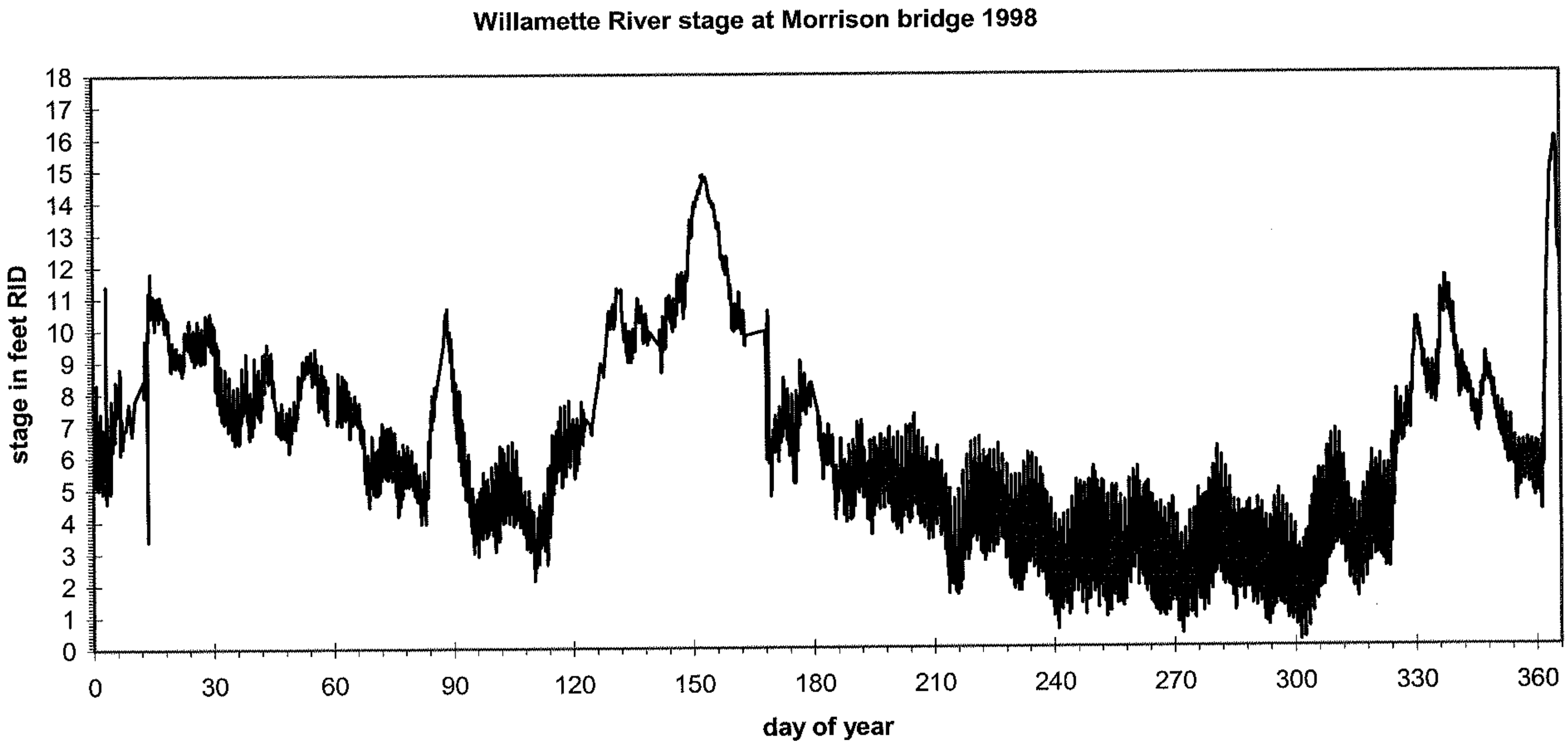

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FIGURE
2

Willamette River stage at Morrison Bridge 1998

Pacific Habitat Services, Inc.

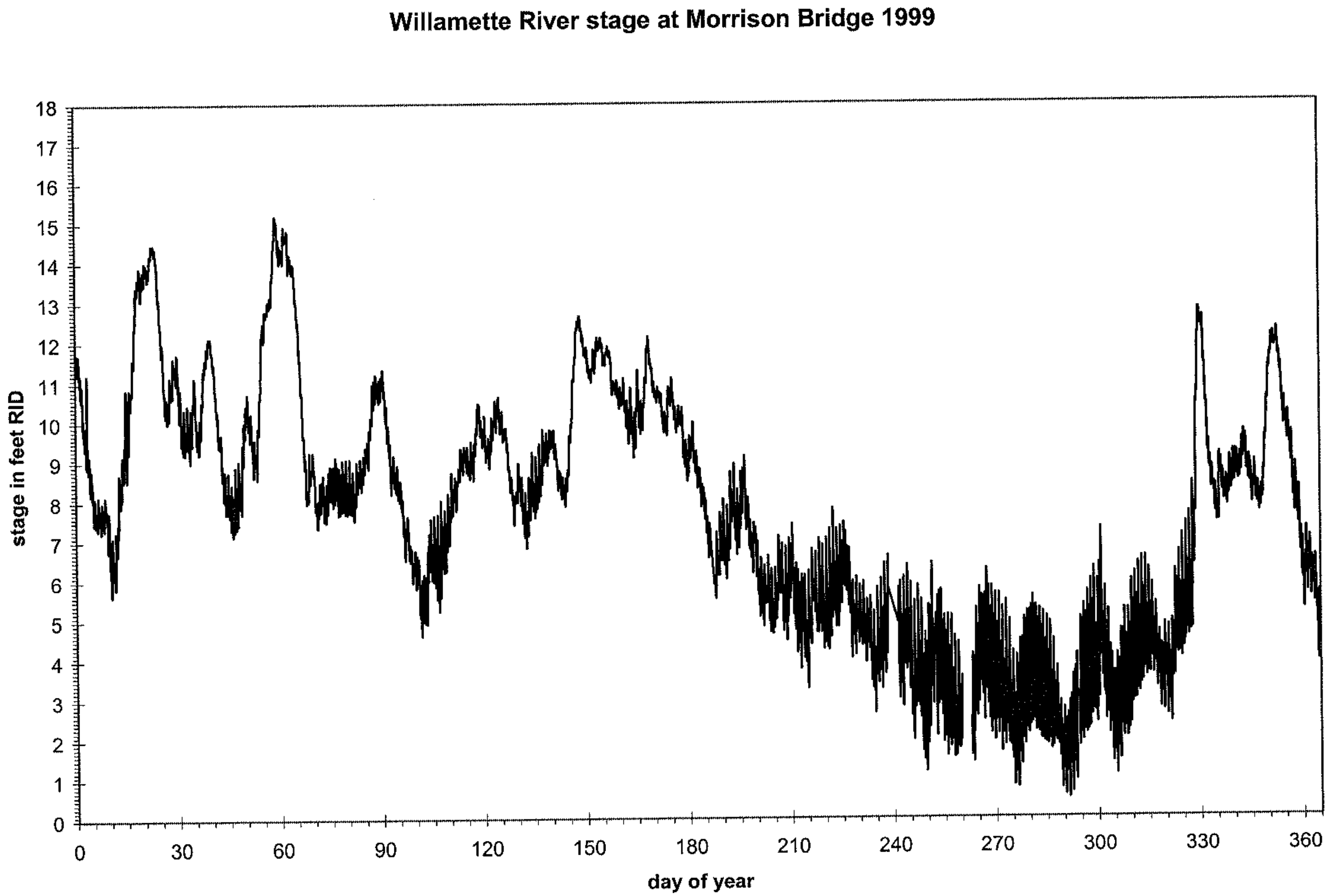

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FIGURE 3

Willamette River stage at Morrison Bridge 1999

Pacific Habitat Services, Inc.

Willamette River stage at Morrison Bridge 2002

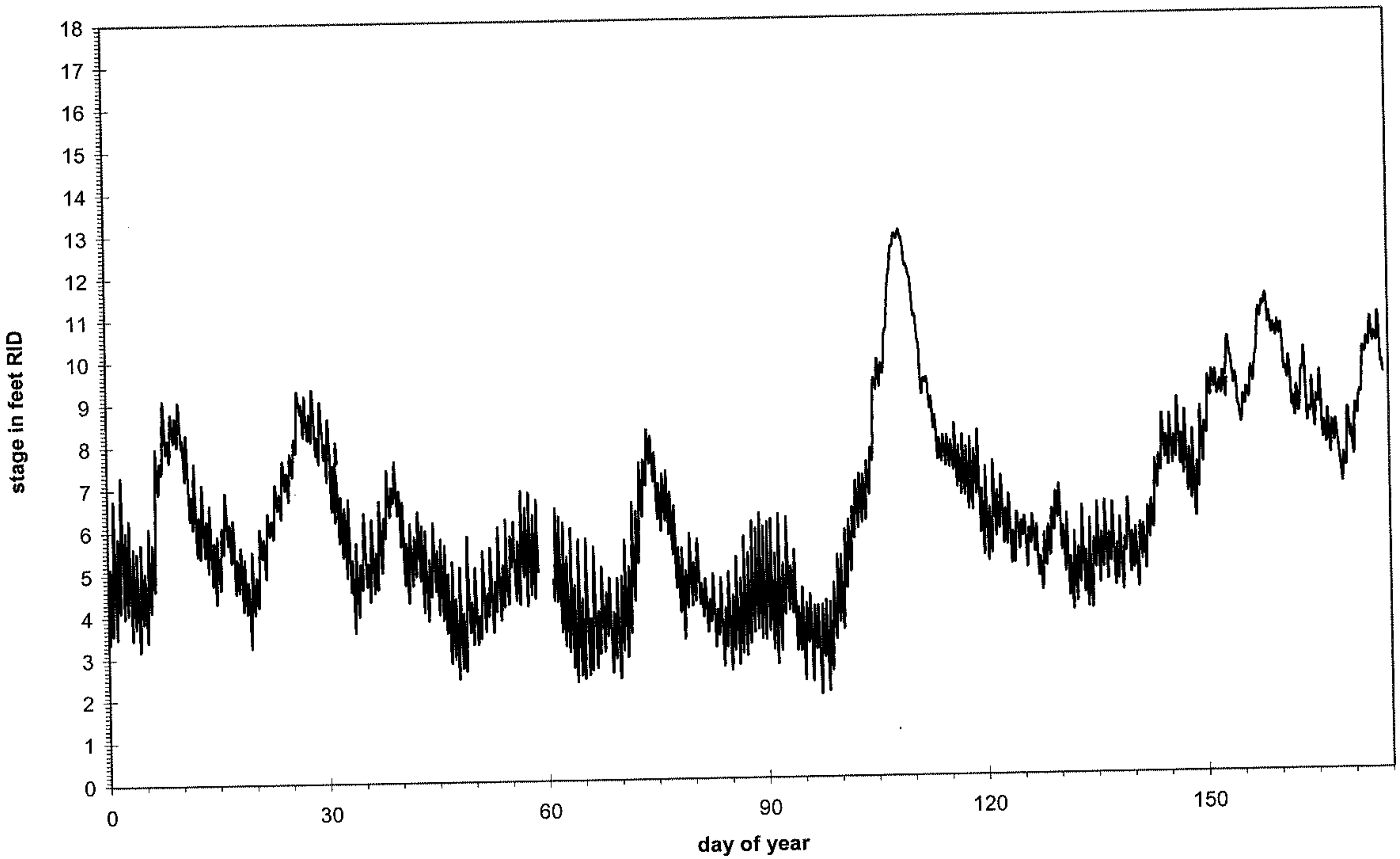

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FIGURE 4

Willamette River stage at Morrison Bridge 2002

Pacific Habitat Services, Inc.

2.2 Soils/Substrate

The base of the island is a layer of consolidated Troutdale Formation at a depth of approximately –120 feet RID. On top of the consolidated deposits are more recent alluvium. The native soil materials are the excessively drained coarse alluvium that has been quarried for several decades. The Natural Resources Conservation Service (formerly the Soil Conservation Service) maps these materials as Pilchuck Sand. The mapped unit has a porosity of 40-43%. The saturated hydraulic conductivity is listed at 0.5-1.67 feet/hour, but hydraulic modeling of the tidal response for a shallow monitoring well on the southwestern dike suggests that the rate may be a bit higher in some disturbed fill areas.

Fill material from a sediment-settling pond on Hardtack Island has been used to begin reclamation filling on the southern portion of the lagoon near the present water level range. This material is a fine sand with 10-15% of the mass retained on the number 50 sieve, approximately 50% retained on the number 100 sieve, and 10-15% retained on the 200 sieve. This material, while much finer than the extracted fraction of the native material, tends to be coarser and probably has a higher hydraulic conductivity than soil materials along the Columbia River away from the main channel. Tidal drainage of the fill will therefore be more rapid.

2.3 Vegetation Communities

The riparian area along the higher, undisturbed portions of Ross Island is dominated by an overstory of black cottonwood (*Populus trichocarpa*), with Oregon ash (*Fraxinus latifolia*) also present. The understory includes low shrubs such as osoberry (*Oemleria cerasiformis*), red elderberry (*Sambucus racemosa*), and snowberry (*Symphoricarpos albus*). The native trailing bramble California dewberry (*Rubus ursinus*) appears to blanket some of the cottonwood forest floor. A few bigleaf maples (*Acer macrophyllum*) and black locust (*Robinia pseudacacia*) are seen near the opening of the lagoon. Near the waters edge are clumps of Scouler's willow (*Salix scouleriana*) and Sitka willow (*Salix sitchensis*), though the dominance of these is limited to a narrow fringe in a few locations. The disturbed margins of the riparian area are dominated by Himalayan blackberry (*Rubus discolor*). Few emergent plants exist around the perimeter of the lagoon, apparently because the excavated margins of the interior are very steep.

The southern edge of the lagoon has recently disturbed fill along the lagoon margin with very little vegetation. An area at the top of the slope has been planted with Douglas fir (*Pseudotsuga menziesii*) and western red cedar (*Thuja plicata*). These trees have been planted into a medium amended with organic compost and seeded with white clover (*Trifolium repens*) and Spanish clover (*Lotus purshiana*).

Sediment ponds along the southwestern and southeastern edges of the island are currently unvegetated.

3.0 DESCRIPTION OF REFERENCE SITES

3.1 Selecting Reference Sites

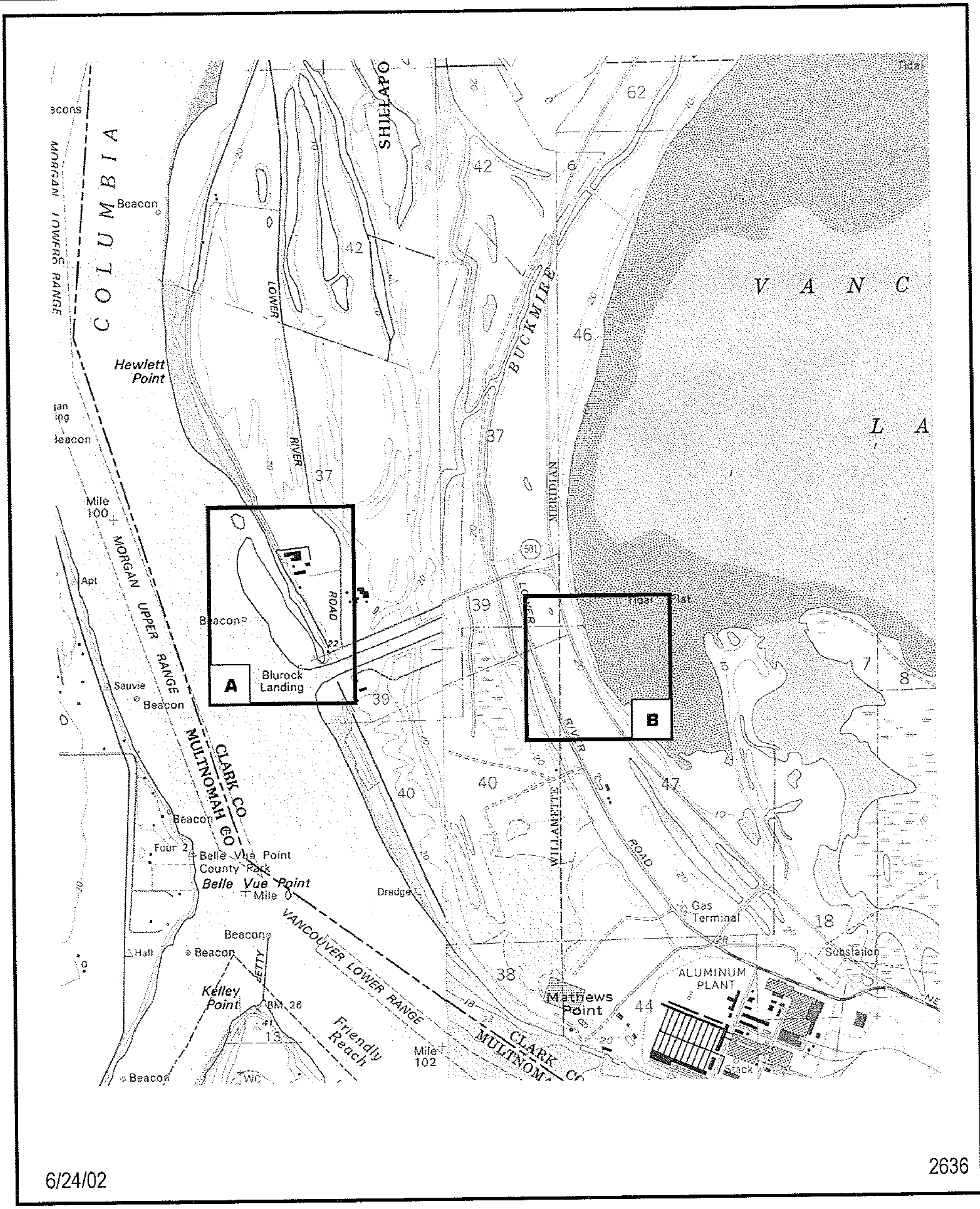
Our analysis determined that few reference sites exist along the Willamette River and adjacent portions of the Columbia River. A reference site is one that is subject to similar daily tidal fluctuations and annual flooding regime as the Ross Island Lagoon, that is isolated from the geomorphic effects of channel scour, and that supports a wetland plant community similar to the one targeted for the lagoon (i.e. exhibits zonation of plants from scrub-shrub wetland to annual emergents). The quality of the reference site as wildlife habitat was not considered.

The banks of the main channel of the Willamette River are subject to scour and consequently little emergent wetland exists. Historically, reference sites adjacent to the Willamette River were likely present in locations such as Guild's Lake, Mocks Bottom, and Oaks Bottom. These were all shallow backwater areas underlain by fine-grained alluvial silts that were likely connected to the main river for some portion of the year. Guild's Lake was filled for industrial uses after the 1905 Lewis and Clark Centennial Exposition and Mocks Bottom was completely filled in 1975 (Audubon Society of Portland, 2000). Although Oaks Bottom remains a bottomland area providing valuable habitat, it is isolated from the river by a railroad, which was constructed at the turn of the century, and is now isolated from tidal fluctuations by a water control structure. As such, Oaks Bottom does not represent an adequate reference site.

Another reference site considered for the study is a large area along the Multnomah Channel known as South Multnomah Wetlands. Four properties in this area have been acquired by Metro, which is in the process of planting trees and developing water management strategies to improve existing habitat conditions. The area is characterized by ash, willow and cottonwood forest with meadows and pasture. It represents typical floodplain/wetland habitat for areas adjacent to the river, but is separated from the tidal regime of the open river. This separation from the tidal regime of the river means that it does not possess the same hydrologic conditions that are present within the Ross Island lagoon. As such, it was also not considered an adequate reference site.

Another reference site considered is the Smith and Bybee Lakes Wildlife Area, which is also owned by Metro. Smith and Bybee Lakes contain riparian forests dominated by cottonwood, Oregon ash, alder, big leaf maple, willows and shrubs; seasonally flooded wetland forest; and wetland prairie similar to that which may once have existed at Ross Island. This site is of interest because historically, the hydrology of the lakes functioned in a similar manner to the Ross Island lagoon. Before 1983 the lake system was directly connected to the Columbia Slough. Between 1983 and 2002, however, the lake system has been isolated from tidal fluctuations of the river to prevent avian botulism. A new control structure will allow tidal fluctuation in the lake system through part of the year. Until the lakes are open to tidal fluctuations, they do not represent an ideal choice for a reference site.

Two reference sites, though, that are open to tidal fluctuations are located adjacent to Vancouver Lake (Figure 5). The first is along the southwestern margin of the lake. Within the interior of the lake, this reference site is an area of quiet water that supports an emergent and



Location of the two reference sites (A–Frenchman's Bar and B–Vancouver Lake) in Clark County, WA (USGS, Vancouver, WA-OR, 1961, photorevised 1978, and Sauvie Island, OR-WA, 1990).

FIGURE 5

scrub shrub community and with hydrology similar to Ross Island. The second reference site is behind a bar (known as Frenchman's Bar) along the Columbia River adjacent to Vancouver Lake. An examination of tidal data at the I-5 Bridge near Vancouver, Washington shows that the tidal regime in this portion of the Columbia River is very similar to the one at Ross Island.

Figure 6. The southwest edge of Vancouver Lake.

The photograph on the left shows the mature Pacific willow community with reed canarygrass in the understory. The photograph on the right shows a red osier dogwood/Pacific willow community. Both photographs were taken during high water and do not show other herbaceous species that may be present later in the growing season.

Figure 7. The Frenchman's Bar reference site

The photograph on the left shows the Columbia River willow community during a high water event. The photograph on the right shows a dense Pacific willow community with reed canarygrass growing on the margins.

Another reference site is a small wetland within the Willamette Park along the west bank of the river. This wetland, which is depicted on Figure 1, is located north of a boat launch ramp within the park. The substrate in this area has been aggrading for 10 years and now supports a dominant stand of willows (Columbia River willow and Pacific willow) growing in fine substrate (silts) on a very shallow slope (i.e. between 30:1 and 40:1). In addition to the willows, the outer perimeter of the wetland supports a variety of emergent wetland plants including western goldenrod (*Solidago occidentalis*) and soft rush (*Juncus effusus*). Although the wetland is relatively small (less than 0.5 acre) it provides valuable habitat for a variety of wildlife.

Other areas reviewed as potential reference sites include the lowlands at the north end of Sauvie Island, within Scappoose Bay, and at Ridgefield, Washington (all along the Columbia River). These locations possess large wetlands and many sloughs. However, the wetlands accessed as part of this study were isolated from the daily tidal fluctuations and do not possess the hydrologic regime of Ross Island. Also, the banks of the sloughs and channels are scoured from the large Columbia River currents and do not contain adjacent wetlands.

3.2 Description of Three Reference Sites

The reference sites at Vancouver Lake, Frenchman's Bar and the Willamette Park were selected as sites that exhibited similar hydrologic conditions as the wetland/riparian area proposed for the Ross Island lagoon. These sites also have vegetation communities that contain similar zonation and vegetation that are proposed for the reclamation effort. Table 1 compares the features of the three sites. A more detailed description is included in the sections below.

Table 1. Comparison of three reference sites reviewed for the Ross Island Sand and Gravel Reclamation area.

Name	Vegetation	Substrate	Tidal range	Flood range
Willamette Park	*Salix lasiandra* *Salix fluviatilis* *Solidago occidentalis* *Juncus effusus*	sandy silt	Same as Ross Island	Same as Ross Island
Frenchman's Bar	*Salix fluviatilis* *Salix lasiandra* *Phalaris arundinacea* *Solidago occidentalis* *Amorpha fruticosa*	Medium sand along edge of slough; silt in higher backwater areas	Same as Ross Island	Same as Ross Island
Vancouver Lake	*Juncus spp.* *Salix lasiandra* *Cornus sericea* *Phalaris arundinacea* *Populus trichocarpa*	Silt	Approximately 1 foot maximum	Same as Ross Island

3.2.1 Hydrology

The southwestern margin of Vancouver Lake was chosen as one reference site because it is subject to similar daily tidal fluctuations seen at Ross Island and because it supports areas of emergent wetland. Vancouver Lake is connected to the Columbia River via a "flushing" channel with a tidegate, which was constructed at the lake's southern end approximately 15 years ago. This tidegate allows flood peaks similar in elevational range to the peaks seen at Ross Island. Water enters the lake through the flushing channel, but discharges through Lake River; a channel at the northern end of the lake.

The southwestern shore of the lake has a low sloping edge from approximately 20 feet NAVD to an elevation of 4 feet NAVD, approximately 250 feet offshore. A stage exceedance probability curve constructed for 1999 at the Columbia River Bridge at Vancouver suggests the 4-foot elevation is exceeded approximately 93% of the time, the 6-foot elevation is exceeded approximately 77% of the time, the 8-foot elevation is exceeded approximately 60% of the time and the 10-foot elevation is exceeded approximately 40% of the time.

Data collected for a study of the Shillapoo Lakes area (adjacent to Vancouver Lake) through the spring and summer of 1998 suggest that tidal fluctuations at the north end of Vancouver Lake are damped by hydraulic restrictions in the Lake River to the north and at the tidegates at the end of the flushing channel. The daily tidal fluctuations within the lake are less than a foot compared to 2-3 foot fluctuations within the flushing channel.

The second reference site is immediately north of the flushing channel at a location called Frenchman's Bar. This longitudinal bar of medium grained sand separates a backwater area, which supports a scrub-shrub wetland. The backwater area is connected to the open river through a narrow channel at its northern end. At higher levels of the Columbia River, this area is inundated. On June 12, 2002 when the Columbia River reached 10 feet CRD at Vancouver, the backwater area was flooded with approximately 1 foot of water.

The Willamette Park reference site located on the west bank of the Willamette River near the south end of Ross Island has a tidal regime very similar to the regime with the Ross Island lagoon. The river bank has a low gradient from 7 to 1 feet RID with the result that approximately 150 feet of sediment is exposed at the lowest river levels. The outer edge of the shoal is slightly higher than some of the area closer to shore, creating a shallow pooled area at some low tides. Wave wash across this shallow slope is apparently quite severe at some tidal stages with heavy boat traffic in the river.

3.2.2 Soils/Substrate

Soils within and adjacent to Vancouver Lake tend to be rather fine grained. The 1960 Soils Conservation Service mapping indicates that much of the soil along the edge of Vancouver Lake is Sauvie silt loam and Sauvie silty clay loam. These soils typically have 15 -25 % mass retained on the number 200 sieve. Permeability is on the order of 0.2 –0.6 inches per hour. The very edge of the lake is mapped as Newberg silt loam, which has a sandy horizon at depth. The upper 7 inches of this soil is a silt loam with 20 – 30 % mass retained on the 200 sieve and a permeability of 0.2 –0.6 inches per hour. The subsoil has 40-45% passing the 200 sieve with a permeability of 2 –6 inches per hour. The local soil stratigraphy suggests the area is underlain mostly by fine silty sediments with local sandy sediments along the lake edge produced be wave winnowing.

Fine sand along the portions of the lake edge near the constructed flushing channel and a developed park area appear to originate from Columbia River dredge spoils, though the underlying sediments are probably much finer.

The Frenchman's Bar reference site is underlain by fine silty sediments and is separated from the riverine communities by a levee of coarser (medium grained) sandy material.

The Willamette Park reference area is underlain by silt and fine sand. The outer edge of the shoal is a bar of fine sand. Areas behind this are filled with at least 3 feet of unstratified silt. The area at slightly higher elevations along the shore has a higher fraction of sand from wave winnowing at higher river stands. The steeper banks rising to the main park area are comprised of coarse fill. The northern edge of the shoal is the Willamette Sailing Club facility, which is periodically dredged to maintain navigability. The shoal appears to have rather rapid sediment deposition resulting from its topographic position downstream from the boat launch ramp and perhaps some hydrodynamic effect of the Willamette Sailing Club facilities.

3.2.3 Vegetation

The Vancouver Lake reference site has a relatively gentle slope that exhibits the plant zonation targeted for the Ross Island Lagoon wetland. A fringe of black cottonwoods (*Populus balsamifera trichocarpa*) spaced approximately 6 to 10 feet apart, with a sparse understory of snowberry (*Symphoricarpos albus*) and California dewberry (*Rubus ursinus*) grows along the drier, higher portions of the lake's riparian zone. This lake-margin of cottonwoods is fairly well defined.

At lower elevations and immediately to the east of the cottonwood fringe is an approximately 30-feet wide area partially filled with red-osier dogwood (*Cornus stolonifera*), with small patches of reed canarygrass (*Phalaris arundinacea*), creeping bentgrass (*Agrostis stolonifera*), Columbia sedge (*Carex aperta*), pointed rush (*Juncus oxymeris*) and creeping jenny (*Lysimachia nummularia*). These emergent plants grow within the open areas of the dogwood stand.

Zones of willow (dominated by Pacific willow (*Salix lucida lasiandra*) are prevalent at even lower elevations adjacent to the cottonwood fringe. The willow stands vary in width between approximately 50 and 100 feet and are closely spaced at 4-8 feet. Many have been chewed off at 1.5 to 2 feet above the ground surface by beavers. In the areas of regrowth, the willow shoots forms a dense thicket precluding development of an understory. The outer edge of the willow thicket, which is exposed at lower tides, is an emergent wetland dominated by reed canarygrass, water horsetail (*Equisetum fluviatile*), common spikerush (*Eleocharis palustris*), and pointed rush (*Juncus oxymeris*).

The age of the plant communities within the lower elevations of the lake margin are not known, but most of the trees appear to be younger than the 15 years since the construction of the flushing channel.

The Frenchman's Bar reference site is surrounded by black cottonwoods. Lower areas within the backwater area created by the bar and that contain finer sediments are populated by Pacific willow (*Salix lucida lasiandra*). Columbia river willow dominates at lower elevations within the interior of the backwater area. Emergent vegetation within the backwater area consists primarily of reed canarygrass within the southern portion. Portions of the backwater edge also have soft rush (*Juncus effusus*), speedwells (*Veronica* spp.) and creeping jenny. In the coarser sand areas nearer the Columbia River are found clusters of Indigobush (*Amorpha fruticosa)* with some baltic rush (*Juncus balticus*).

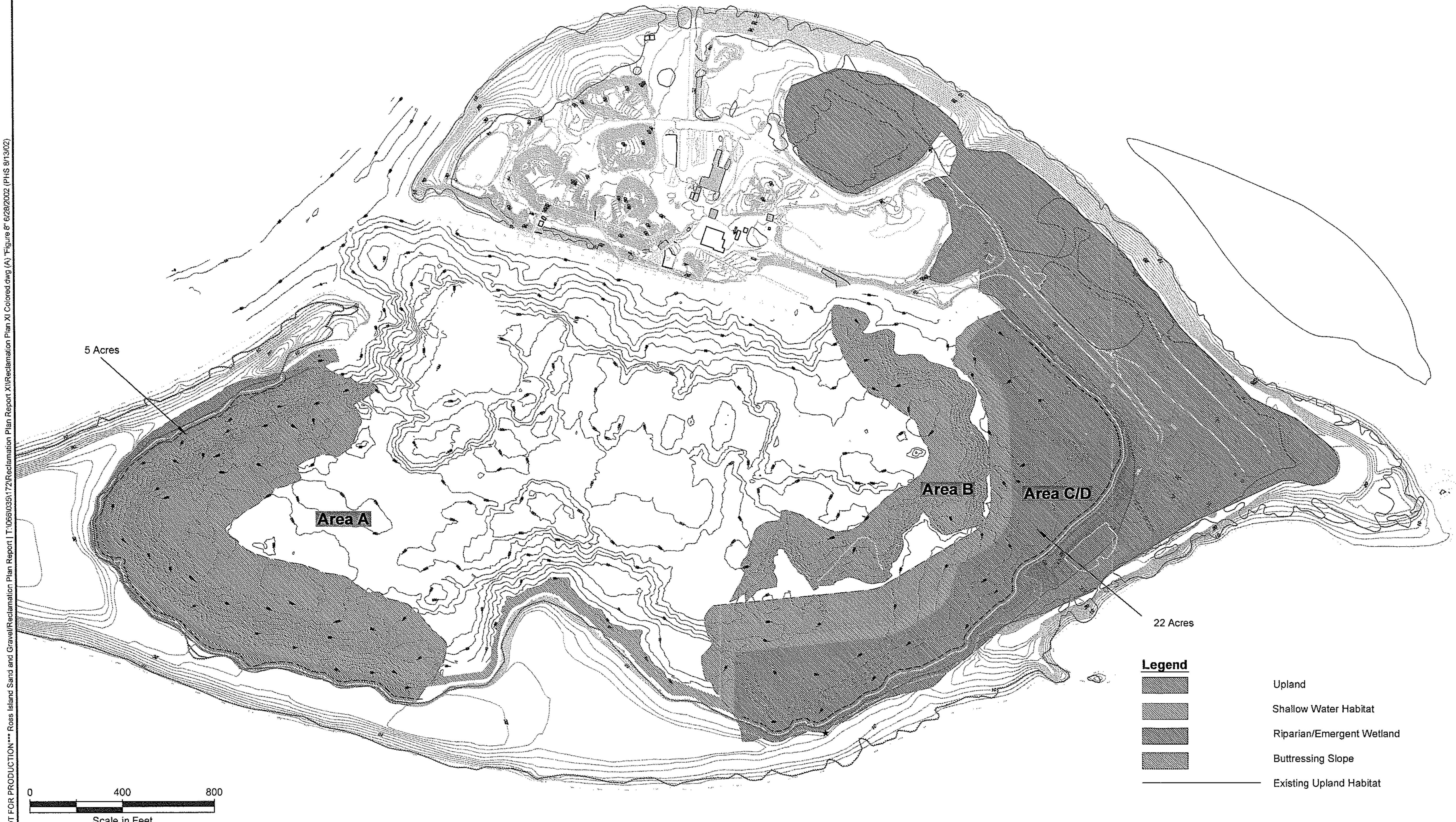
The Willamette Park reference site is covered mostly with Columbia River willow and Pacific willow (*Salix lasiandra*). The Columbia River willow tends to occur at the outer edge of the wooded zone as a low thicket with the pacific willow closer to the river bank. Along the river bank are small amounts of reed canarygrass and yellow iris (*Iris pseudacorus*). Western goldenrod (*Solidago occidentalis*) is scattered near the outer edge of the woody vegetation. The outer edge of the shoal has very little vegetation apparently because of wave-wash and rapid sediment movement.

4.0 FEASIBILITY DETERMINATION

Establishing a wetland community within the Ross Island lagoon will require creating a slope with a similar substrate, hydrologic regime and geometry as the selected reference sites (i.e. the margin of Vancouver Lake, the backwater area created by Frenchman's Bar, etc.). We believe this is possible primarily because the Ross Island lagoon is isolated from the flood scouring of the main river and because a stable gentle slope can be created within the lagoon that will persist and support wetland plant communities. The proposed location of wetland creation is illustrated on Figure 8.

Also illustrated on Figure 8 is the location of riparian habitat, shallow water habitat and upland habitat. Riparian habitat will be created along the upper edge of the fill slope immediately bordering the wetland area. Upland habitat will be established along the north end of the lagoon and within the higher portions of the southern end of the island. Shallow water habitat will be within Area A at the northern end of the lagoon and adjacent to Area C/D.

As discussed above, larger reference sites along the Willamette River, such as Mocks Bottom, have been filled and no longer exist. Others, such as Oaks Bottom, have been isolated from daily tidal fluctuations of the river and no longer resemble pre-settlement conditions. Although large wetlands were likely never associated with Ross Island, the reclamation plan will restore a portion of the tidal backwater habitat lost to industrial development in the lower Willamette River.



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Landau Associates

Pacific Habitat Services, Inc.

Ross Island Sand & Gravel
Portland, Oregon

Proposed Fill Plan and Habitat Creation

Figure
8

The successful creation of wetland will require that the substrate of the created wetland be much less permeable than the coarse sandy materials generally found along the banks and bars of the river. Emergent wetlands appear to be generally lacking from the lower Willamette River because of the lack of backwater habitat. Scour in the main river steepens the topography of the banks and does not allow for the deposition of material with a fine particle size. The outer banks of Ross Island, for example, generally have steeper slopes and appear to be comprised of Pilchuck Sand, the mapped soil unit for the area. Similar conditions are found along the Columbia River below the confluence. Few plants are adapted to a regime where they are exposed to daily tidal fluctuations of up to three feet. Even fewer plants withstand growing in a coarse substrate, with little organic matter and quickly fluctuating soil-water pressures.

Emergent wetland and scrub-shrub communities are thriving, however, along the shores of Vancouver Lake, which is subject to the same long-period water level fluctuations as the lower Willamette River. Although the areal extent of emergent vegetation is relatively small (an analysis of aerial photographs has not been conducted), a variety of plants, both native and non-native are established.

We believe that in order to achieve these communities within the Ross Island lagoon, the reclamation plan needs to address the following factors:

4.1 Slope Geometry

The wetland will be created on a gentle slope that will vary between 2% (50:1) to 3% (33:1) in order to reduce the effects of the daily tidal fluctuations and the associated physiological stresses that this hydrologic regime places on vegetation. A fluctuating water level has greater effect on a steeper slope than a gentler slope. If the slope is too steep, buffering the soil water pressure fluctuations will require more aquitard than is feasible at this site.

We propose that the surface of the slope be created from an elevation of approximately 12 feet RID at the upper edge to approximately 1 feet RID at the lower edge. A slope approximately 400 to 500 feet long is possible within the lagoon.

The finished slope should not be uniform, but should contain irregularities. However, these irregularities should not be sufficient to create an impoundment and trap fish. It is likely that the daily tidal fluctuations and the annual higher water events will play a significant and long-term role in shaping slope geometry. A series of linear channels with a depth of 1 foot, width of 2 feet and long slope spacing of 300-400 feet will be initially with the same downslope gradient as the general slope for the initial construction phase. The subsequent construction phases will have channel configurations designed to match the geomorphic response of the initially installed channels.

The material will be placed during the in-water work periods of July 1 through October 31st and December 1st through January 31st. The material will be placed from a barge by RIS&G staff. The details of how the material is actually placed within the lagoon and how long it will take will be determined by RIS&G with assistance by PHS.

4.2 Substrate

At this time, the type of material that will be used to create the slope is not known. However, it is possible that much of the material will be sand from dredging projects. If this is the case, it will be necessary to place a layer of relatively impermeable material on top of the sand to hydraulically separate the surface layers from the well-drained materials beneath.

We propose that an aquitard (relatively impermeable layer) be placed approximately parallel to the surface of the slope. The thickness of the aquitard will depend on the contrast in hydraulic properties between the two horizons.

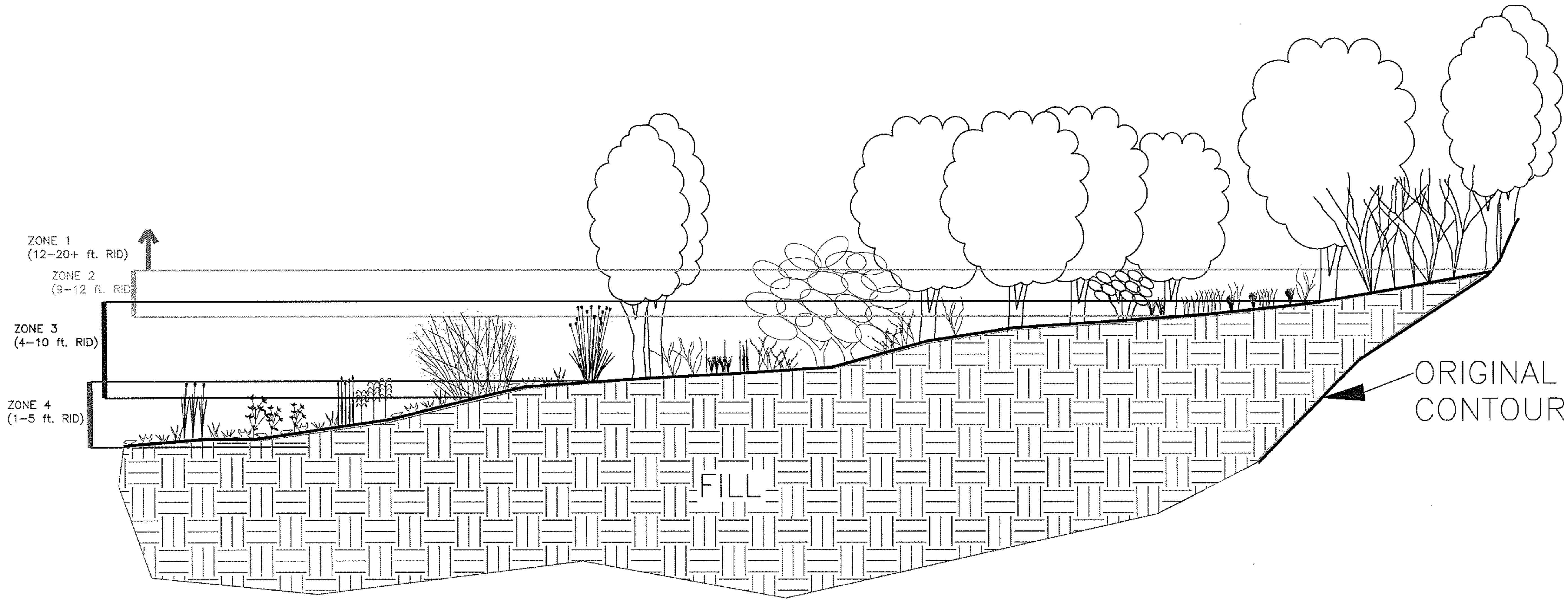
We feel that the aquitard is necessary to change the drainage within the upper horizon from mainly vertical to more horizontal, which will allow the upper profile to respond in a hydraulically steady manner. Vertical water movement through coarse-grained material is quicker than vertical water movement through finer-grained material. In coarse-grained material, the relatively rapid water surface fluctuations create rapid fluctuations in soil-water pressure. Soil-water pressure effects the ability of the plants to transport water and to survive. Pilchuck sand (the mapped series for Ross Island) is a relatively coarse alluvium with little capacity to buffer changing pressures. The fluctuations of soil-water pressure are not as severe in soils such as Sauvie silty clay loam, which is one of the soils mapped along the edge of Vancouver Lake. As such, the ideal aquitard is probably a silty clay loam, though any substrate with saturated hydraulic conductivity of less than approximately 0.5 inch per hour will likely suffice.

4.3 Vegetation Communities

We propose to plant the slope in zones corresponding to inundation regimes for the vegetation. These idealized zones are depicted on Figure 9. The lowest level of the wetland (Zone 4) will be inundated for much of the year and emerge from the water for the first time after the summer solstice. The highest zone (Zone 1) will occasionally be inundated during flood events, but will likely be dry throughout the year. The idealized location and species proposed for each zone are listed below in Table 2.

Table 2 Idealized zonation of plants based on a range of elevations for a reclaimed slope within the Ross Island Lagoon.

Zone 1 (Upland)	12-20+ feet RID	Size	Spacing
Acer macrophyllum	bigleaf maple	2-3 feet	10 feet
Bromus carinatus	California brome	seed	1 lb/1000 ft^2
Elymus glaucus	blue wildrye	seed	1 lb/1000 ft^2
Holodiscus discolor	oceanspray	1-2 feet	7 feet
Populus trichocarpa	black cottonwood	2-3 feet	7 feet
Rhamnus purshiana	cascara	2-3 feet	10 feet
Sambucus mexicana	blue elderberry	1-2 feet	7 feet
Symphoricarpos albus	snowberry	0.5-1 feet	3 feet



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Typical cross–section through the proposed fill slope. Graphic illustrates proposed plants.

FIGURE 9

Pacific Habitat Services, Inc.

Table 2, continued

Zone 2 (Riparian/Scrub Shrub Wetland)	**9-12 feet RID**		
Agrostis exerata	spike bentgrass	seed	0.1 lb/1000 ft^2
Elymus trachycaulus	slender wheatgrass	seed	1 lb/1000 ft^2
Lonicera involucrata	twinberry	1-2 feet	5 feet
Oemleria cerasiformis	osoberry	1-2 feet	6 feet
Populus balsamifera trichocarpa	black cottonwood	2-3 feet	7 feet
Salix scouleriana	Scouler's willow	2-3 feet	10 feet
Zone 3 (Scrub Shrub Wetland)	**4-10 feet RID**		
Agrostis exerata	spike bentgrass	seed	0.1 lb/1000 ft^2
Cornus stolonifera	red-osier dogwood	1-2 feet	5 feet
Deschampsia cespitosa	tufted hairgrass	seed	0.1 lb/1000 ft^2
Fraxinus latifolia	Oregon ash	2-3 feet	10 feet
Salix fluviatilis	Columbia River willow	2-3 feet	4 feet
Salix hookeriana	Hooker's willow	2-3 feet	7 feet
Salix lucida lasiandra	Pacific willow	2-3 feet	6 feet
Salix sitchensis	Sitka willow	2-3 feet	7 feet
Zone 4 (Emergent Wetland)	**1-5 feet RID**		
Alopecurus geniculatus	Water foxtail	seed	0.1 lb/1000 ft^2
Bidens cernua	nodding beggar's ticks	seed	0.2 lb/1000 ft^2
Bidens frondosa	tall beggar's ticks	seed	0.2 lb/1000 ft^2
Carex aperta	Columbia sedge	plugs	2 feet
Cyperus aristatus	awned flatsedge	seed	0.1 lb/1000 ft^2
Elatine brachysperma	short-seeded waterwort	plugs	5 feet
Elatine rubella	red mud-purslane	plugs	5 feet
Eleocharis ovata	ovate spikerush	seed	0.1 lb/1000 ft^2
Gratiola ebracteata	bractless hedge-hyssop	plugs	5 feet
Gratiola neglecta	common hedge-hyssop	plugs	5 feet
Juncus bufonius	toadrush	seed	0.1 lb/1000 ft^2
Juncus oxymeris	pointed rush	plugs	2 feet
Leersia oryzoides	rice cutgrass	seed	0.2 lb/1000 ft^2
Limosella aquatica	mudwort	plugs	5 feet
Lindernia dubia	false-pimpernel	plugs	5 feet
Ludwigia palutsris	water-purslane	plugs	5 feet
Ludwigia peploides	jussiaea	plugs	5 feet
Lythrum portula	peplis	plugs	5 feet
Polygonum hydropiperoides	waterpepper	plugs	3 feet
Rotala ramosier	toothcup	plugs	5 feet
Sagittaria latifolia	wapato	plugs	2 feet
Scirpus tabernaemontani	softstem bulrush	plugs	3 feet
Scirpus cyperinus	woolly sedge	plugs	3 feet
Verbena hastata	simpler's joy	plugs	4 feet

The response of wetland plants to episodic inundation varies. Submergent plants, which remain entirely below the water surface (i.e. below the lower elevations of Zone 4) photosynthesize by direct gas or ionic exchange within the water column. These plants have populations that tend to be transient in time and space. The alkalinity of the Willamette River is probably high enough to maintain a bicarbonate ion supply for these plants during the growing season. These plants will be affected significantly by aquatic predators (e.g. fish and ducks) and by turbidity within the water column. Under the current management regime of the lagoon (i.e. no dredging), near-surface turbidity seems to be limited to a fringe at the water's edge.

Through the low-water conditions of late summer, the lagoon will experience tidal fluctuations of 2-3 feet depending on the phase of the moon, Willamette River discharge controls, and Columbia River discharge controls. Most vascular plants, which are adapted to life in these water level fluctuations, operate by photosynthesizing during periods of exposure to air and shutting down during periods of inundation. A few perennial emergent forbs may have sufficient internal gas storage to maintain an internal recycling of respiration and photosynthesis, but most adapt by rapidly starting and stopping when they meet the air. These are mostly annuals germinating from a seedbank when daily water temperature fluctuations are favorable. They will not be greatly affected by turbidity within the water column. Perennial rushes and sedges can deal with rapid tidal fluctuations and will be adapted to the outer edge of the wetland. These plants will be installed through the zone between 2-4 feet RID. These plants will also be installed as plugs when this zone is exposed to the air on a low tide about the first of July.

Annuals adapted to this regime will dominate Zone 4, though a few perennial herbaceous plants may extend down to this lower zone. The community of skeletal remains of annuals in Zone 4 that retain a seedbank within the zone will probably take several years to develop.

The ability to shut down in periods of inundation during the active growth period is limited to a few woody plants such as Oregon ash and willows. These plants will thrive in areas that are inundated in the spring periods of fish migration. A few species, such as indigobush may thrive under these conditions. However, the status of whether these plants are considered invasive is uncertain. The willows of Zone 4 will be installed in early March before the reservoir releases for outmigrating spring chinook. All of the woody plants in Zones 1-3 will also be installed in early March before the spring high water periods. This will allow the plants some time to adapt to the rooting medium before leafing out and minimize the stress of later inundation.

The grass seeding above 8 feet RID should also be done in early March. Seeding below this elevation will have to wait for lower water levels after the salmonid outmigration (late June-early July).

Many woody plants can survive high winter water levels. The cottonwoods that form the dominant woody canopy on Ross Island are well suited for areas that are occasionally inundated during winter storms.

Plant communities around the perimeter of Vancouver Lake grow in zones reflecting their adaptation (in part) to a specific range of water levels. The creation of a gentle slope within the Ross Island lagoon will also create a range of specific hydrologic conditions and allow for the establishment of planting zones.

Many variables effect plant growth and it is likely that not all plants will survive or stay contained within the zones described above. It is suggested, therefore, that "tongues" of selected plantings extend across the elevations (or zone borders) in order to ensure that plants are exposed to varying conditions.

To increase the likelihood of success of woody plants through the first growing season, an overnight weekly irrigation equivalent to 1.5 inches of rainfall is preferable between June 20 and September 20. For the second growing season and for as many growing seasons as is deemed necessary, the plants can be similarly irrigated every two weeks. Irrigation should not be necessary for plants below +8 feet RID.

4.4 Shallow Water Habitat

Outmigrating juveniles (chinook, steelhead, and coho) have been documented in the lagoon during the outmigration. To augment the habitat for these salmonids, an area of shallow water habitat will also be created within Area A at the northern end of the lagoon. The habitat will extend from an elevation of approximately +1 foot RID, which may support a fringe of emergent vegetation, to an undulating bench, which will be created with a maximum width of 140 feet at an elevation of approximately –10 feet RID. The Corps reservoir releases to assist outmigration may raise water levels in the lagoon from +5 feet RID to a level of +10 feet RID. With these water levels, the shelf will have the 15-20 feet water depths considered important for salmonid habitat. Numerous pieces of large woody material (whole trees with root wads and branches still intact) will be anchored on the bench to provide structural complexity and refuge that is currently lacking in the lagoon. The bench will provide a substrate for benthic macroinvertebrates, which will in turn provide food for juvenile salmonids. This bench will be supported by the buttressing slope, which will be created at an approximately 3:1 grade.

4.5 Upland Habitat

Approximately 5 acres of upland habitat will be created at the north end of the lagoon and approximately 32 acres of upland habitat will be created at the southern end of the lagoon. A portion of the southern end of the lagoon has already been planted with native trees.

Upland plantings along the northern end of the lagoon in the steeper upland fill slopes will consist of black cottonwoods, red elderberry (*Sambucus racemosa*), and Scouler's willow (*Salix scouleriana*). The species listed in Zone 1 will be planted within the upland areas at the southern end of the lagoon.

To ensure their survival, weekly spray irrigation will be provided for woody plants above an elevation of approximately 8 feet RID. The irrigation system will deliver the equivalent of 1.5 inches of rainfall once a week between June 20 and September 20. For the second growing season, the irrigation system will be operated every two weeks through the same summer period. Irrigation beyond the second season should not be needed unless new plants have been installed on the site.

4.6 Success Criteria

Wetland/Riparian Habitat

The successful growth of native vegetation and the control of non-native vegetation will form the basis of a successful reclamation effort. Focusing on the success of the vegetation assumes that a fill slope will be created between 2% (50:1) and 3% (33:1); that the lower elevations of the slope will be approximately +1 feet RID; that an aquitard will be placed within the surface of the fill slope; and that each of the planting zones will be exposed to the hydrologic regimes described in the sections above. It is anticipated that variations to this idealized scenario are unavoidable given the large amount of fill that needs to be placed to create the slope and the fact the fill will be placed using a barge and, therefore, cannot be precisely located. For this reason, it is assumed that some alteration of the fill slope may be needed to correct situations that vary widely from the assumptions described above.

The wetland and riparian creation will be considered successful if (1) no more than 20% of the wetland and the planted riparian area below 10 feet RID is covered with reed canarygrass and no more than 20% of the area above 10 feet RID is covered with Scot's broom (*Cytisus scoparius*) or Himalayan blackberry, (2) if at least 75% of the woody plants installed above elevation 4 feet RID (in the wetland, riparian, and upland areas) are surviving 5 years after installation; and (3) that approximately 22 acres of wetland and riparian habitat will be created on the fill slope at the southern end of the lagoon and that a portion of the fill slope meets the definition of jurisdictional wetland as described in the U.S. Army Corps of Engineers, Environmental Laboratory, 1987. *Corps of Engineers Wetland Delineation Manual. Technical Report Y-87-1* (1987 manual).

The exact area of wetland that will be created will primarily depend on the water level fluctuations within the lagoon (which are dependent on dam releases and precipitation). It is assumed that wetland will be created below an elevation of 5 feet RID if the fill slope is inundated or saturated to the surface for more than 12.5% of the growing season. Wetland may be created below an elevation of approximately 10 feet RID if the fill slope is inundated or saturated to the surface for more than 5% of the growing season. Based on these elevations, it is estimated that between 8 and 16 acres of the 22-acre wetland/riparian habitat area will satisfy the jurisdictional definition of wetland.

Given the uncertainty of establishing herbaceous vegetation at lower elevations, we feel that RIS&G should not be held to a specific success criteria. However, an estimate of total cover within the lower zone (Zone 4) of the reclamation area will be assessed and photographs of the vegetative cover will be included in the annual monitoring reports.

Upland Habitat

The reclamation of upland areas will be considered successful is at least 75% of the trees and shrubs are living and in good health five years after their installation. If the plant counts fall below the 75% survival level 3 years after installation, other trees and shrubs will be installed to increase the number to the requisite 75%. If necessary, healthy volunteer trees and shrubs of the same species or native species approved by the Division of State Lands as an appropriate substitute can be counted as replacements in order to reach the 75% survival level.

4.7 Monitoring and Maintenance

The reclamation areas will be monitored and maintained annually to determine whether the effort is successful. Data collected during the monitoring period will be included in an annual monitoring report to be provided to interested parties and regulatory agencies. The report will include a discussion on the success of the reclamation effort, issues that may affect the success of the plants and proposed management options; and photographs illustrating the reclamation area.

Hydrology Monitoring

The creation of jurisdictional wetland on the fill slope requires that the three required criteria of the 1987 Manual are satisfied: wetland hydrology, dominant hydrophytic vegetation and hydric soils. It is assumed that if the fill slope is graded correctly, it will be exposed to a hydrologic regime that satisfies the jurisdictional definition of wetland hydrology as included in the 1987 manual. It is also assumed that if wetland hydrology is created, hydrophytic vegetation will dominate and soils with redoximorphic features (i.e. hydric soils) will develop.

Areas that always meet the jurisdictional definition of wetland hydrology are those that are inundated or saturated at least 12.5% of the growing season. With supporting wetland characteristics (i.e. dominant hydrophytic vegetation or hydric soils) areas may be inundated only 5% of the growing season. The growing season is defined as the period of time between the last killing frost (defined as the last winter date with minimum temperature of 28° F for five years out of ten) to the first killing frost (the first winter date with minimum temperature of 28°F for five years out of ten). For Portland (during the years 1951-1976) the last killing frost was March 4 and the first killing frost was December 1. This gives a growing season of 272 days.

For the fill slope at the southern end of the lagoon, this means that soils saturated to the surface for less than 14 days (5%) between March 4 and December 1 do not satisfy the wetland hydrology criterion. Soils saturated to the surface for more than 34 days (12.5%) between March 4 and December 1 are definitely considered to have wetland hydrology. Soils with saturation regimes between these extremes require additional evidence to satisfy the wetland hydrology criteria.

The hydrology of the slope throughout the year can be determined by comparing the elevations of the fill slope with the river level fluctuations measured at the Corps of Engineers river gage on the Morrison Bridge. The fluctuations of the water level in the Ross Island lagoon is, of course, closely related to the water surface fluctuations at the Morrison Bridge.

An analysis of the Corps' data, indicates that the water surface elevation of the Ross Island lagoon (River Mile 15) is approximately 0.2 feet above the water surface at river mile 13 near the Morrison Bridge. Lower flows may have a slightly steeper gradient, but with no more than 0.5 feet in river surface elevation difference.

An as-built topographic survey of the fill slope will be prepared each year to establish the slope's elevations. This topographic survey will be compared with the corrected water levels within the lagoon and areas that satisfy the wetland hydrology criterion will be determined. As vegetation becomes established, it is anticipated that the wetland area may increase due to the dominance of wetland plant communities.

A wetland delineation, to be concurred with by the Division of State Lands, will be conducted at the end of the monitoring period to determine the final wetland boundaries.

Vegetation Monitoring

To determine the success of the plants, monitoring will occur in the late summer using a belt transect placed at 50 feet intervals along the outer edge of the planted zone. Transects will extend 5 feet on each side of a straight line from a baseline established at the upper edge of Zone 1 and extending to the edge of the water. The transects will be broken into 20-foot plots starting furthest away from the lagoon. Areal cover of Himalayan blackberry, Scot's broom, and reed canarygrass and other invasives will be assessed by ocular estimate as a percent of each 10 foot x 20 foot plot. The presence and abundance of woody species will be established within each of the plots along each of the transects.

The transects will cover approximately 20% of the fill slope. The counts for each woody plant within each of the 10 x 20 plots will be used as a sample population for the entire woody plant population. With these samples, we will be able to make a statistical estimate of the plant populations to a given confidence level using the standard deviations and means of the samples.

This same method will also be used at the northern end of the lagoon to establish the success of vegetation within the upland area.

As discussed above, an as-built topographic survey of each new section of the fill slope will be conducted. This survey will aid in determining the optimal elevations for each of the species installed and the elevations at which new plants are colonizing.

Non-Native Plant Control

The vegetation zones across the fill slope will likely have to contend with the invasion of weedy species. Blackberries and Scot's broom will likely grow in the higher elevations of the fill slope. Reed canarygrass and creeping bentgrass (*Agrostis stolonifera*) will likely be present in the central elevations of the wetland. In addition, the lowest elevations of the slope may provide habitat for non-native annuals that are adapted to the daily tidal fluctuations.

Controlling blackberries and reed canarygrass during the initial plant establishment period may be necessary to allow the desired plants to thrive. As such, we propose semiannual mowing of the invading plants during the first two years (or as deemed necessary) after initial installation to control their growth.

If more than 20% cover of reed canarygrass is within the wetland area, the grass growing above the water will be mowed three times during the growing season (the first of June, the middle of July, and the middle of October). Areas with more than 20% cover of Scots broom and Himalayan blackberry will be treated following the recommendations of the Portland Parks and Recreation *Pest Management Program* and methodologies of the City's Revegetation Program.

Adaptive Management

Due to the array of variables that can affect plant growth, it will be necessary to adaptively manage the reclamation effort. Issues that may require changes in how the reclamation area is managed include, but are not limited to: competition from non-natives not considered by this study (e.g. purple loosestrife (*Lythrum salicaria*)); predation from herbivores (e.g. geese, beaver, nutria); long-term and short-term instability of the fill slope; plant mortality from annual creation of the fill slope (e.g. smothering newly planted species with fill material); creation of potential fish entrapment sites as the slope is filled; and elevations or angle of slope not conducive to the proposed range of hydrologic regimes.

The annual report will describe any physical changes that may be required to the reclamation area and any changes in management strategies. These changes will be discussed with the agencies prior to implementation the following year.

4.8 Construction and Monitoring Phasing

The buttressing slope at the south end of the lagoon (Area B) will be the first area of fill placed as part of the reclamation plan. This butressing slope may take three years to form and will likely have to be in place before the wetland/riparian area (Area C/D) can be created. The first lobe of wetland/riparian creation will likely be an area along the southwest side of the lagoon near the north end of the earthen berm between Ross Island and Hardtack Island. This lobe will be graded at an approximately 3% slope from an elevation of 12 feet RID on the landward side to an elevation of 1 foot RID at the outer edge of the fill. The first phase of wetland construction will consist of a single year's fill (approximately 450,000 yd^3) extending southeast from the northwestern corner of the wetland. The basal portion of the fill will probably be fine sand dredge spoil. After the first lobe has been placed it will be planted and then monitored. Each of the lobes will be monitored for five years. Fill will be placed within Area C/D until the approximately 22-acre wetland/riparian area has been created.

Fill will continue to be placed within the lagoon until the approximately 4.5 million yd^3 have been placed to complete the entire reclamation plan. The final phases of the reclamation plan will be to create the upland and shallow water habitat and the buttressing slope at the northern end of the lagoon (Area A). This area will also be monitored for five years after the plants have been installed. Monitoring will begin the first year after the plants have been installed in Area C/D and end five years after the last plants have been installed in Area A. The entire monitoring period, therefore, may extend over more than 10 years.

5.0 REFERENCES

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U.S. Geologic Survey 7.5 Minute topographic map. Portland OR-WA quadrangle, 1961, photorevised 1970 and 1977, and Lake Oswego, OR quadrangle, 1961, photorevised 1984.

APPENDIX B

Major Themes from Workshops

Expert Panels - Ross Island Reclamation Technical Workshops

Workshop #1 – Aquatic Species (10/4/2001)

Peter Bayley
Fisheries and Wildlife
Oregon State University

Kevin Coulton
Philip Williams Associates Ltd.

Paul Fishman
Fishman Environmental Services

Stan Gregory
Fisheries and Wildlife
Oregon State University

Dave Ward
ODFW - Northwest Region

Gordon Grant
Research Hydrologist
USDA Forest Service – PNW Research Station

Workshop #2 – Uplands (11/20/01)

Peter Bayley
Oregon State University

John Christy (historic vegetation)
Oregon Natural Heritage Program

Char Corkran (reptiles/amphibians)

Paul Fishman
Fishman Environmental Services

Dick Forbes (mammals)

Dave Marshall (birds)

Major Themes from Fall 2000 Technical Workshops
Ross Island Reclamation Plan Review Process

Workshop #1 – Fish (10/4/2001)

- The lower Willamette River does provide important habitat for out-migrating juvenile salmonids, especially in complex, near-shore shallow water areas and at tributary junctions. The stretch of the Willamette in which Ross Island is situated could be especially important.
- The 1979 plan is "too static" and "too landscaped". Specifically, the finished elevations of the upland in the 1979 plan are too high and do not provide enough topographic and habitat diversity. Cottonwoods will not be successful over the long term at elevations currently prescribed by the plan.
- The transition zone from upland to aquatic areas is too steep and narrow.
- Ross Island should be looked at in the context of other planning and habitat work in this part of the river (e.g. Oaks Bottom, North Macadam, River Renaissance).
- The experts on both panels advocated a more "natural" approach to reclamation emphasizing long-term river and floodplain processes to improve fish and wildlife habitat. This approach to reclamation requires tools and actions that "set the stage" for more interaction between the river and island. For instance:
  - Grading to create diversity in upland elevations and make the current shoreline more irregular.
  - A more gradual, shallow transition from upland to water than the current 3:1 slope to support emergent vegetation species.
  - Allow natural deposition of sediments over time, assisted by lowering of the berm between Ross and Hardtack islands to allow entry of flow from the mainstem and more frequent inundation of shoreline areas.
- This approach requires accepting some level of uncertainty and a long-term, institutionalized commitment to monitoring, evaluation and adaptive management.

Workshop #2 – Uplands (11/26/2001)

- *Vegetation* - Historic vegetation would likely have included cottonwood and some oak at higher elevations, ash and willow in swales and in the transition zone between upland and river, possibly open wet prairie in some areas. In general, the island was wetter, and wetter more often, being subject to both winter and June floods. Still see remnants of historic vegetation in places like Ross Island, but much has been replaced by invasive plant species like English ivy, Himalayan blackberry, and others.

- *Birds* – Approximately 120 species of birds can be expected to occur regularly, assuming there is some marsh habitat. Noted that herons move around and shouldn't be counted on to stay at the island regardless of the approach to reclamation. Especially true if cottonwoods aren't being replaced and maturing – but even if they are the herons may relocate. Eagles exhibit similar behavior.

For birds, creating more marsh habitat (instead of more upland, as the 1979 plan requires) would be more beneficial. Similar upland habitat can be found in other places, but marsh habitat is very rare in the metropolitan area.

- *Amphibians and Reptiles* – Given historical topography and vegetation (including small channels and isolated seasonal ponds) – there would likely have been newts, tree frogs, long-toed salamanders. All these still occur on Sauvie Island. The island may or may not have had turtles. A "fringing marsh" would be more appropriate for turtles, but might also attract predators like bass and bullfrogs.

  In general, the island would be more amenable to amphibians with more elevation diversity; the more diverse the habitat the more species could perhaps "find a little corner".

- *Mammals* – With few exceptions, what occurred at the island historically is probably still there. There is not much difference between the mammals you would find in urban and non-urban settings for this type of habitat (e.g. a lot of small mammals like moles, mice and shrews; rabbits; otter, beaver and nutria, etc.). Reclamation will not make that much difference in mammal populations.

  The potential loss of higher uplands is not significant compared to the benefits of a gain in floodplain forest and marsh.

<u>Summary of Benefits of the Proposed Approach</u>

- As the river/island complex approaches more "natural" function, conditions will improve for diverse plant and animal species. Establishing a greater diversity of native vegetation will produce significant benefits for fish and wildlife as well.
- The proposed reclamation approach could produce beneficial results sooner than the 1979 plan.
- This approach creates significant opportunities for long-term education and research. Middle schools, high schools and others in the community could become involved in monitoring and documenting changes at the island. These important lessons could be applied elsewhere to great public benefit.
- This more "naturalistic" approach is arguably less costly than the 1979 plan.

<u>Caveats and Concerns</u>

- Uncertainty regarding long-term outcome – what will it look like? How do you measure success?
- Uncertainty regarding amount of "naturally available" sediments, sediment transport and deposition rates, risk from scouring, catastrophic events.
- Concern about exposing fish and wildlife to contaminated sediments.
- Public access/resource protection issues.
- Invasives will always be a problem.

APPENDIX C

Hydraulic and Sediment Transport Modeling for the Willamette River and Ross Island Lagoon (West Consultants, Inc.)

Hydraulic and Sediment Transport Modeling For the Willamette River And Ross Island Lagoon

FINAL REPORT

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May 3, 2002

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Hydraulic and Sediment Transport Modeling for the Willamette River and Ross Island Lagoon

Executive Summary

WEST Consultants, Inc. (WEST) was tasked by Landau Associates (Landau) to investigate hydraulics and sedimentation in the Willamette River and Ross Island Lagoon for Perkins Coie LLP on behalf of Ross Island Sand & Gravel. The investigation was to evaluate hydraulics and natural sedimentation in the lagoon due to flood flows, evaluate the possibility of headcuts within the lagoon and to explore options to increase sedimentation in the lagoon. A set of two-dimensional hydraulic and sediment transport models, the U.S. Army Corps of Engineers' RMA-2 and SED2D, were used in the analysis.

WEST reviewed numerous reports prepared by Landau, CH2M-Hill, GeoSea Consulting, the US Army Corps of Engineers, US Geological Survey, and others. The Willamette River was modeled for a 6.2 mile reach from the Broadway Bridge to about a mile below Elk Rock Island. Modeling consisted of both hydraulics and sedimentation to determine flow patterns and sedimentation rates that could be expected in Ross Island Lagoon due to natural flows in the river.

Modeling indicated that flow in the immediate area of Ross Island is controlled by a constricted area at the downstream end of Ross Island. This constriction limits the impact of lowering the berm between Ross and Hardtack Islands. Due to the downstream constriction, only very limited increases in flow and sedimentation resulted from the lowering of the berm. Currently flood waters overtop the southwestern edge of Ross Island and flow into the lagoon. This water then flows along the western edge of the lagoon and exits over the narrow western and northeastern portions of the island which separate the lagoon from the river and Holgate Slough. High flows do not cause significant velocities into or out of the lagoon via the entrance on Holgate Slough.

Based on model results it appears that natural sedimentation in the lagoon, consisting primarily of fines (silts and clays), is on the order of a few inches per year with more deposition occurring at the lagoon inlet. Increased deposition occurs at the inlet due to the reduction of flow velocities in the entrance allowing the suspended sediment load to deposit. Events that overtop the river side of the island do carry some sediment into the lagoon but flow patterns are such that most deposition is along the river side of the lagoon. Deposition rates were low over the entire range of flows modeled from 10,000 cfs to 459,000 cfs. Deposition of sediment in the lagoon could be expected to be fines based on the upstream geomorphology of the river.

A plan to lower the existing 900 ft long berm between Ross and Hardtack Islands to an elevation of +15 ft NGVD was also modeled. Model results showed some increase in the amount of flow

entering the Ross Island Lagoon but increases were not as dramatic as expected. The flow constriction at the downstream end of the island limited the impact of this option. The increased flow did not increase the depth of sedimentation but only increased the area of the lagoon receiving the maximum deposition for a fixed duration of flow.

The lowering of the berm would require erosion protection for the remaining berm as well as for the thin portions of the island between the lagoon and the river and Holgate Slough at the northern end of the lagoon. The erosion protection would be necessary to prevent the berm from eroding during a flood event with subsequent damage to the other perimeter areas at the northern end of the lagoon. Protection may also be necessary where the flows exit the lagoon to prevent floods from breaching the relatively narrow portions of the island at the northern end of the lagoon.

If the berm were to fail during a flood, a head cut could be propagated up the river from the lagoon as well as endangering the containment cells in the lagoon just downstream of the weir. Given the modest increase in flow and sedimentation in the lagoon it is unlikely that the increased risks of erosion, bank failures and other problems are warranted.

1. Introduction

WEST Consultants, Inc. (WEST) was tasked by Landau Associates (Landau) to investigate hydraulics and sedimentation in the Ross Island reach of the Willamette River for Perkins Coie LLP on behalf of Ross Island Sand & Gravel. The investigation was to evaluate flow patterns and natural sedimentation in the lagoon due to flood flows and to explore options to increase sedimentation in the lagoon. The evaluation of flow patterns and natural sedimentation required the use of two-dimensional hydraulics and sediment transport models. The U.S. Army Corps of Engineers' (Corps) RMA-2 and SED2D models were used to perform this analysis in conjunction with the SMS model interface.

1.1 Scope

The study, as commissioned by Landau Associates, consisted of developing an existing condition hydraulic and sediment transport model of the Willamette River upstream and downstream of Ross Island as well as for the Ross Island Lagoon and Holgate Slough. This model was to estimate existing deposition rates in the lagoon for various flood flows that overtopped the island perimeter for both existing, proposed lowered berm conditions, and a proposed fill scenario.

Two proposed plans were developed and studied. One plan consisted of lowering the existing berm between Ross and Hardtack Islands as a possible means to increase sedimentation and to possibly improve habitat in the lagoon. This alternative involved lowering the berm that prevents flow between Ross Island (the western island) and Hardtack Island (the eastern island where Ross Island's plant equipment is located) to an elevation of +15 ft NGVD for a distance of approximately 900 ft. This option is referred to as the "lowered berm" plan.

The second alternative involved placing fill in the lagoon to reinforce the northern perimeter and protect existing disposal cells in the southern portion of the lagoon. Fill was to be placed along the northern perimeter to reduce the existing steep slope as well as to increase the top width of the island around the northern perimeter of the lagoon. Fill was proposed to be placed along the south end of the lagoon not only to reduce the slope and provide extra protection for confinement cells, but also to allow wetland and upland plants additional area for improved aquatic and upland habitat.

1.2 Project Overview

As a means to accomplish the desired tasks, WEST developed a two-dimensional finite element grid of the Willamette River from Broadway Bridge (River Mile (RM) 11.8) to a location approximately one mile downstream of Elk Rock Island Park near Waverly Heights (RM 18) as shown in Figure 1. The upstream and downstream limits of the model were selected so as to be sufficiently far from the area of interest to allow the model to overcome any effects of upstream and downstream boundary conditions for flows through the Ross Island reach of the model.

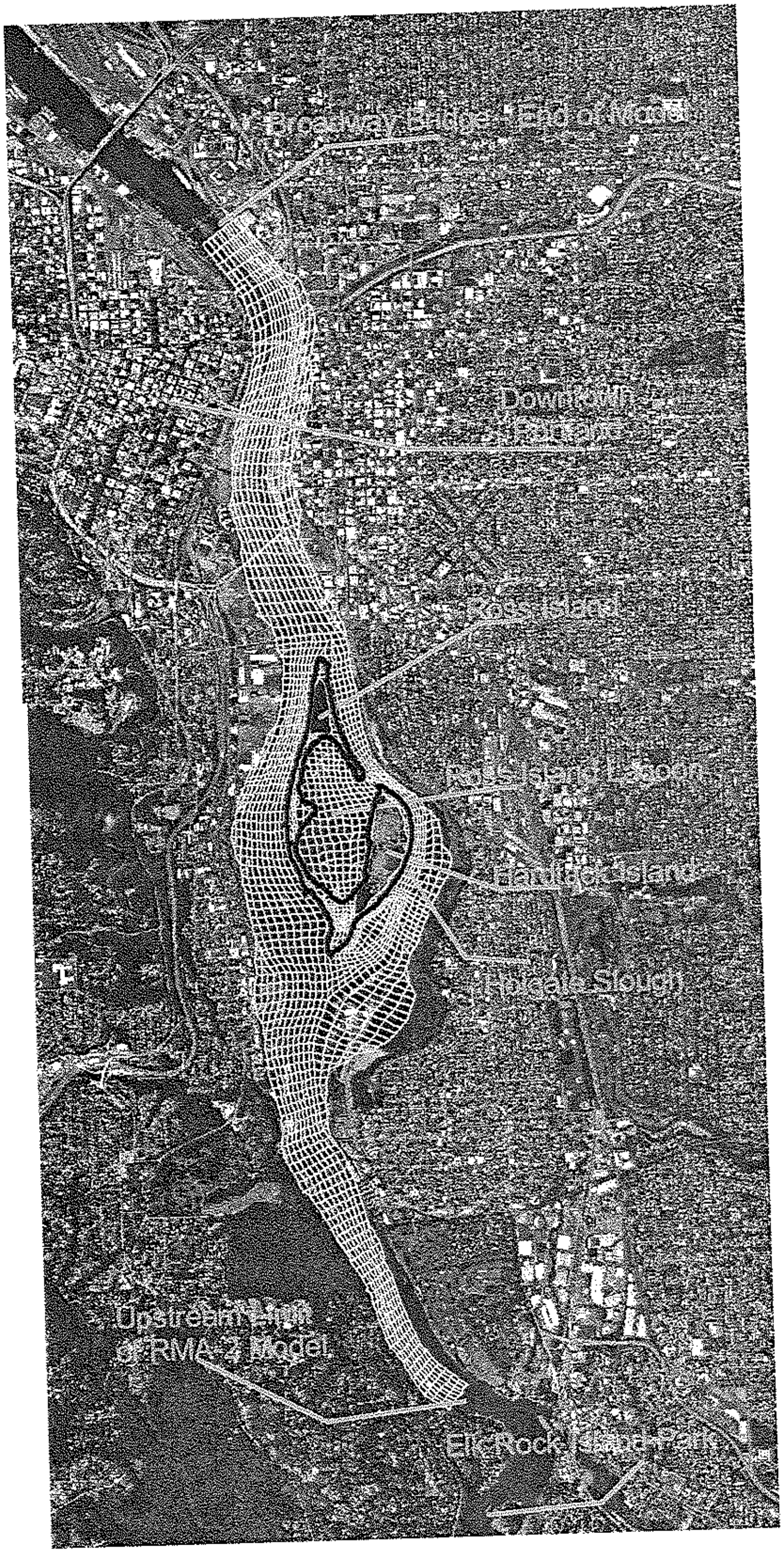


Figure 1. Aerial View of Project Location showing River, Computational Mesh and Study Limits.

Relative amounts of sedimentation that would occur in the lagoon for flood conditions for existing and a proposed lowered berm conditions were investigated by modeling the peak flow for what were estimated to be the 5-yr, 10-yr, 100-yr, and 1996 floods. On the basis of the 23 years of data that were obtained for this analysis, the 1996 flood appears to be on the order of a 500-year flood. However, another flow of approximately the same magnitude can be found in December 1964 when all but a few of the dams on the Willamette River were completed. This would lend credence to the idea that the 1996 flood was not the 500 year flood but something much more frequent. The detailed analysis of the hydrologic data was beyond the scope of this study and flows presented here are listed as actual flow rates rather than by recurrence intervals.

2. Review of Existing Data and Prior Studies

Large volumes of data were reviewed in preparation for the modeling effort. Numerous reports were furnished by Landau and additional data were obtained from USGS and Corps sources. The reports reviewed can be seen in the References section of this report. The reports included previous modeling efforts to assess turbidity in the lagoon, suspended sediment sampling and analysis program reports and sediment characteristic reports of deposits located just downstream of the study reach in the Portland Harbor as well as upstream at the Willamette Falls Lock. Several Corps and USGS reports were also reviewed and found to contain helpful information. A report titled "Sediment Trend Analysis for the Lower Willamette River" by GeoSea Consulting was also reviewed and provided some insight into sediments in the area.

Several studies have been conducted in regards to sediment transport and the makeup of deposits in the Willamette River and the Portland Harbor. These study reports contained information on sediment gradations, classifications and size distributions.

2.1 Bathymetry and Topography

Bathymetry for the model was obtained from the US Army Corps of Engineers, Portland District. The bathymetry consisted of the most recent data available as of December 31, 2001 and was provided in digital format. This data included bathymetry for the river as well as Holgate Slough but no topographic data for overbank areas. In order to augment this data digital elevation models (DEMs) developed by the USGS were also downloaded and trimmed to remove the river and areas away from the river floodplains. The data used was contained in the Portland and Lake Oswego 7.5 minute quadrangle files. Digital orthophotos were also obtained for the areas of interest and used as background photos to assist in model development and n value determination.

The river bathymetry showed very deep holes in the Willamette River upstream from Ross Island. These deep holes showed bottom elevations as low as -115 ft NGVD. Other holes exist with bottom elevations on the order of -85 ft to -90 ft NGVD. These very deep holes would tend to trap any large bed material moving in the river, i.e. gravels, cobbles, and coarse sands. Bed elevations for the Willamette River in the Ross Island reach are much shallower, being on the order of -30 to -50 ft NGVD.

2.2 Hydrology

The Ross Island gage is located at the Ross Island bridge and gage zero or elevation 0.00 ft at the gage is referred to as the Ross Island Datum. This datum differs from NGVD 1929 by +1.55 ft. This means that 0.00 NGVD is actually -1.55 ft Ross Island datum. The Ross Island gage is subject to tidal influences as well as backwater from the Columbia River. The stage discharge plot is shown in Figure 1 and the wide variation in stage for a particular flow rate can be readily noted. This scatter complicates the modeling of flow through the reach. Modeling was performed assuming a low downstream head which increases velocity and transport in the river. The higher tidal and backwater conditions will most likely result in lower velocities in the river and less ability to transport sediment into the lagoon. The slower velocities due to deeper water may offset deposition by allowing more time for deposition as the water passes, however, velocities in the lagoon are already very low under conditions of no backwater from the Columbia River. Velocities inside the lagoon will not change significantly based on backwater given the 130 ft depths already present in the lagoon.

A detailed analysis of the current hydrology of the Willamette River was beyond the scope of this study. Peak flow values for the Ross Island gage were available from the USGS website for a 23-year period from 1972 until 1994. Flows based on the routing of upstream reservoir releases were available for the same gage from 1994 until 2000 from the U.S. Army Corps of Engineers.

The annual peak discharge data was analyzed using both the USGS estimation software and the Corps' FFA program and estimates were obtained for the various return periods. Analyses were run on the USGS record, the combined record and the combined record without the 1996 flood peak. Based on the data available since 1972, the February 1996 peak daily average of 420,000 cfs was considered to be a statistical outlier. The various estimates for return periods varied significantly depending on the length of record used. Since the exact return period was not critical to the analysis, estimated peak values calculated from the USGS data were used as the inflows for the models. The flows used in the modeling effort were as follow:

1996 Flood Peak	459,000 cfs
100 Year Peak*	318,500 cfs
10 Year Peak*	224,000 cfs
5 Year Peak*	195,400 cfs

* Estimates based on 1972-1994 Period of Record.

The 1996 flood peak is based on an hourly record while the other peaks are based on daily averages. The daily average of the 1996 flood was approximately 420,000 cfs. The determination of more exact flow rates for the return periods was not necessary for the current modeling effort since a simple range of flows were needed to view the hydraulics and sediment transport due to differing flow conditions. The estimates based on the 23 years of USGS data were considered to give an adequate range of flows to meet the purposes of this study, especially when used in conjunction with the 1996 flood peak.

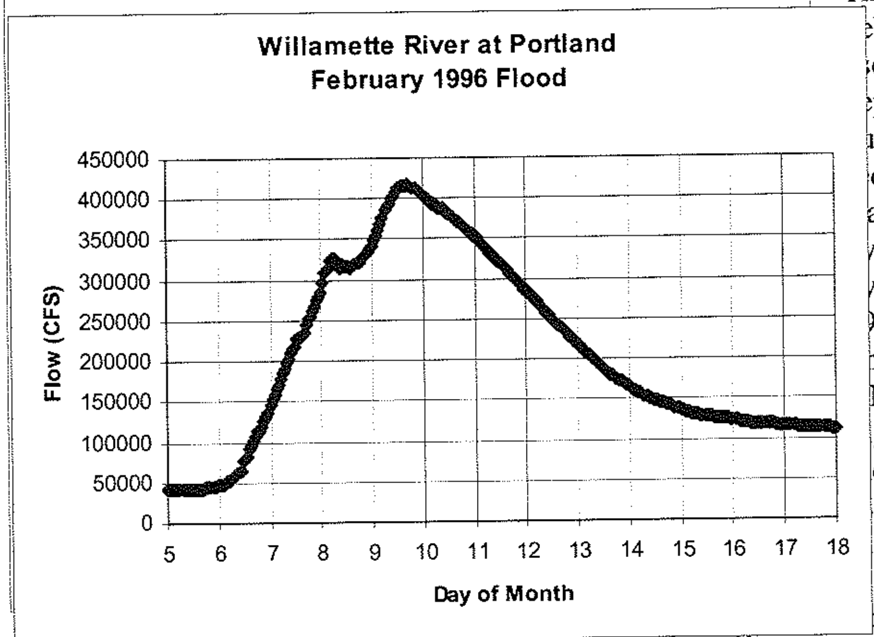
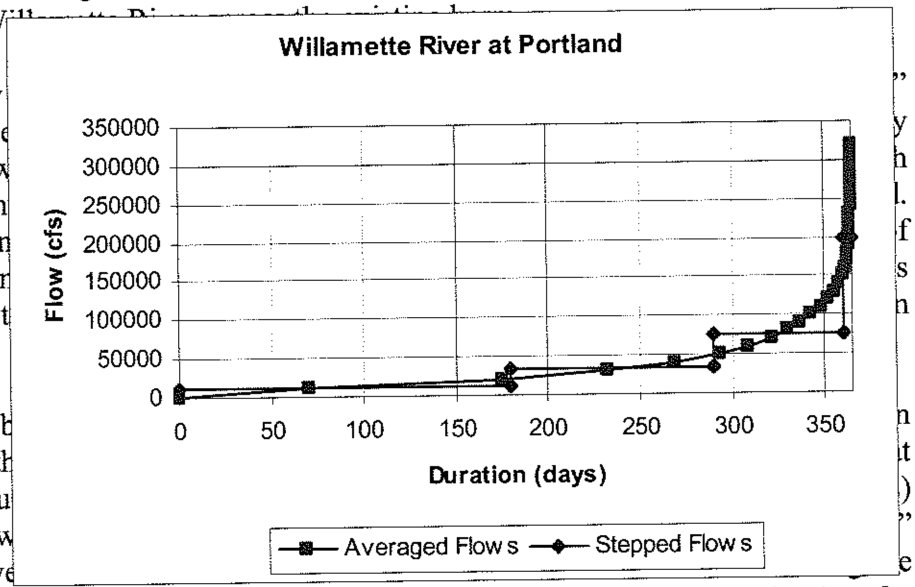


Figure 1. Stage Discharge Relationship for Willamette River at Portland. (Ross Island Datum)

The upper portion of the ebruary 1996 hydrograph was ;ed to estimate total sediment eposition within the lagoon ıring the flood event. Due to diment model limitations, it as necessary to use a stepped ydrograph to model the ydrographs of interest. The 996 hydrograph as nplemented in the Corps' NET model is shown in gure 2. It can be noted that e model peaks at 420,000 cfs opposed to the 459,000 cfs the observed record.

he minimum flow modeled for the 1996 flood hydrograph was 195,400 cfs. Extended flows below 195,400 cfs were not modeled as they do not flow over the island and directly into the lagoon under the normal head conditions on the Columbia River which were modeled. The only sediment transfer into the lagoon under these lower flow conditions is through the inlet. Later modeling verified that sediment deposition under these conditions is not large unless the flows occur for a relatively large number of days. This stage of the modeling was evaluating high flows that entered the lagoon directly from the W



Near the end of the study ”
hydrograph to view sedim y
dividing the observed flow h
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This procedure resulted in f
record used. The resultin s
hydrograph a series of st h
"average" year.

A previous RMA-2 study b n
studying turbidity inside th t
utilizing the three flows u)
along with the lowest flow ”
annual flow duration curve e
"average" annual hydrogr
Figure 3 was discretized u
last for 180 days, 35,000

Figure 3. Flow Duration Curve for Willamette River at Portland.

totaling 365 days and being representative of the average annual flow distribution.

Figure 2. February 1996 Flood Hydrograph from the UNET

2.3 Inflowing Sediment Loads

Numerous sediment samples have been collected and analyzed for the reach being modeling for this project. Sediment samples for the most part were described in terms of the percent smaller than 0.0625 mm (clays and silts) and total concentration. Suspended sediment samples indicated that very little sand is present in suspension in the river. Concentrations of materials in the sand sizes are usually less than 15% of the total and most commonly on the order of 5-10%.

Observed concentrations vary widely based on flow but this is common to sediment sampling programs. A plot from the 1964 Willamette River flood showing flow and sediment load illustrates the disconnect between the flow hydrograph and the sediment concentrations. (Figure 3) As can be noted, the highest concentration of sediment often does not occur with the peak flow. For the purposes of this study the two peaks were taken to correspond since a detailed analysis of when the sediment samples were taken in relation to peak flows was also beyond the scope of this project. Given the scatter that exists in flow-concentration curves (See Figure 4), further analysis was not warranted for this study.

Sediment samples existed for the entire range of flows modeled in this effort. The observed sediment concentrations for various flow rates are shown in Figure 4. The best fit line used to estimate sediment concentrations at the Ross Island Bridge is also shown.

The highest observation shown in Figure 4 was actually obtained at the St. Johns Bridge at RM 6 rather than at Ross Island Bridge (RM 14) but it is the only sample that was found

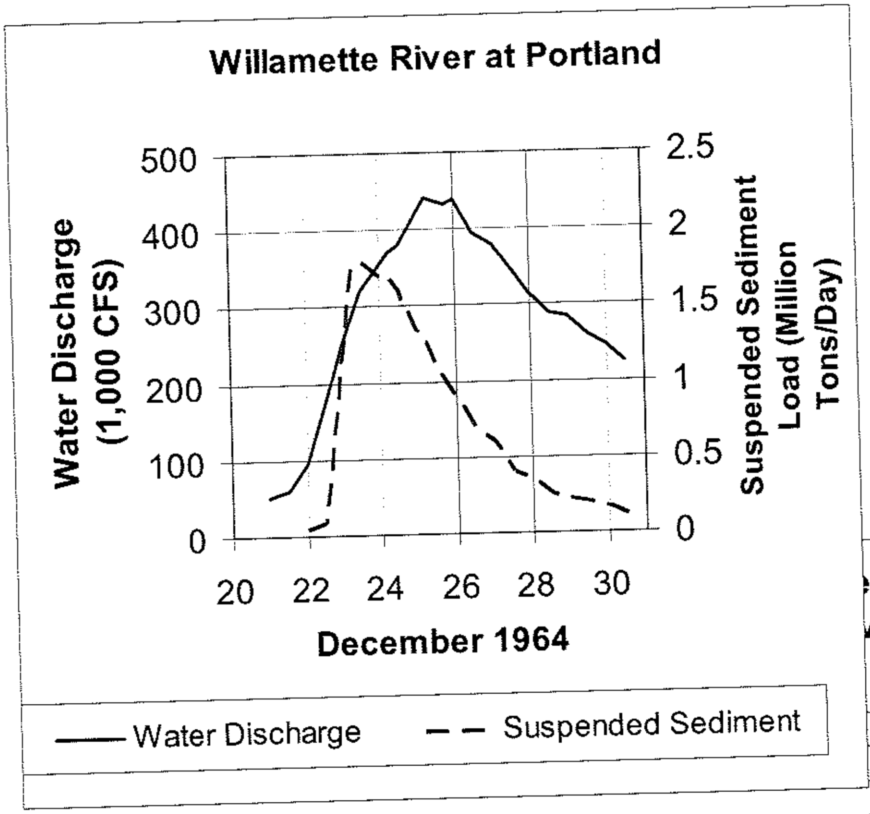

Figure 3. Observed Flow and Sediment Load for 1964 Willamette River Flood.

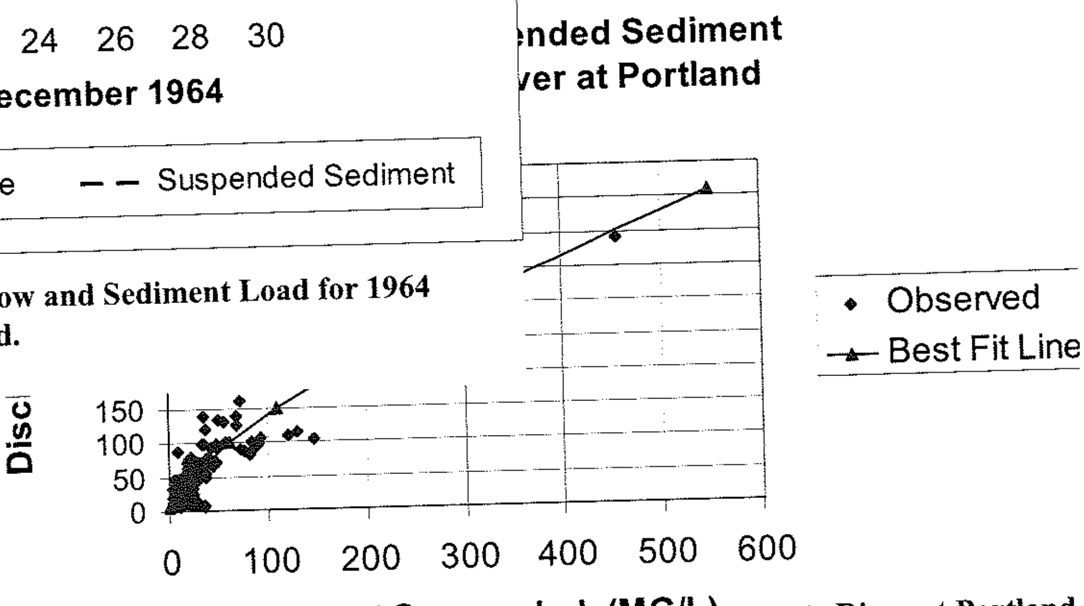

Figure 4. Observed Suspended Sediment Data for Willamette River at Portland.

points. Examining the placement of the point in Figure 4 lends credence that the data from St. Johns Bridge appears to correspond with the data taken at Ross Island Bridge. Taking into account the uncertainty associated with the flow-concentration curve the value plots within the expected scatter and was thus used as an estimate of the sediment concentration at Ross Island Bridge for the 1996 flood. It would appear that the observation from St. Johns Bridge may be on the high side of the scatter and thus could slightly over predict the actual value at the Ross Island Bridge. This would tend to slightly over estimate deposition in the lagoon and associated river reach.

2.4 Determination of Sediment Gradation for Use in SED2D

The SED2D model uses a single grain size for the calculation of sediment transport. The selection of this gain size should correspond to the predominate size that is expected to be of importance in the area of interest. All available data that could be readily located were reviewed to insure that the sediment size used in the modeling effort was representative of the sediment being transported and deposited in this reach of the Willamette River.

Numerous suspended and bed sediment samples have been taken in the Willamette River near Portland. The suspended sediment samples have most often been taken at the Ross Island Bridge just downstream from Ross Island. Other suspended sediment samples were taken in the Ross Island Lagoon, at various locations in the river and Holgate Slough near Ross Island and in the Harbor area.

The concentrations of the various size classes in the suspended samples is not normally measured or reported. Only the percent of the sample below the lower sand limit of 0.0625 mm is reported. This size corresponds to the break between fines (silts and clays) and sands. Samples from the Ross Island area indicate that sands are not found in abundance in this reach of the river. Sand concentrations in suspended sediments vary from 0% to about 30% sand, with the vast majority being 15% or less.

Samples obtained from the National Water Information System (NWIS 2002) show the percentage of fines ranges from a low of 58% to 100% with only 3 samples of 210 analyzed being less than 70% fines (1.4%). 67% of the samples have more than 90% fines and 89% of the samples have more than 80% fines. No sieve analysis was found for the coarse fractions of the suspended sediment samples taken in this reach of the Willamette River.

Sediment analysis data were also found for sediment deposits in the Willamette Falls Lock and deposits in the Portland Harbor. Sediment samples obtained from deposits in the harbor area again indicate that most of the materials transported in the river are fines. Samples from depositional areas indicate that while some sands come into the system from upstream the amount of sand material that is deposited is only about 1/3 of the amount of total deposition. Since the sand is much more likely to deposit than the silts and clays the fact that only about a third of the deposit is sand indicates again that the vast majority of sediments being transported down the river are fines. Results from the various samples are found in Table 1.

The material marked Willamette Falls / Oregon City in Table 1 was taken from the downstream entrance to the lock (RM 26.5) and was obtained from USACE 1996a while other information for other samples were taken from the harbor and described in USACE 1988, 1992, 1996 and 1999.

Sediment load calculations performed by the USGS and others show very little bed load movement in this reach. Laenen in 1995 estimated that bed load for the Willamette at Portland was on the order of 1% of the total load. He defined bed load as that portion of the total load that was unsampled in the suspended sediment samples. Given the extremely deep areas upstream from Ross Island it would be very unlikely that bed material would move into the reach adjacent to Ross Island. These very deep holes would be expected to very effectively trap any bed load (i.e. large sediment sizes such as gravels and coarse sands) prior to its reaching Ross Island.

Given the flow regime in the river it would also be expected that any sand that was in suspension would be very fine. Larger sediment sizes would drop from the flow at the first reduction in velocity and deposit in the deep holes upstream where velocities drop due to increased flow areas. These analyses suggest that modeling should concentrate on sediment sizes near the break between the sand and silt size classes.

Since the average measured sediment size in the observed deposits was 0.04 mm for the last two sampling regimes in the lower Willamette, this was selected as the size to be used in the sediment analysis. Several model runs were also performed using sand with a grain size of 0.0625 mm which is the lower limit of sand and the upper limit of silts and results were similar.

Table 1. Historic Bed Samples for Willamette River Deposits.

Site / Year	Material	Observed %	Mean Values	Mean Diameter
Willamette Falls Oregon City				
	Sand	72-75		
	Fines	25-28		Not Reported
	Silts	91		
	Clays	9		
Portland Harbor				
1988	Fines	6.3-89.9	64.6	Not Reported
1992	Sand	11.5-93.2	33.2	0.084
	Silt	5.9-75.5	58	
	Clay	0.9-13.0	8.8	
1996				
	Sand	22.2-50.1	34.9	0.04
	Silt	24.5-53.2	37.1	
	Clay	19.5-31	25.5	
1999				
	Gravel	0.0-2.9	1.2	0.04
	Sand	29.5-43.7	35.2	

	Silt/Clay	55.1-74	63.7	

3. Development of the RMA-2 Hydraulic Model

The modeling of hydraulics in the Willamette River was performed using RMA-2 developed by the US Army Corps of Engineers. RMA-2 employs the finite-element method to solve the depth-averaged hydrodynamic equations to calculate horizontal velocities and water surface elevations on a finite-element mesh. The finite-element mesh makes use of quadratic triangular and quadrilateral elements which have six and eight nodes, respectively. In order to model different discharge rates, it is customary to use the wetting and drying option in RMA-2.

The RMA-2 model of the Willamette River was constructed using the Surface water Modeling System (SMS) developed by Brigham Young University in conjunction with the U.S. Army Corps of Engineers Engineering Research and Development Center (ERDC, formerly WES). The system is a graphical interface for the RMA-2 and SED2D models and allows visualization of input as well as model results.

Current limitations in the SED2D model lead to serious complications when using wetting and drying in RMA-2 and the option was not used for final modeling in this study. In the current version of SED2D deposition in dry areas of the grid is not calculated correctly and it was necessary to use an alternate approach that utilized only elements that were "wet" – i.e. under approximately 3 feet or more of water during the flow of interest.

To enable modeling the flows at different discharges, several finite-element meshes were developed covering the main river channel and extending into shallow floodplain areas until depths were on the order of 2-3 feet. This required trial-and-error approach using the wetting and drying option in RMA-2 until the boundaries of the wet mesh could be determined. After the wet areas were determined the elements that were dry or shallower than approximately 2-3 ft were eliminated from the mesh and wetting and drying turned off.

Bathymetry for the model was obtained from the US Army Corps of Engineers, Portland District as described in the previous section. Digital orthophotos were also obtained for the areas of interest and used as background photos to assist in model development and Manning's n value determination.

The RMA-2 model also requires that boundary conditions are prescribed along the upstream and downstream boundaries. The river flow rate or discharge is prescribed at the upstream boundary, in this case at the south-end of the model just downstream of Elk Rock Island. At the downstream end, the water-surface elevation is prescribed as the boundary condition. The water-surface elevation varies with the discharge and appropriate values were determined from the UNET model and observed gage data. The length of the river to be modeled was determined such that the model extends sufficient distance above and below Ross Island so as to eliminate the impact of errors in setting the boundary conditions on flows in the vicinity of Ross Island.

Given the wide range of stage for a given flow, it is unlikely that any error in stage would be unrealistic in the river's flow regime.

Prior RMA-2 modeling performed by NHC (Northwest Hydraulics 2000) concentrated on low flows and turbidity inside the Ross Island Lagoon. The NHC model used a Manning's n value of 0.25 in the river in order to calibrate to low flow head data. This value was used for the channels and lagoon in the WEST model. Overbank and vegetated areas were assigned a value of 0.045. Flows used in the NHC models were all in-channel flows and were 75,000 cfs or less.

3.1 Calibration of Two-dimensional RMA-2 Model

The RMA-2 model described above was run for the peak of the 1996 flood and water surface elevations were compared with results from a UNET model provided by the Portland District of the U.S. Army Corps of Engineers. The UNET model used for the calibration of the RMA-2 model is identified in the first lines of the model as follows:

```
*    LOWER COLUMBIA RIVER - UNET MODEL
*    DEVELOPED BY MIKE KNUTSON,USACE,PORTLAND DISTRICT (CENWP-PE-HY) 04-25-96
*    MODIFIED BY KEN YOKOYAMA, USACE, PORTLAND DIVISION (CENWD-NP-ET-WH) 06-18-99
*
*    REVISIONS:
*    1. -ORIGINALLY CALIBRATED TO FEB 1996 FLOOD (APRIL 96)
*       -INCLUDED LAKE RIVER, BACHELOR ISLAND SLOUGH, VANCOUVER LAKE,
*        & CONNECTIONS DEVELOPED BY BOB ELLIOT OF NORTHWEST HYDRAULIC
*        CONSULTANTS, SEATTLE (JUNE 99)
*       -COMMENTED OUT NHC SHILLAPOO DRAINAGE ADDITIONS
*       -MANNING N VALUES READJUSTED BY NWD TO CALIBRATE TO FEB 1996 DATA
```

The UNET model covers the lower Columbia River as well as the Willamette from its confluence with the Columbia to the Willamette Falls at Oregon City (approximately RM 26.5). The UNET results are stored in a DSS file and values can be viewed either in dedicated Corps software or in the HEC-RAS hydraulic model. The UNET output consists of hourly flow rates and stages for each cross section in the UNET model for this application.

The water surface elevation for the RMA-2 model was compared to the maximum stage values from the UNET model and values compared quite well between the two models as shown in Figure 4. While the models appear to diverge above RM 18, the models follow very closely from Mile 12 to Mile 18 with a only a couple of exceptions. The differences above RM 18 are not significant to the Ross Island reach and may be due to the elimination of sharp river bends between River Mile 18 and Elk Rock Island as well as constrictions and bends around Elk Rock Island.

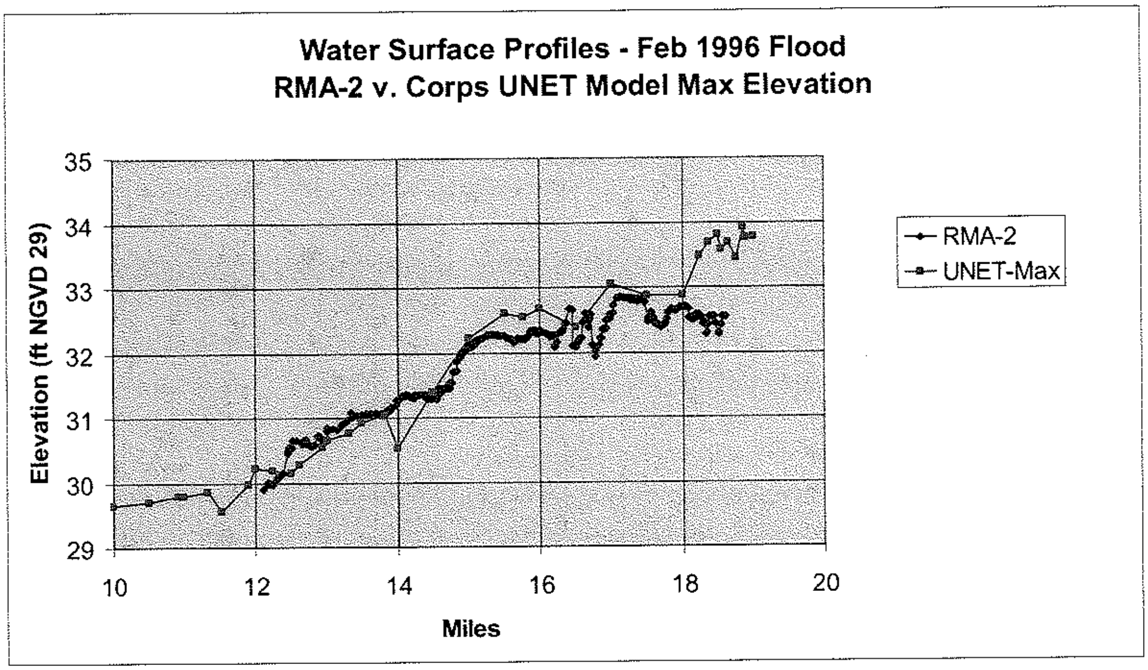

Figure 4. Calculated Water Surface Elevations for WEST RMA-2 model and Corps UNET model.

The RMA-2 water surface elevation appears to oscillate between RM 16 and 17 but velocities through this reach vary due to the large variations in water depth previously described. Deep holes with depths greater than 90-100 ft and relatively shallow areas with depths of approximately 30 feet exist in this reach and velocities increase and decrease accordingly. Some deep portions of these holes may be ineffective flow at the bed but flows recover prior to reaching Ross Island and are smooth through the Ross Island reach. When variations in velocity heads are taken into account, the oscillations disappear in this reach.

Differences exist between the UNET model and the RMA-2 model in the area of Ross Island due to differences in the way the lagoon and islands were modeled. The lagoon was modeled as a storage cell in UNET while RMA-2 calculated flow across the island and through the lagoon. This increases the flow area and reduces the water surface through the Ross Island reach (RM 15 to 16) as can be seen in Figure 4 for the RMA-2 model.

Average river slope in this reach is very low and is approximately $9.5x10^{-5}$ ft/ft (0.5 ft/mile) for the 1996 flood and 3.2x10-5 ft/ft (0.167 ft/mile) for a 195,000 cfs flow based on the UNET model results. From the review of gage records at the Ross Island gage, it appears the Willamette is tidally influenced up to a flow of approximately 200,000 cfs depending on flow conditions in the Columbia River.

Video taken during a visit to the Ross Island processing plant during the 1996 flood by Ross Island Sand and Gravel personnel shows little water movement around the Ross Island equipment and a very calm lagoon area – at least near the equipment. Results from the RMA-2 model also indicate that very little velocity is present in the area of the processing plant along the east bank of the lagoon. This field observation tends to confirm that the two-dimensional model is working properly in the lagoon area.

The only portion of the Ross Island video showing significant velocities was the portion showing the approach to the northeast (outer) bank of Holgate Slough in the area where the Ross Island boat house is normally located and across the slough from the entrance to the lagoon. Video footage in this area shows higher velocities along the outer bank of Holgate Slough but still not extremely high – probably on the order of 2-4 ft/sec. This is in the same range as the velocity results produced by the RMA-2 model and again indicates that the model is reproducing the 1996 flood event correctly.

4. Hydraulic Results

4.1 Existing Condition Results

Hydraulic results for the RMA-2 study indicated that, during large floods, water flows over the southwestern perimeter of Ross Island roughly parallel to the flow in the river and then flows back out over the lower portions of the island. This phenomenon can be seen in Figure 5 for the 1996 flood. It can also be quickly seen that flow into and out of the entrance to the lagoon is minimal even when flows have overtopped the island along the Willamette main stem. This

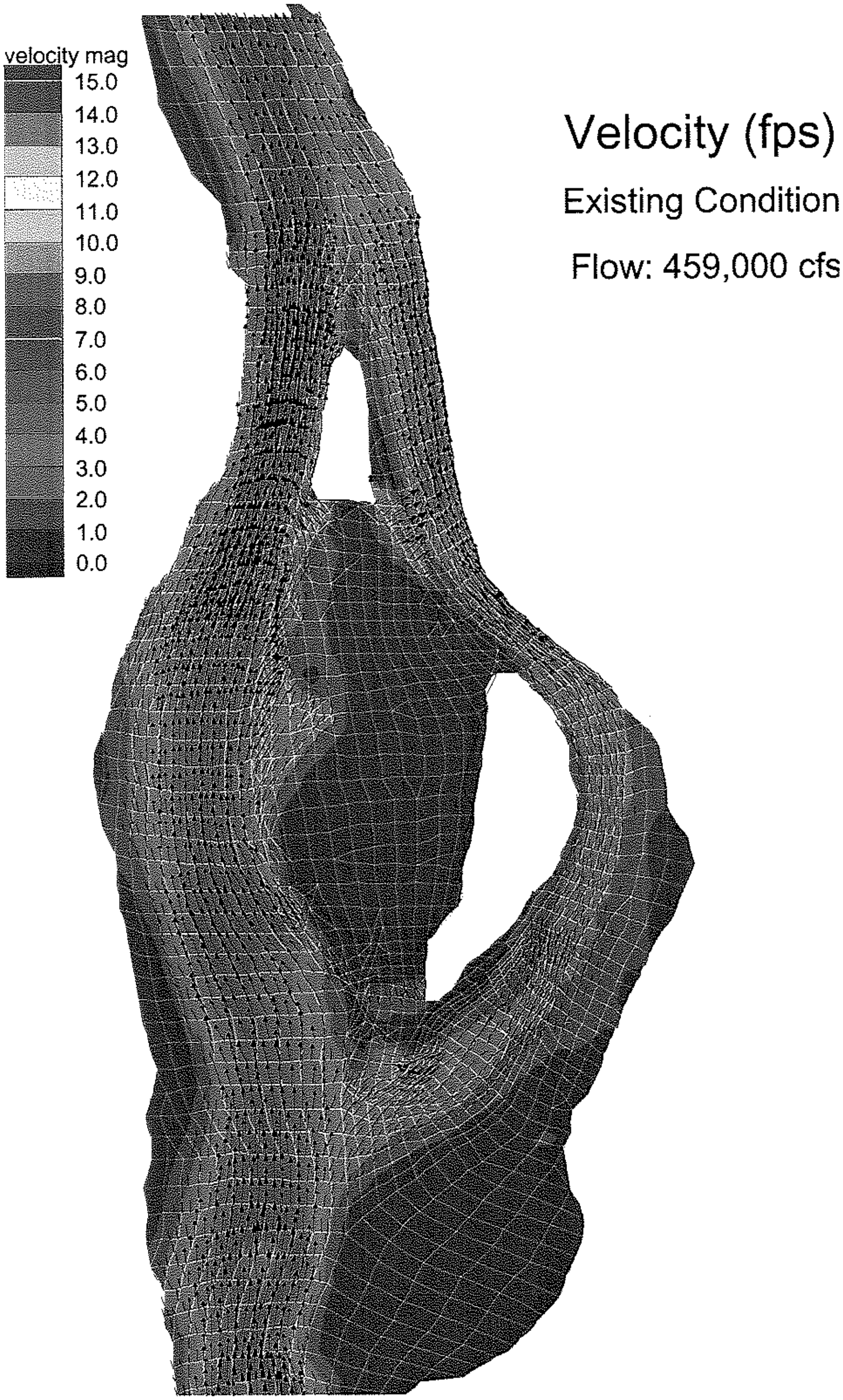

Figure 5. Velocity for 1996 Flood Peak for Existing Conditions.

phenomenon is not limited to very large floods such as the 1996 flood but the same process occurs during lower flows as can be seen by viewing the velocity plots for all four flood flows modeled. (See Appendix I for the 318,500 cfs, 224,000 cfs, and 195,400 cfs flows respectively.)

It can be seen in Figure 5 that some flow is diverted from the mainstem Willamette to the Holgate Slough under the 1996 flood conditions. This flow exits the lagoon over the portion of Ross Island that borders the north edge of the lagoon along Holgate Slough rather than through the lagoon inlet. This flow pattern can also be seen to lesser extents in Appendix I for the remaining flows

4.2 Proposed Plan Condition Results – Lowered Berm

Ross Island proposed the lowering of a berm installed between the southern ends of Ross and Hardtack Islands to prevent normal river flows from entering the lagoon formed by the excavation of materials. This berm is approximately 900 feet long and is high enough that only flows near the 1996 flood elevation overtop the berm. The plan, as evaluated, consisted of lowering the berm to elevation +15 ft NGVD for the 900 foot length of the berm. The specified flow rates were again run for this plan condition.

The lowering of the berm allowed somewhat more water to flow into the lagoon from the Willamette River as can be seen in Figure 9 for the 1996 flood. The water that entered the lagoon over the lowered berm did not, however, flow out of the lagoon entrance into Holgate Slough. The increased inflow simply increased the flow over the lower portion of Ross Island into both Holgate Slough and the Willamette River. This added flow increases velocities across the higher portion of the island and increases the potential for erosion along these forested areas. Flow moving out of the lagoon also impacted velocities in the river not only along the lower portion of the island but downstream from Ross Island. Under this plan condition more flow is diverted across the lagoon and into Holgate Slough for all floods modeled. However, given the length of the berm that was lowered to obtain these results, the necessity to protect the lowered section against erosion, the marginal increase in flow into the lagoon and the limited increase in sediment deposition; the risks associated with the alternative most likely outweigh any benefits that could be obtained.

The results for the 1996 flood under existing conditions can be seen in Figure 5. A plot showing the difference between the base and velocity magnitudes for the lowered berm plan can be seen in Figure 7. The difference plot in Figure 7 show the values for the plan or lowered berm condition minus the existing condition velocity values. The positive values indicate velocity increases for the plan condition and negative values indicate decreases in velocity for the plan condition. Plots for the other flow rates can be seen in Appendix II. It can be noted that no large differences exist between base and plan flow conditions. The maximum differences occur due to the lowering of the berm along the southwestern edge of the lagoon. The moderate changes in the lagoon are constrained by the exit conditions from the lagoon during high flows. The flows in the Willamette River and Holgate Slough are constrained in the area where the river and Holgate Slough must pass around the lower portion of Ross Island. Thus changes in geometry at the upstream end of the lagoon do not have large impacts on the flows within the lagoon.

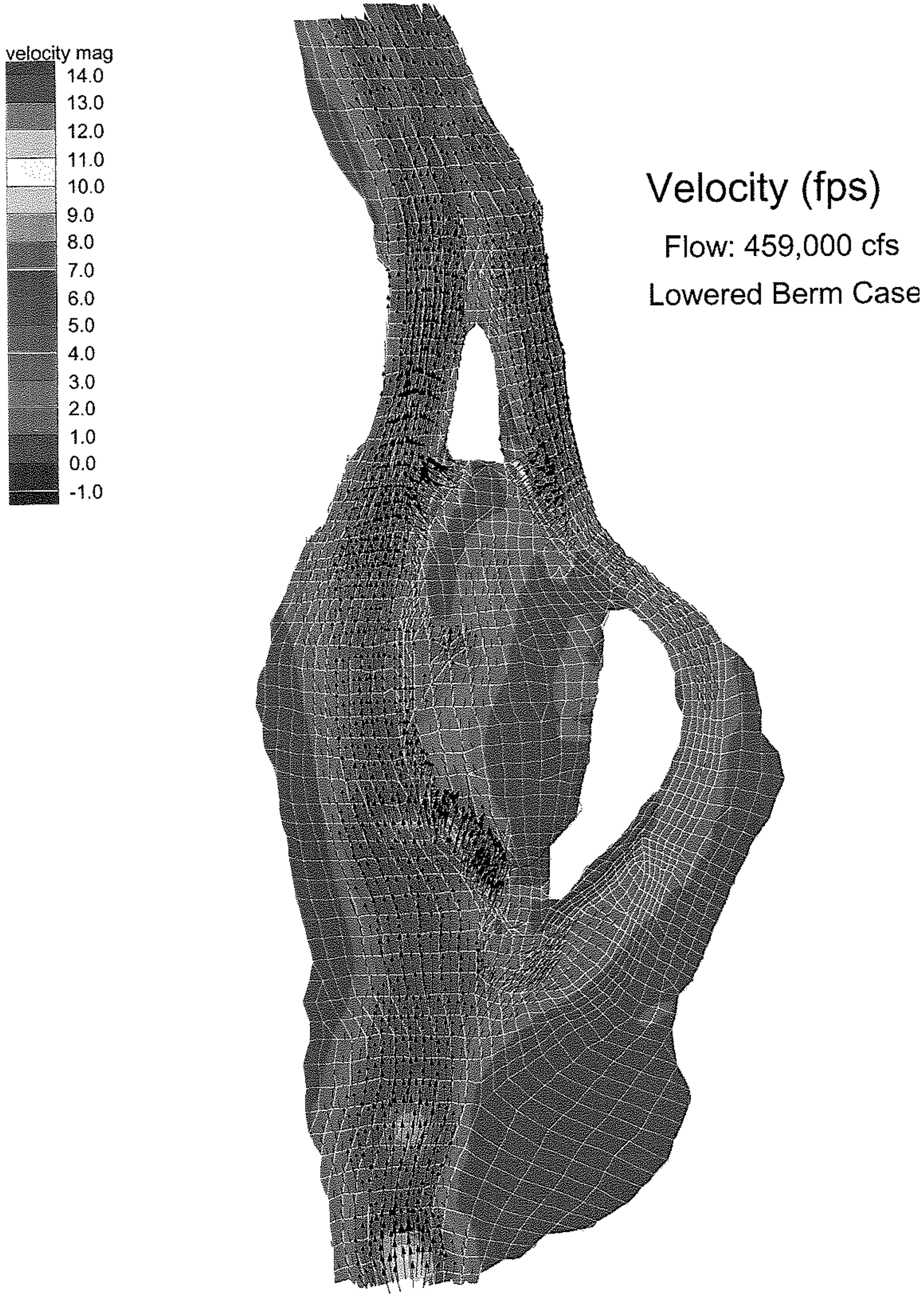

Figure 6. Velocity for 1996 Flood Peak for Lowered Berm Conditions.

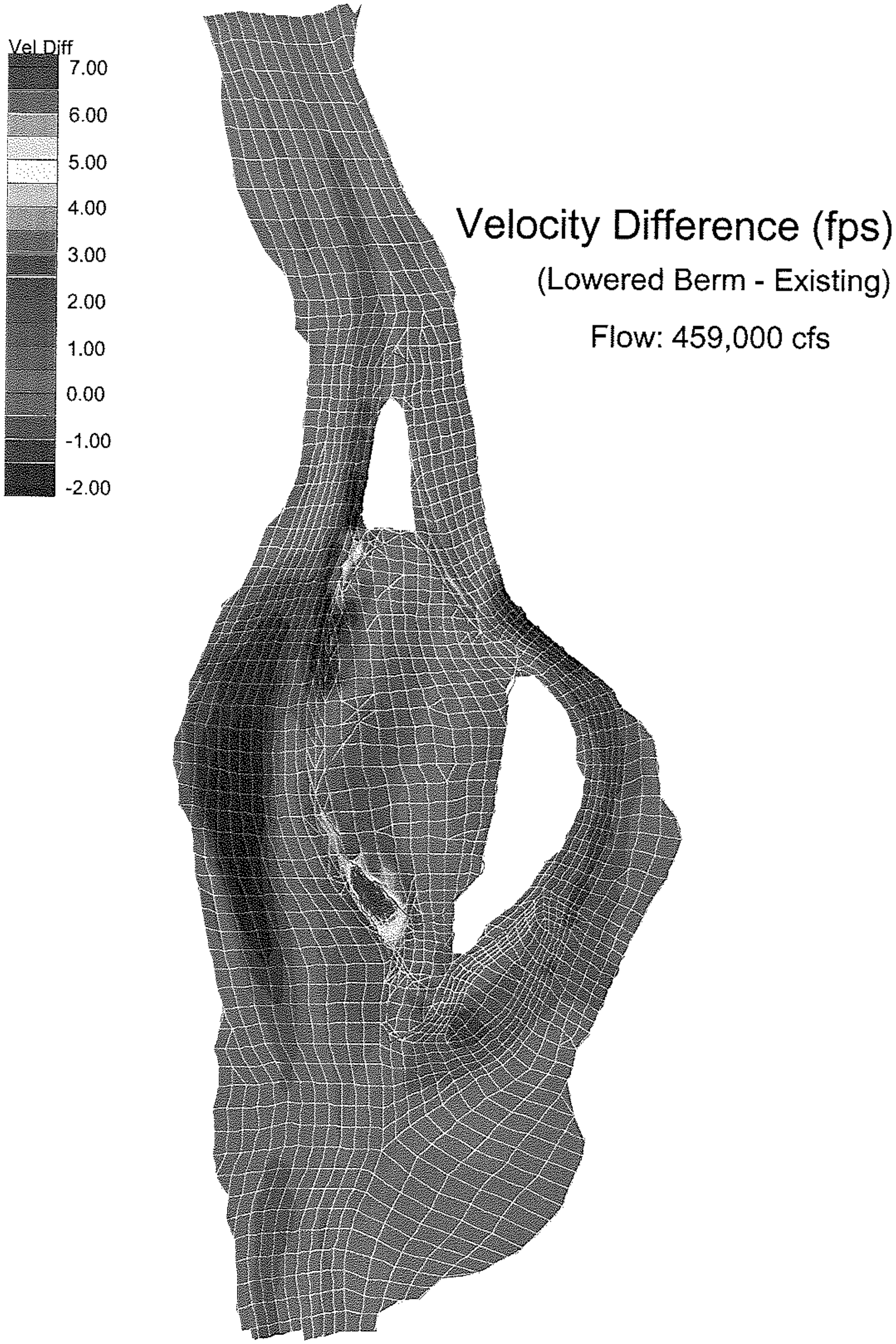

Figure 7 Velocity Difference between Existing and Lowered Berm Conditions – 1996 Flood Peak.

If the berm were to breach it is possible that a head cut could be propagated some distance up the Willamette River. The deep holes upstream would likely arrest the upstream movement of any head cut and given the flow constriction at the lower end of Ross Island it is unlikely that any head cut would impact the containment cells inside the lagoon. If erosion were to occur on the channel banks at the lower end of Holgate Slough it is possible that an erosive feature could be propagated some distance upstream from the lagoon. The area around Ross Island will likely continue to be depositional given the sudden expansion in flow area at Ross Island and the constriction downstream. The historical forces that formed the islands will continue to operate and the Ross Island reach of the river will, for the most part, continue to be depositional.

4.3 Lagoon Fill Scenario

Currently the slopes of the lagoon are steep and extend to approximately -130 ft NGVD. The second scenario modeled called for the placement of fill along the north and west boundaries of the lagoon as well as at the south end of the lagoon as shown in Figure 8. The berms are designed to reduce the slope and provide additional geotechnical support for the portions of the island immediately adjacent to the lagoon. The reduced slope will also enhance public safety when the area is opened for public use by reducing the steepness of the bank.

The placement of this fill has minor impacts on flow through the lagoon as shown in Figure 9 for the 1996 flood peak. The impacts, while locally significant, do not significantly change the flow patterns in the lagoon, river or slough.

The velocity changes for the 1996 flood, as shown in Figure 9, highlight that changes are less than ±1.5 ft/sec. The maximum values occur in areas where the fill is high enough to create shallow areas near the perimeter of the island. Changes in velocity for the other flow rates are shown in Appendix IV.

It can be seen in Figure 12 that changes in deposition for the 1996 peak flow between the fill and no fill scenario are less than 0.01 ft after 12 hours with most areas have almost identical bed changes for the both scenarios.

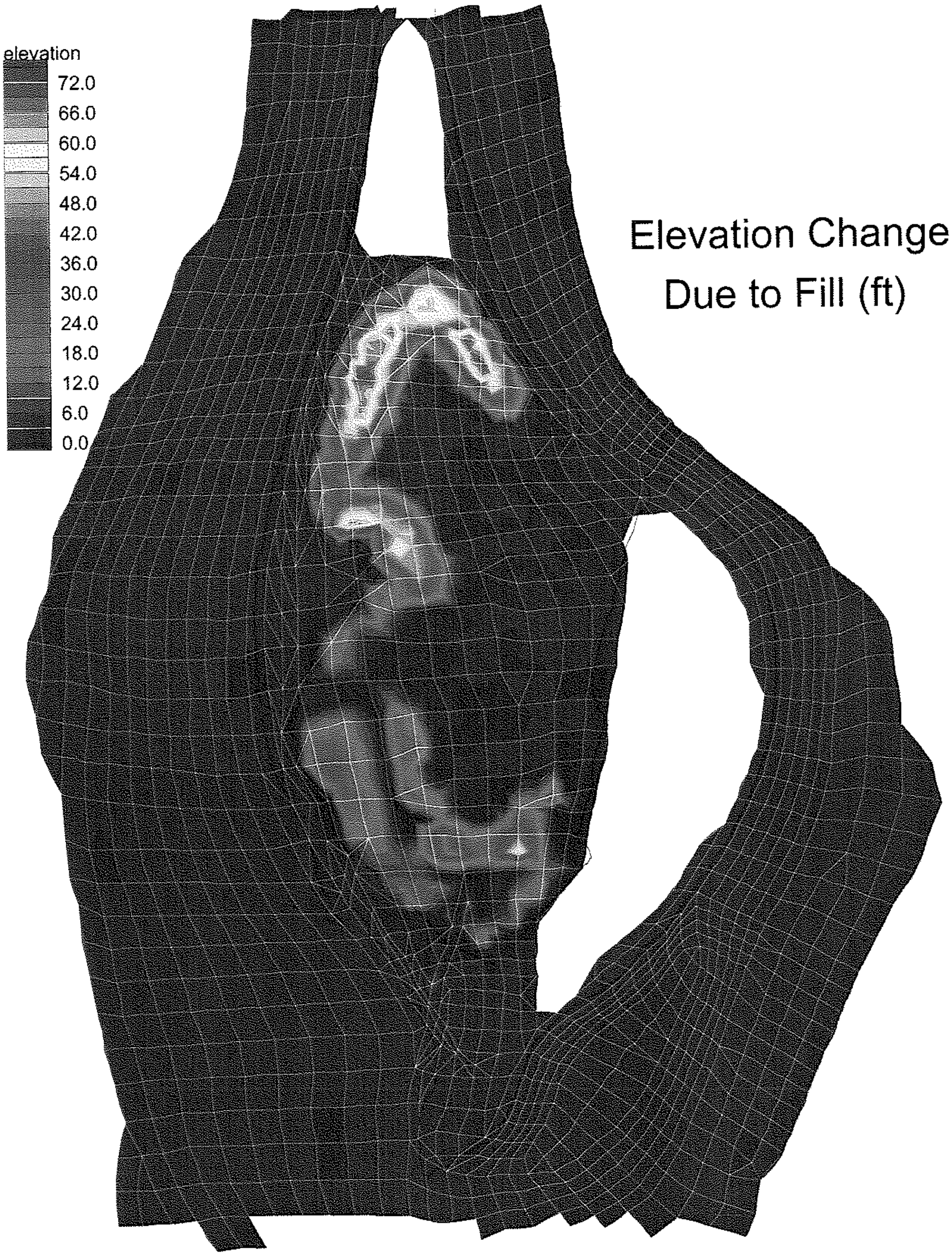

Figure 8. Elevation Difference Due to Fill.

Figure 9. Velocity Difference Due to Fill.

5. Development of the SED2D Sediment Transport Model

The sediment model selected for use on this project was the Corps' SED2D model. SED2D was developed by the U.S. Army Corps of Engineers and is an updated version of the STUDH model developed by the Waterways Experiment Station in the 1970's and 80's. The model has been released for public use but the currently released version contains a number of bugs and quirks that make applying the model challenging. To avoid undesired encounters with the various limitations of the model, the modeling approach was specified to avoid wetting and drying in the sediment model. The avoidance of wetting and drying precluded the modeling of a hydrograph and limited the modeling effort to the modeling of discreet flow events. It is possible, however, to link a series of discrete flows together to represent a hydrograph. This is the approach taken to model sediment transport due to the 1996 Willamette River flood and the "average" annual hydrograph as described above.

The SED2D model uses the bathymetry and geometry from the RMA-2 model as well as the hydraulic output from RMA-2. The RMA-2 output includes velocity and water surface elevations and the SED2D model uses this information to calculate sediment transport in the flow field as well as to calculate deposition or erosion on the bed of model.

5.1 Model Adjustments and Modeling Variables

A sediment grain size of 0.04 mm was used in the entire model domain as discussed in Section 2.4. This sediment size is considered representative of silt which is the average grain size of the sediment being deposited in this reach of the Willamette River. For the purposes of this model it was assumed that the silt sizes being modeled would behave as non-cohesive material. This assumption was made since none of the parameters had been measured that would allow the modeling of the material as a cohesive material and the primary interest was the deposition of material in the lagoon.

Since the primary interest in this study was deposition in the lagoon, rather than erosion of previously deposited cohesive material, it was determined that the SED2D model could be used to model noncohesive material with a slightly smaller grain size than the sand limit. The settling velocity corresponding to this sediment size was estimated as 0.0012 m/sec by extrapolating slightly from Committee on Sedimentation (1957). Bed material depths were set to zero where erosion was occurring since the materials would not scour as easily as predicted by the Ackers White transport equation. It also appeared that bed materials were significantly larger than the silt size being modeled and thus would be less likely to scour. It was expected that, once the areas of concern for scour were identified, further scour analysis would be performed as necessary.

The initial sediment concentration was estimated based on the measurements made at the Ross Island Bridge and other nearby areas as previously described. The model was started with a uniform concentration approximately equal to the inflowing load and was allowed to stabilize. The model stabilized within approximately an hour of simulation time. For the various hydrographs the initial hour of the run was discarded and the model then run for the desired time period. The inflowing sediment concentration at the upstream boundary of the model was varied so that an approximate match was obtained between the observed and computed concentration values at the Ross Island Bridge gage. The bed shear stress was estimated using the log velocity approach in SED2D and the sediment diffusivity was set at 25 m^2/sec. The model time step was set to 0.05 hours (3 minutes) and the default value of 0.67 for the Crank-Nicholson weighting was used.

6. Results of the Sediment Transport Modeling

The SED2D model was used to model sedimentation for peak flow events described above as well as for two hydrographs. The model was thus used to estimate sediment deposition for three types of events, a peak flow, the 1996 flood hydrograph and an "average" annual hydrograph.

6.1 Peak Flood Events

Model runs were performed for the flows listed in Table 1 to compute sedimentation during a period of 12 hours. The results were compared to view relative sedimentation for a 12 hour peak flow of varying magnitudes. Deposition occurring during peak flows was determined for the modeled flow rates of 459,000 cfs, 318,500 cfs, 224,000 cfs, and 195,400 cfs.

Results for the 1996 peak flow existing and lowered berm conditions are shown in Figure 10 and Figure 11. Differences between the existing and lowered berm conditions can be seen in Figure 12. It can be noted that the plan condition allows more water into the lagoon and slightly increases sedimentation on the east side of the lagoon and downstream of the lowered berm. The results for the various flows for both the existing and lowered berm conditions can be found in Appendix III. The lowered berm condition results in slight increases in deposition in the lagoon due to increased water and sediment flow into the lagoon. The depths of the increased sedimentation are very small and are not extremely significant over a 12 hour period.

The areas along the perimeter of the lagoon that are shown in blue in Figure 12 indicate areas that are prone to erosion and areas that erosion protection may be necessary if the lowered berm plan were to be considered for implementation. Areas shown in blue away from the lagoon may be due to slight differences in geometry between the existing and lowered berm bathymetries. These are due to slight adjustments at shallow nodes to insure model stability and are normally small enough that hydraulic results are not significantly different.

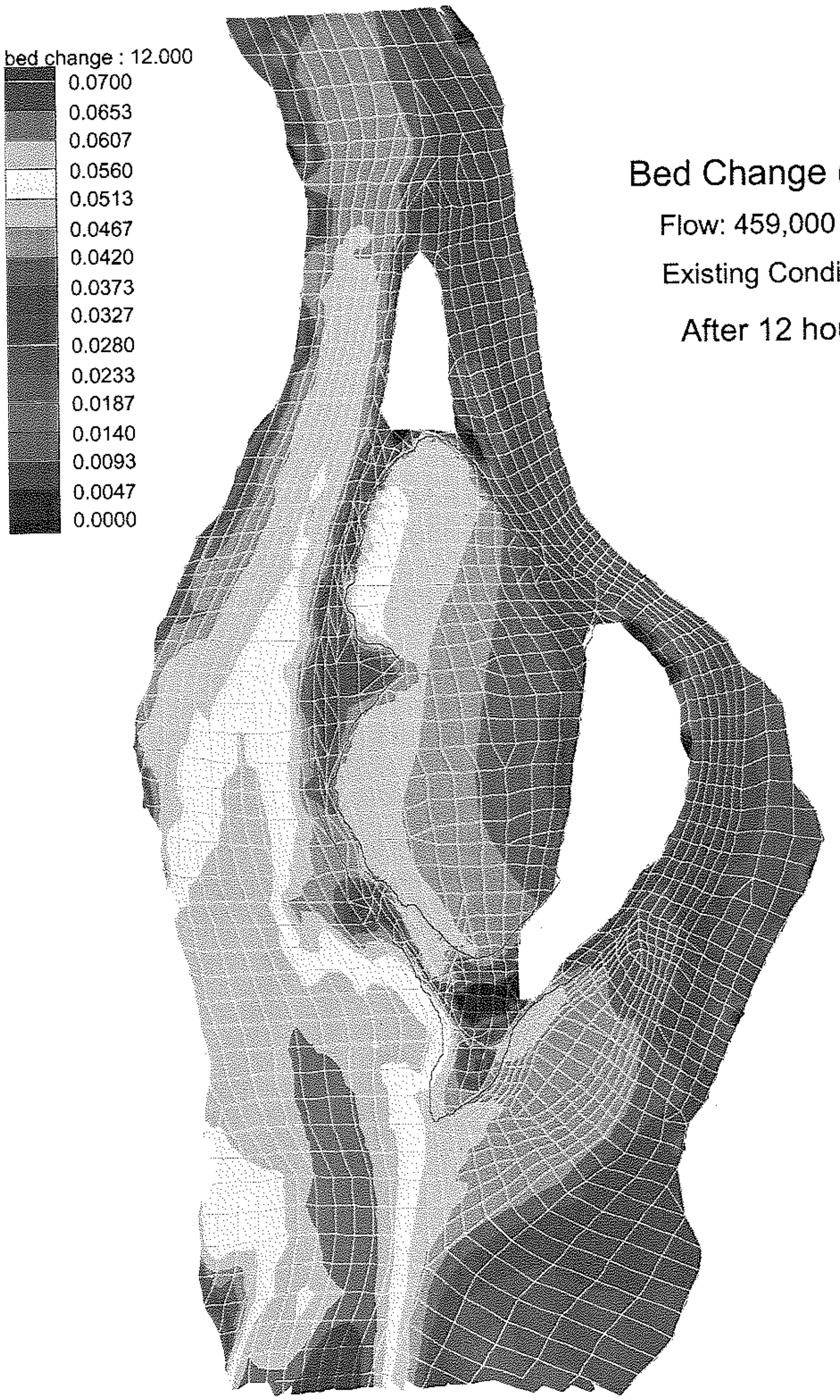

Figure 10. Sedimentation for 1996 Peak Flow for Existing Conditions.

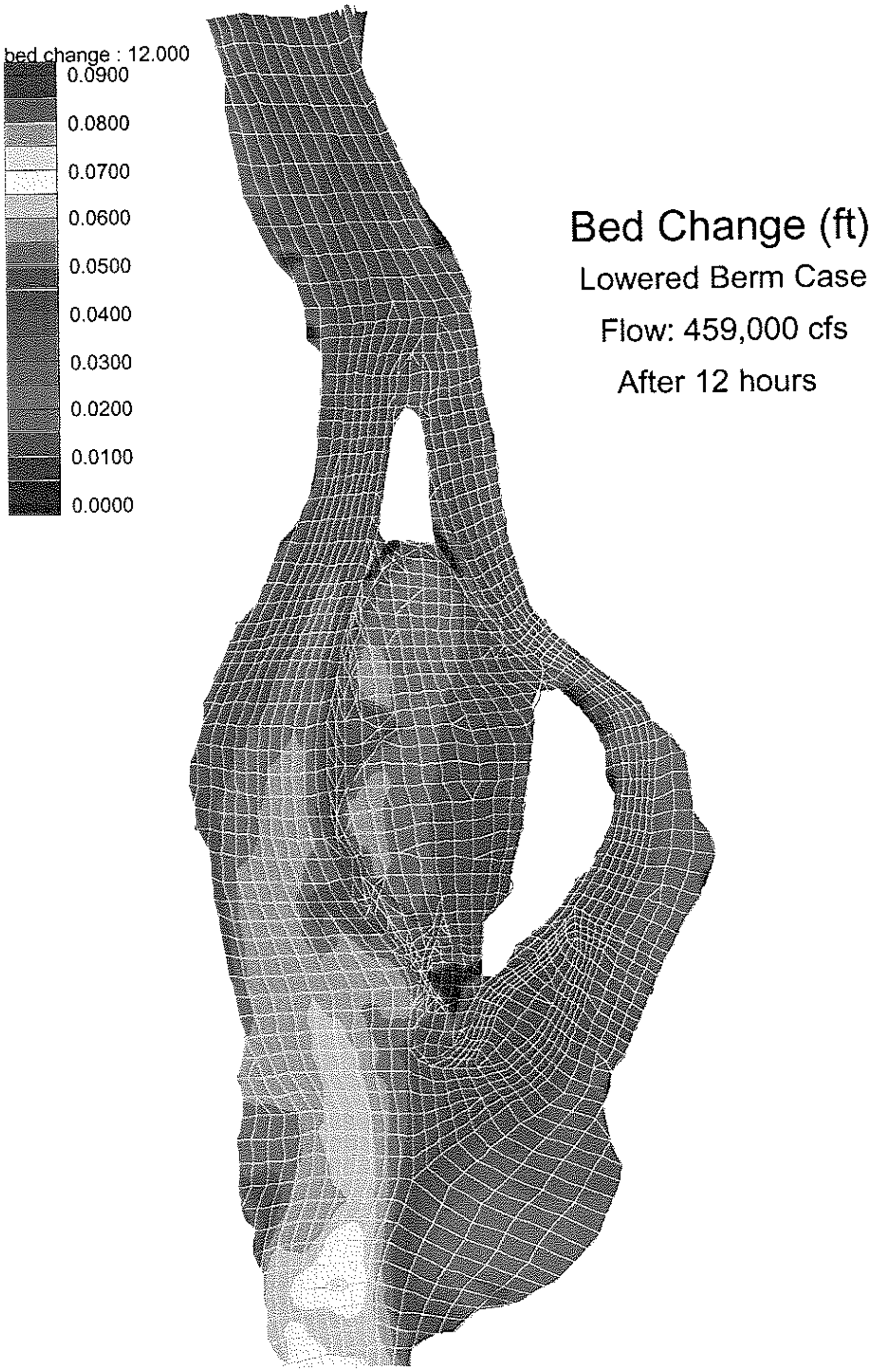

Figure 11. Sedimentation for 1996 Peak Flow for Lowered Berm Condition.

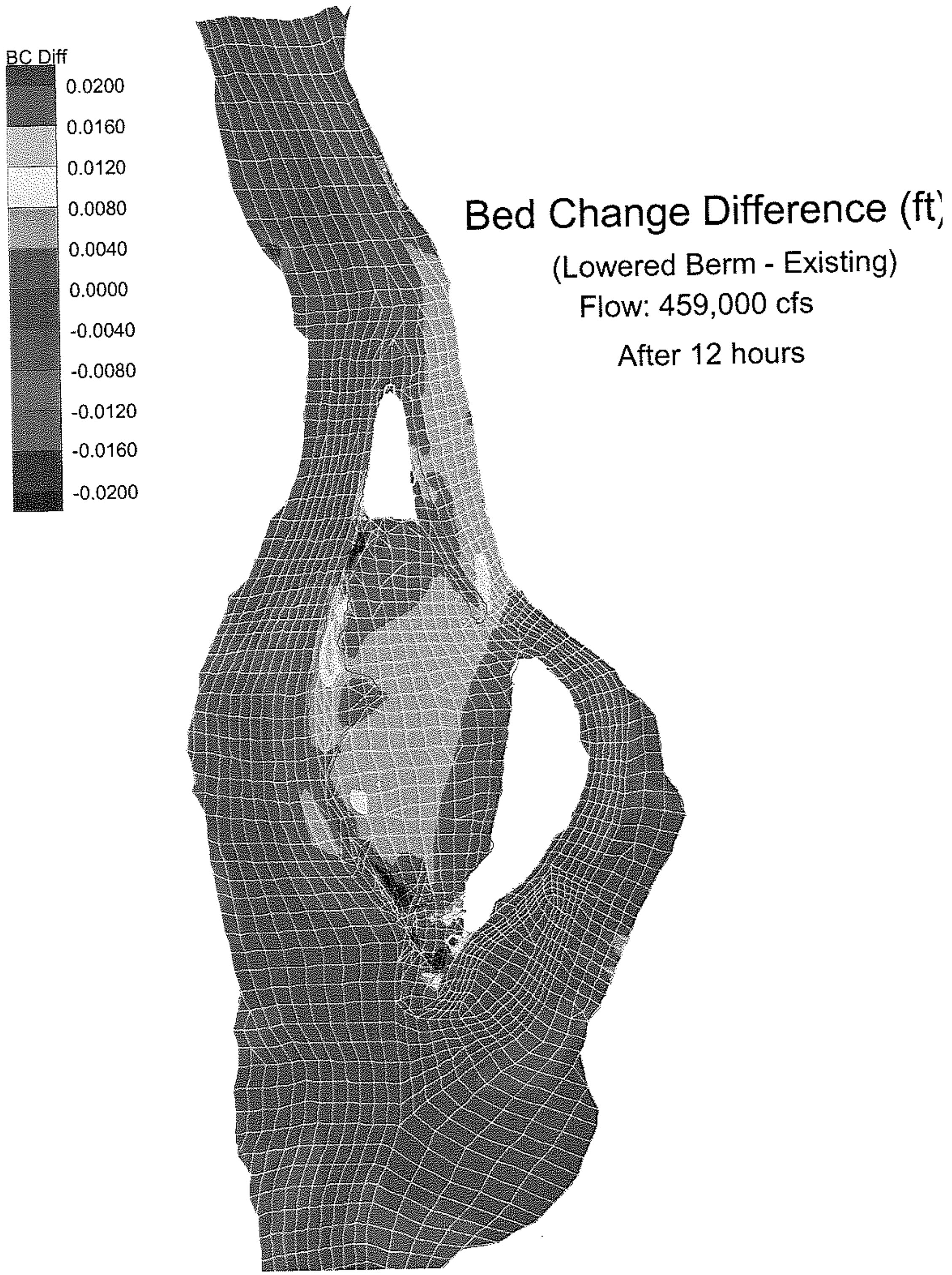

Figure 12. Difference in Sedimentation for 1996 Peak Flow between Lowered Berm Condition and Existing Conditions.

6.2 1996 Flood Deposition

The 1996 flood event was modeled by discretizing the flood hydrograph into the four discharges previously run individually to view the impact of individual flows on sedimentation in the lagoon. These four cases were considered separately and the bed changes computed for each case. The resulting bed changes were then combined in ARCVIEW to give the total bed change for the 1996 flood event.

Deposition was only modeled for the portion of the 1996 flood hydrograph when flow was approximately 180,000 cfs or above. The lower portion of the hydrograph was neglected since 1) most sedimentation would occur during high flow rates when sediment concentrations were high and 2) during lower flows, flow does not move into the lagoon from the Willamette River but only through the lagoon inlet from Holgate Slough. The exact flow at which the berm overtops is unknown and will vary dramatically based on downstream backwater conditions from the Columbia River.

Lower flows had also not been modeled at this point in the analysis. Later modeling for the "average" annual hydrograph confirmed that a few days at the lower flow rates would not dramatically change depositional volumes and depths in the lagoon. Only when long periods (typically weeks) of the lower flows are modeled does the deposition due to these flows become significant.

The results of this analysis can be seen in Figure 13 for the 1996 flood event for the existing conditions case. It can again be seen that most of the sedimentation during the peak of the hydrograph occurs along the west side of the lagoon. The sediment gradually reduces in depth towards the lagoon inlet. The existing island is shown as a red outline in Figure 16 as well as the other plots in this report.

Figure 13. Sedimentation for 1996 Flood above 180,000 cfs under Existing Conditions.

6.3 Average Annual Deposition

The "average" annual hydrograph was also modeled using the same approach as the 1996 flood. The hydrograph was again discretized and run in four steps. Hydraulic results from the model originally used by NHC provided hydraulic data for the lower flows and the SED2D model was used to calculate sediment transport for the various flow rates. The deposition due to the modeling of the "average" annual hydrograph is shown in Figure 14.

In order to construct the stepped hydrograph the sediment model was run for a period of 10 days or the full step duration for steps shorter than 10 days. For periods of time with flow periods of more than 10 days the deposition was extrapolated from the ten-day run to account for the various lengths of the steps. This extrapolation was accomplished by simply multiplying the 10-day deposition by the number of 10-day durations contained in the time step.

The extrapolation of model results would cause concern if the depth of deposition was a significant portion of the water depth. As can be seen in Figure 14 the deposition amounts are insignificant in terms of the water depths in the model. Most depths are 30 ft or greater and depths in the lagoon are in excess of 100 ft while deposition is a maximum of approximately 1 foot for the entire simulation. Even shallow areas along the boundaries were not significantly impacted by these assumptions. Areas where water depths may have been only 3 ft (this being approximately the shallowest boundary nodes) had depositions of only 0.35 ft or approximately 10% of the total depth. Velocities in these areas are normally small as well so hydraulic impacts are extremely limited.

Deposition during the various time periods is shown in Table 2 for selected nodes. The location of the nodes is shown in Figure 15. It can be seen that very little deposition occurs at the very low flow rates. Most deposition occurs at higher flows in the 75,000 cfs range. Flows in this range contribute significantly to sedimentation due to the long duration of the flows and the higher sediment concentrations. The large floods contribute significant amounts of sediment and contain high sediment concentrations but their shorter duration means that overall contributions are less than that from more midlevel floods that occur more often with longer durations.

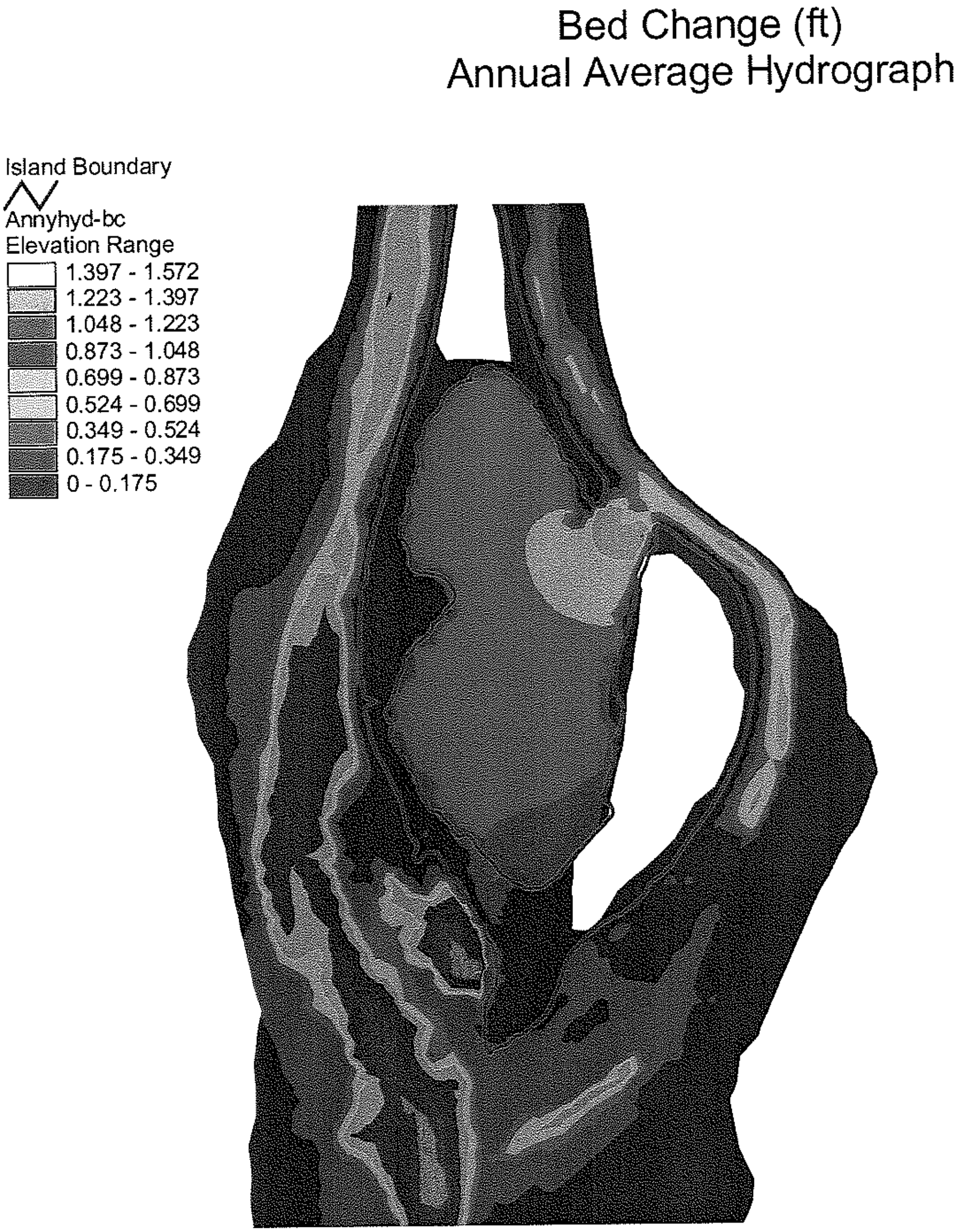

Figure 14. Sedimentation for Existing Conditions Average Annual Hydrograph.

Table 2. Deposition Rates for Various Flows for Selected Nodes based on Average Annual Hydrograph.

Flow Event (CFS)	Duration (days)	Bed Change at Locations (feet)		
		Lagoon Interior (south)	Lagoon Entrance	Lagoon Interior (north)
10,000	180	0.005	0.01	.006
35,000	110	0.007	0.02	.009
75,000	70	0.15	0.58	.27
200,000	5	0.19	0.18	.18
Total	365	0.37	0.79	0.46

The SED2D model predicts approximately 0.8 ft of deposition in the entrance to the lagoon and approximately half of that value in the interior of the lagoon for the "average" annual hydrograph. The impact of the higher flows and higher sediment concentrations can be seen in the amounts deposited in the lagoon. It can be noted that once the flows overtop Ross Island and begin to enter the lagoon directly from the Willamette River that sedimentation becomes more uniform in the lagoon. During periods when flows are below the crest of Ross Island most sedimentation occurs in the mouth of the lagoon entrance where velocities lower drastically and sediment can no longer be held in suspension.

The values calculated in the lagoon entrance compare fairly well with the approximately 1.5 ft of annual deposition that has been observed historically by Ross Island Sand and Gravel. While the two values may not agree perfectly the results are of the same order of magnitude and the model results are representative of what has been observed over the years. The ratio of deposition should be approximately the same for points inside the lagoon and points in the entrance. Thus in years where 1.5 ft of deposition occurs in the inlet approximately 0.75 ft of deposition could be expected in the interior of the lagoon.

6.4 Lagoon Fill Scenario

The addition of fill to the lagoon has only minor local impacts on sedimentation. This is primarily due to changes in local velocities. The bed changes for the 1996 flood between the existing and fill scenarios are shown in Figure 16 and show very little bed change within a 12 hour modeling period with the exception of areas where the fill produces shallow depths and either increased or decreased velocities significantly. The changes do not appear to be significant even in these areas. Of concern are areas shown in blue that may exhibit scour tendencies if very fine fill material is used and no vegetative cover is established. Since cover is expected to be established in this area and fill material is expected to be larger than the silt size used, or at least a mixture that contains larger particles, scour on the fills is not expected to be substantial. There may be some local scour during large flood events but the scour should not be more than that observed on the higher portions of the island during floods of similar magnitudes if fill materials similar to natural soil are used. If vegetative cover is established on the more elevated portions of the fill material the danger from erosion should be relatively minor.

7. Summary of Results

The hydraulic modeling of the Ross Island reach of the Willamette River indicates that flow is currently controlled by the narrower channels at the downstream end of Ross Island. These channels form the river and slough between Ross Island and the west bank of the Willamette River and Ross Island and the east bank of the Holgate Slough. This constriction controls the flow through the reach of the river associated with Ross Island and minimizes the benefits that might be obtained in other situations from the lowering of the berm between Ross and Hardtack Islands. The primary impact of lowering the berm was to increase flow along the west side of the lagoon and over the narrow lagoon perimeters that separate the lagoon from the Willamette River and Holgate Slough at the north end of the lagoon. It could be expected that the increase in flow due to berm lowering would cause erosion in these areas and could ultimately result in breaching of the narrow portions of the islands.

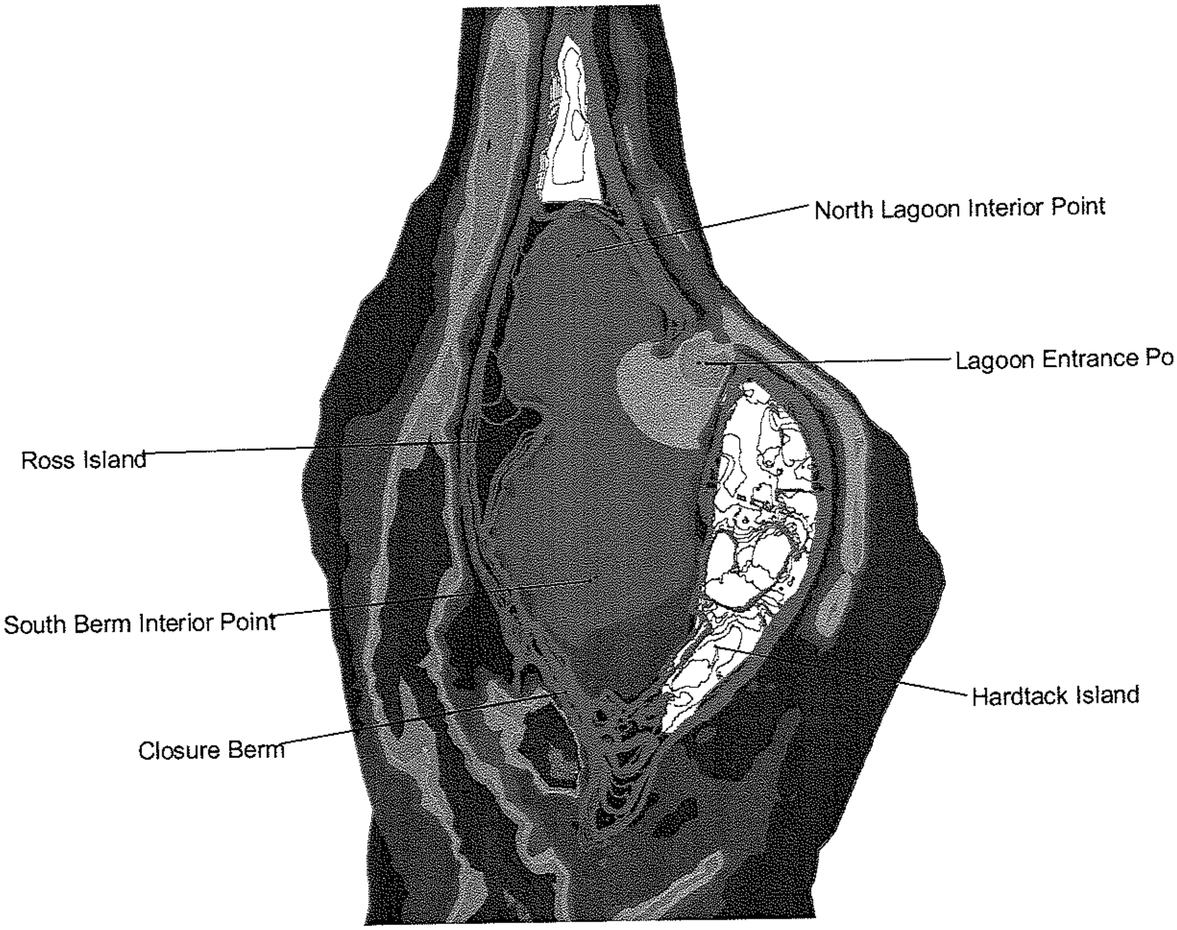

Figure 15. Location of Points for Depths Reported in Table 2 showing Closure Berm Location. Existing Island Shown in Blue.

Figure 16. Differences in Bed Changes for 1996 Peak Flow due to Lagoon Fill.

The SED2D model predicts that natural sedimentation in the lagoon, consisting primarily of fines, is on the order of a few inches per year with more deposition occurring in the lagoon inlet. Increased deposition occurs at the inlet due to the reduction of flow velocities as flow moves into the lagoon and the suspended sediment is deposited. Events that overtop the river side of the island do carry some sediment into the lagoon but flow patterns are such that most deposition is along the river side of the lagoon. Deposition rates were low over the entire range of flows modeled from 10,000 cfs to 459,000 cfs. Results for the 1996 flood showed some deposition inside the lagoon but, due to the relatively short nature of the event (where the island was overtopped for approximately one week), the maximum depths of deposition were not large with a maximum of approximately 0.5 ft (6 inches).

A plan to lower the existing 900 ft long berm between Ross and Hardtack Islands to an elevation of +15 ft NGVD was modeled to evaluate the possibility of increasing sedimentation in the lagoon. The increase in flow obtained by lowering the berm did not increase the depth of sedimentation but only increased the area of the lagoon receiving the maximum deposition during a particular duration of flow.

The lowering of the berm would require erosion protection for the remaining berm between Ross and Hardtack Islands. The erosion protection would be necessary to prevent the berm from eroding during a flood event with subsequent damage to other perimeter areas. Protection may also be necessary where the flows exit the lagoon to prevent floods from breaching the relatively narrow portions of the island at the northern end of the lagoon and causing turbulence and flow problems in the already constrained areas of the river and Holgate slough. If the narrow portion of the island on the Holgate Slough side of the lagoon were to breach, bank scour could very likely be expected on the opposite bank of Holgate Slough.

If the berm were to fail during a flood, a head cut could be propagated some distance up the river from the lagoon. This could endanger the containment cells in the lagoon just downstream of the weir as well as cause additional erosion problems downstream. It is unlikely that a severe head cut would move rapidly upstream or be large given the constrained flow in the area. Further any head cut would be arrested by either the deep holes or rock controls upstream.

The SED2D model produced results for the "average" annual hydrograph for the lagoon entrance that are of the same magnitude of deposits observed at Ross Island. From model results it appears that annual deposition in the lagoon is on the order of 6-10 inches depending on the location within the lagoon and the duration of flows above approximately 50,000 cfs.

Results obtained from the analysis of the fill scenario indicate that high areas of the fill may be subject to scour if left unvegetated and if non-cohesive fine material is used. For final design an additional analysis of large flood events should be performed to insure stability of the material to be used.

8. References

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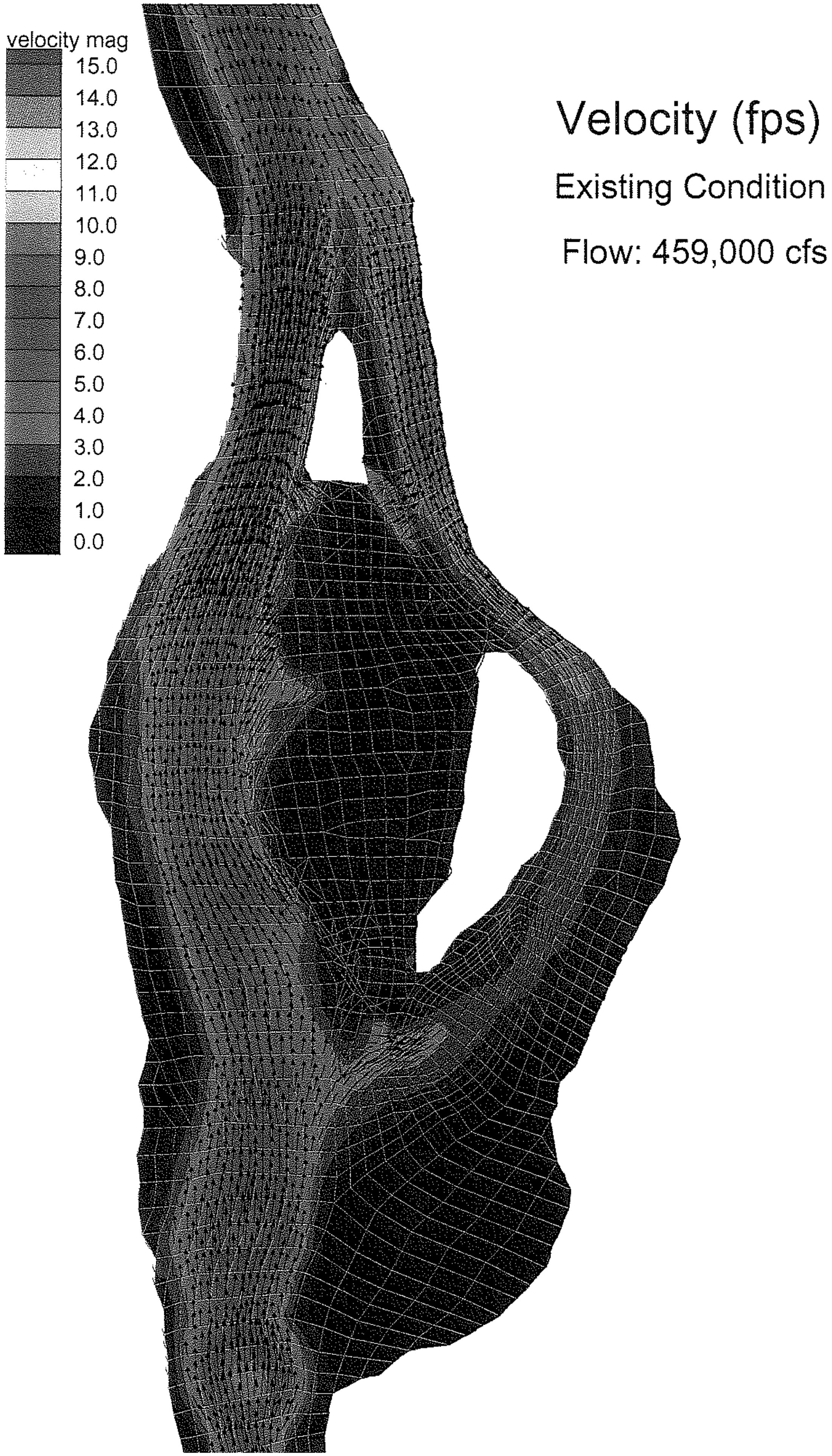
APPENDIX I

EXISTING CONDITION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12.0
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8.0
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3.0
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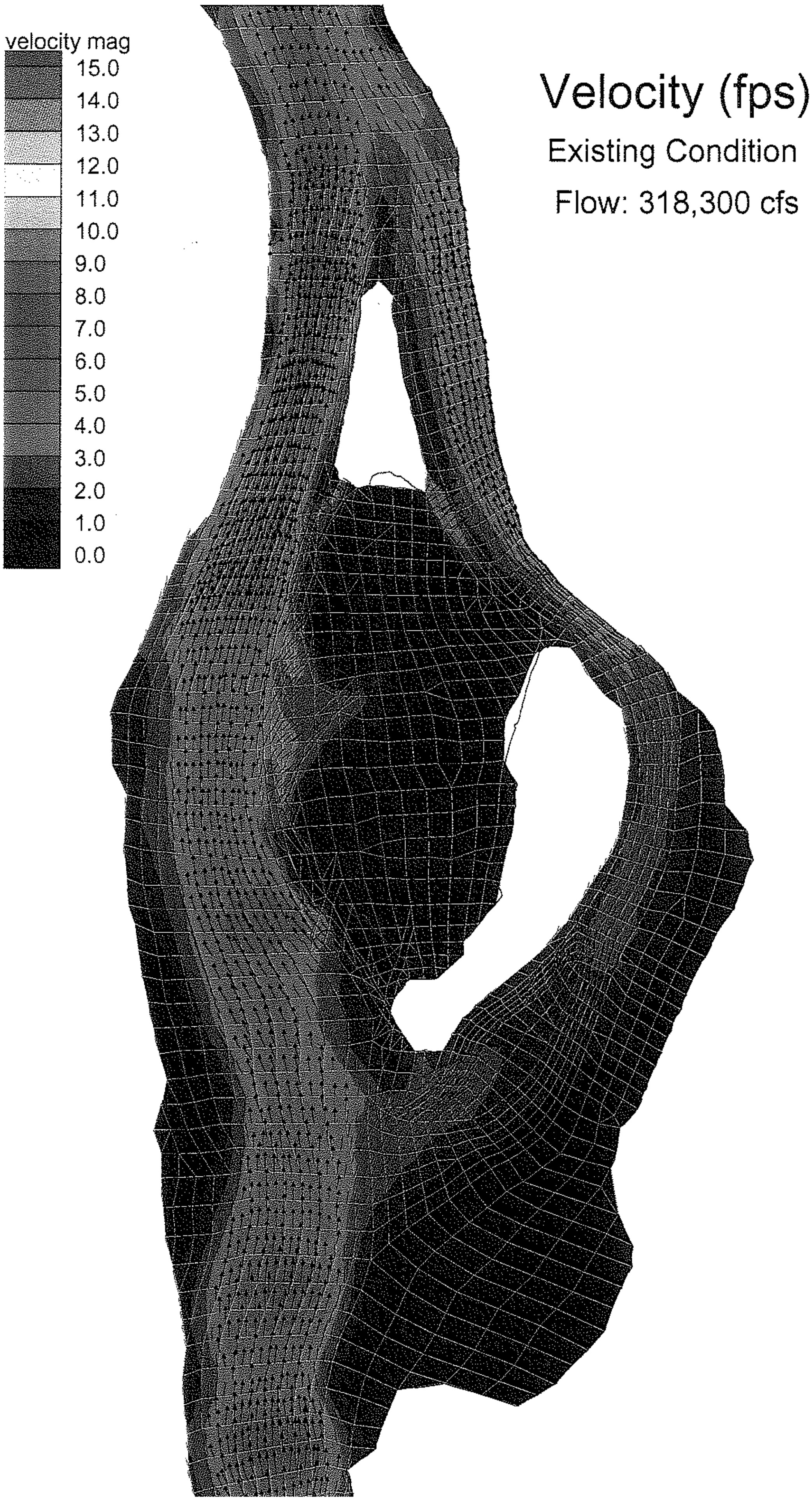
Velocity (fps)
Existing Condition
Flow: 459,000 cfs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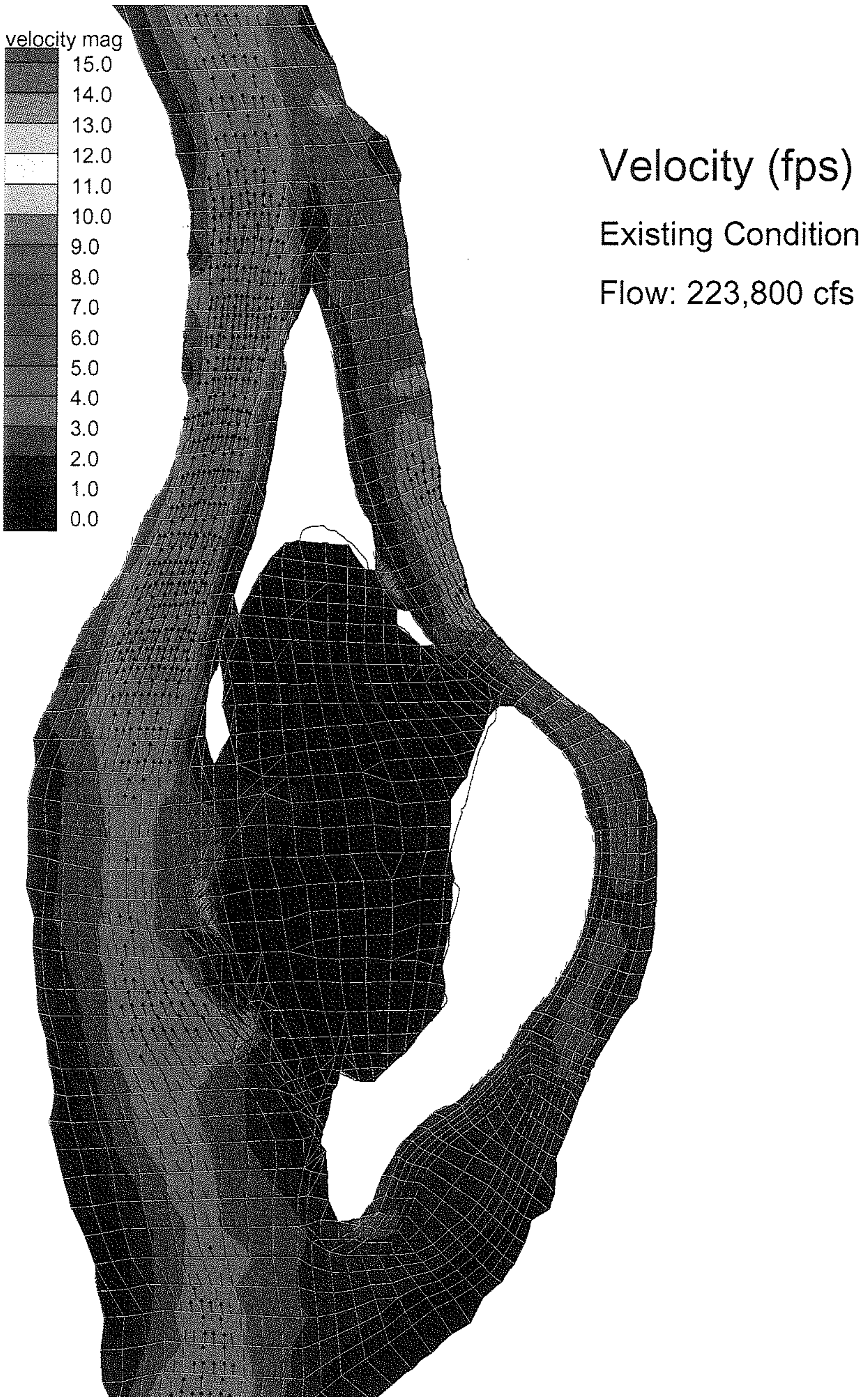
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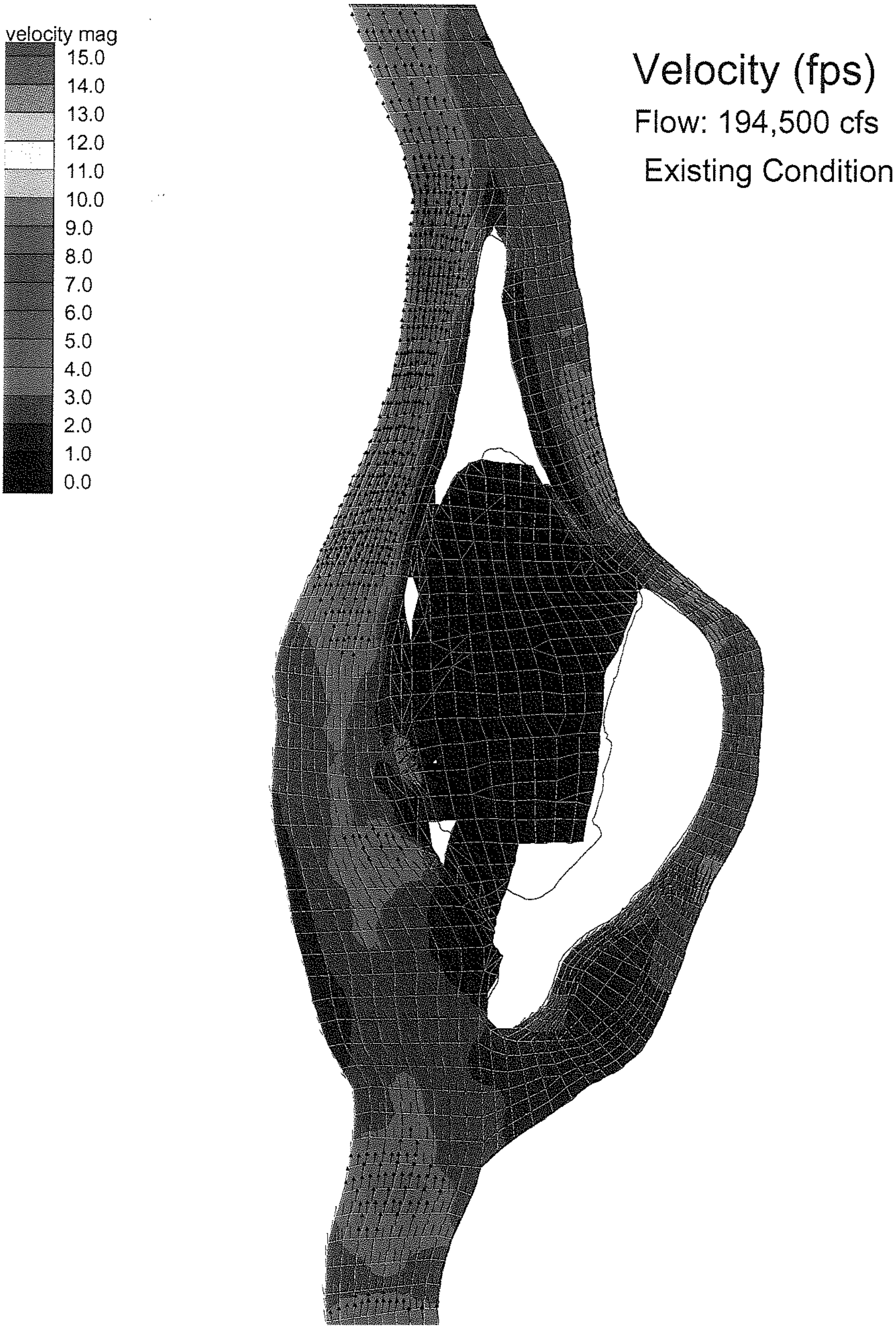
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Velocity (fps)
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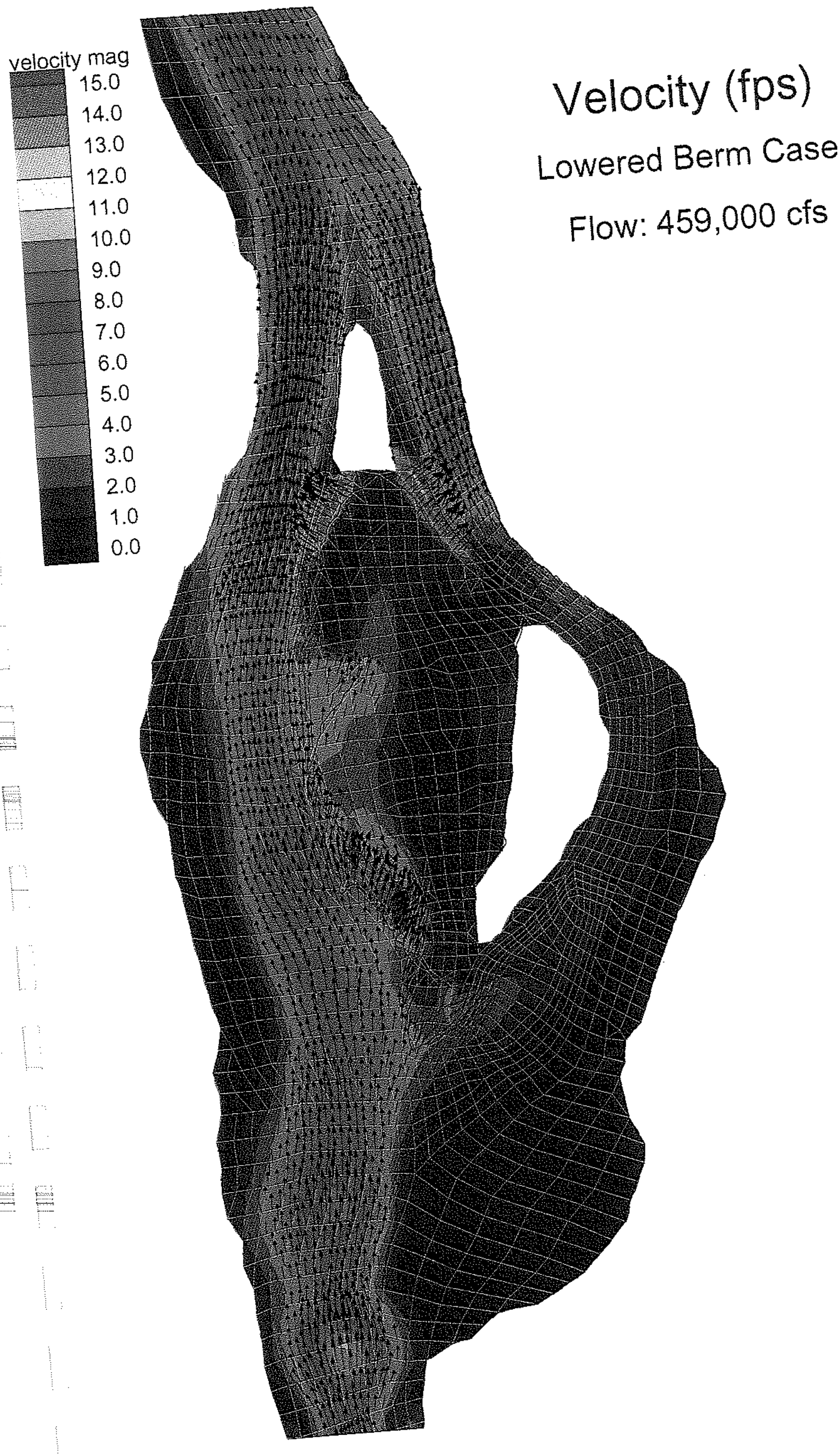
Existing Condition

APPENDIX II

PLAN CONDITION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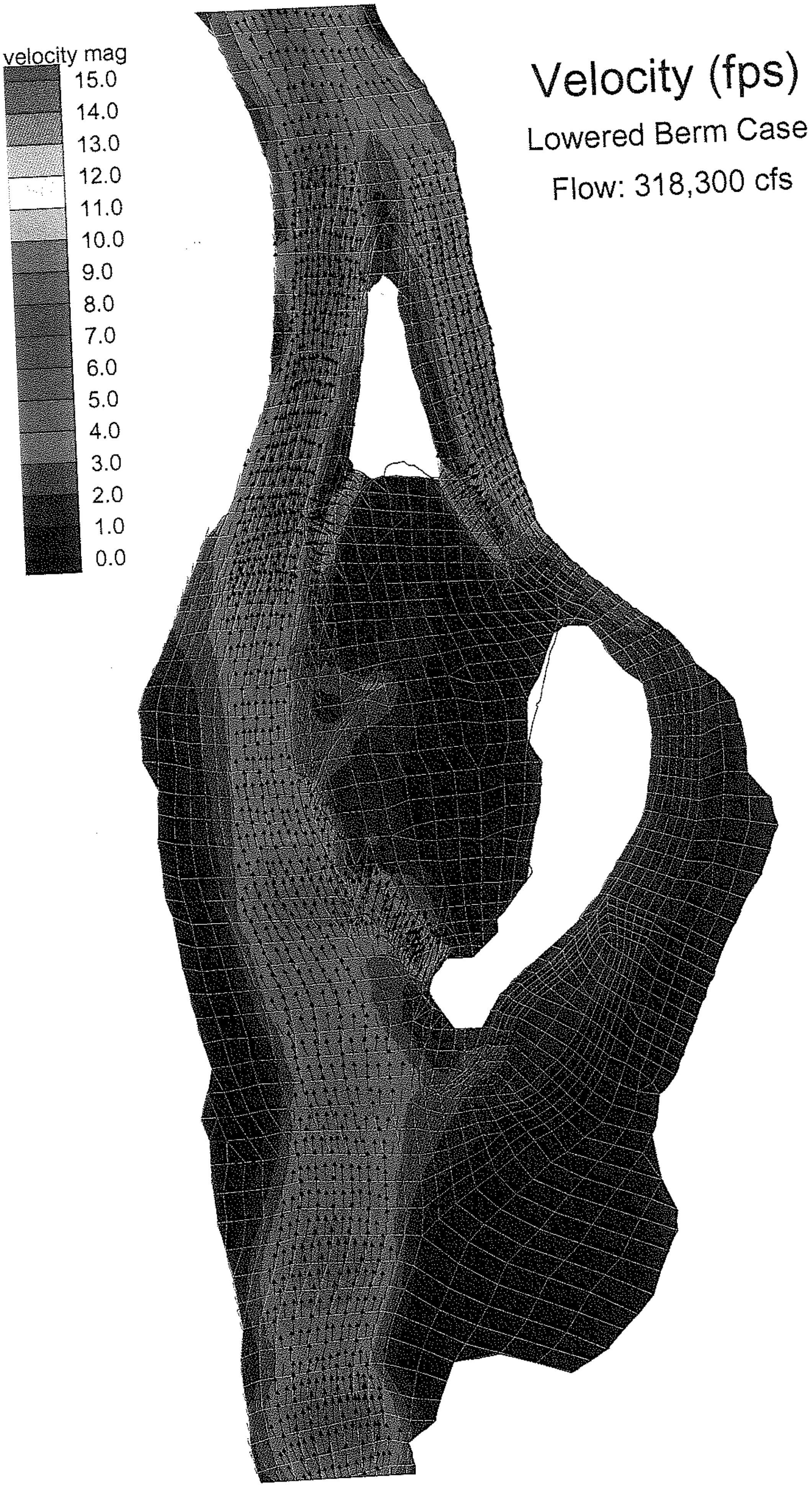
Velocity (fps)
Lowered Berm Case
Flow: 459,000 cfs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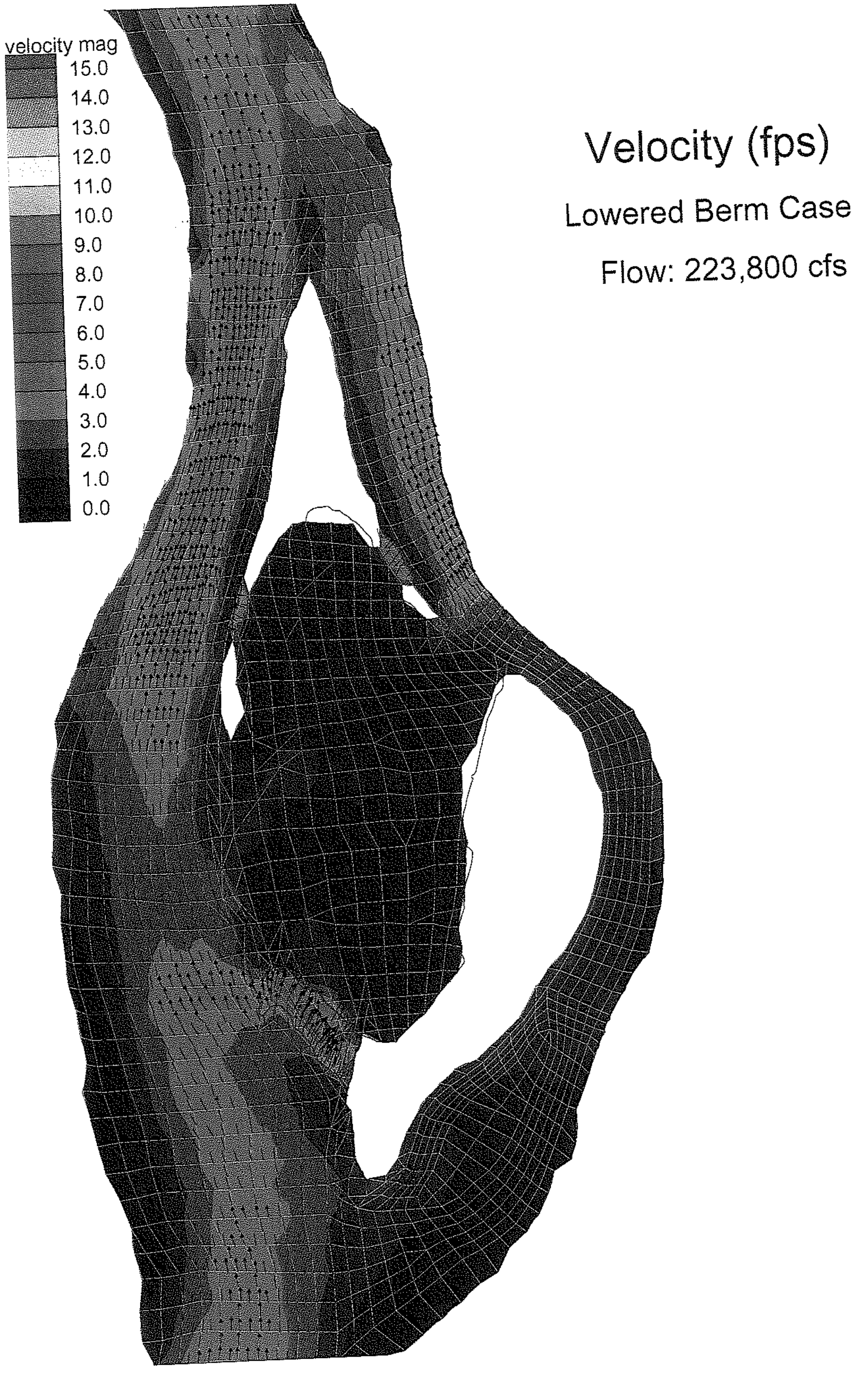
Lowered Berm Case
Flow: 318,300 cfs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4.0
3.0
2.0
1.0
0.0
Velocity (fps)
Lowered Berm Case
Flow: 223,800 cfs


velocity mag
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
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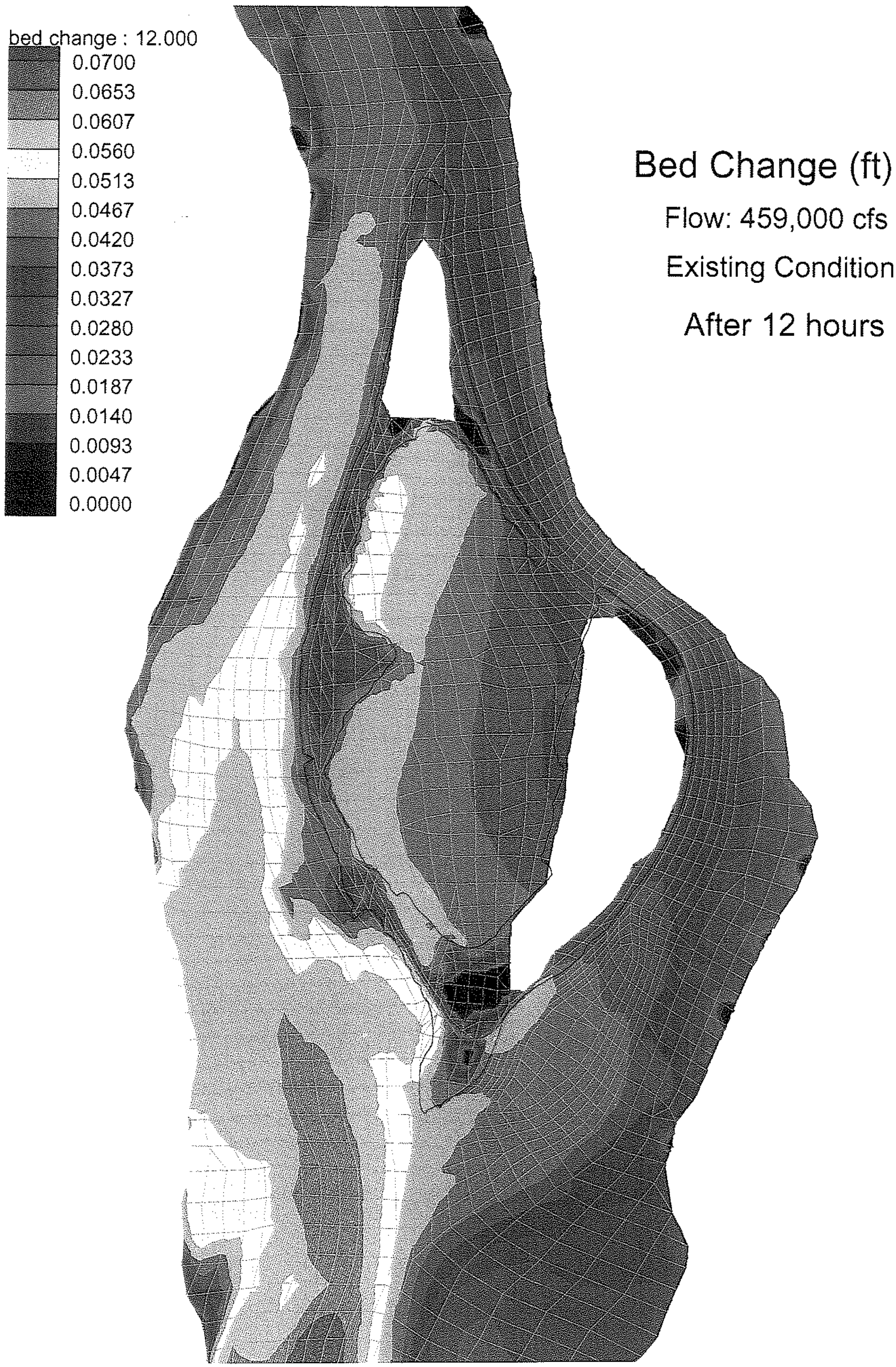
Velocity (fps)
Flow: 194,500 cfs
Lowered Berm Case

APPENDIX III

SEDIMENT TRANSPORT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0.0280
0.0233
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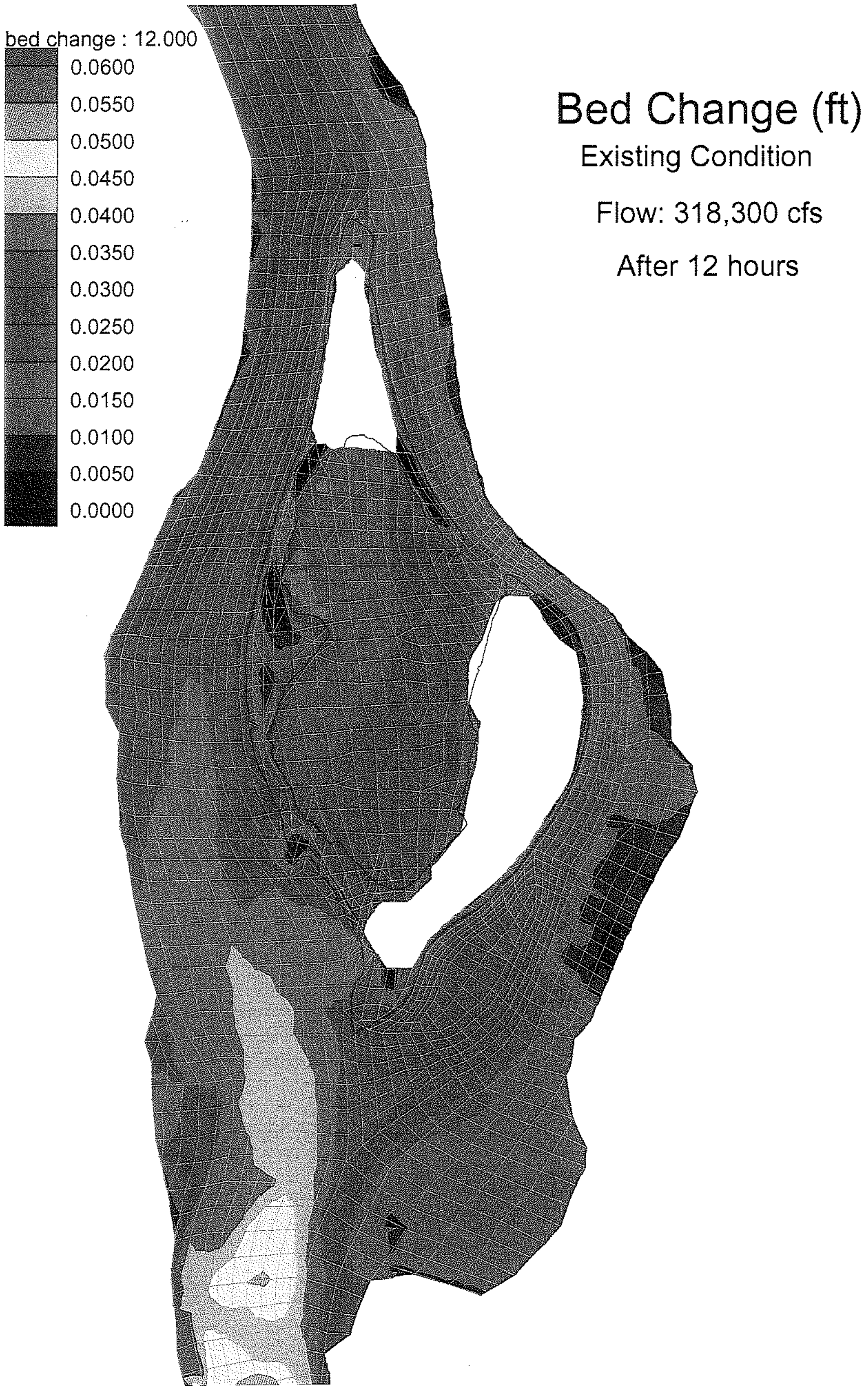
0.0140
0.0093
0.0047
0.0000
Bed Change (ft)
Flow: 459,000 cfs
Existing Condition
After 12 hours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0.0400
0.0350
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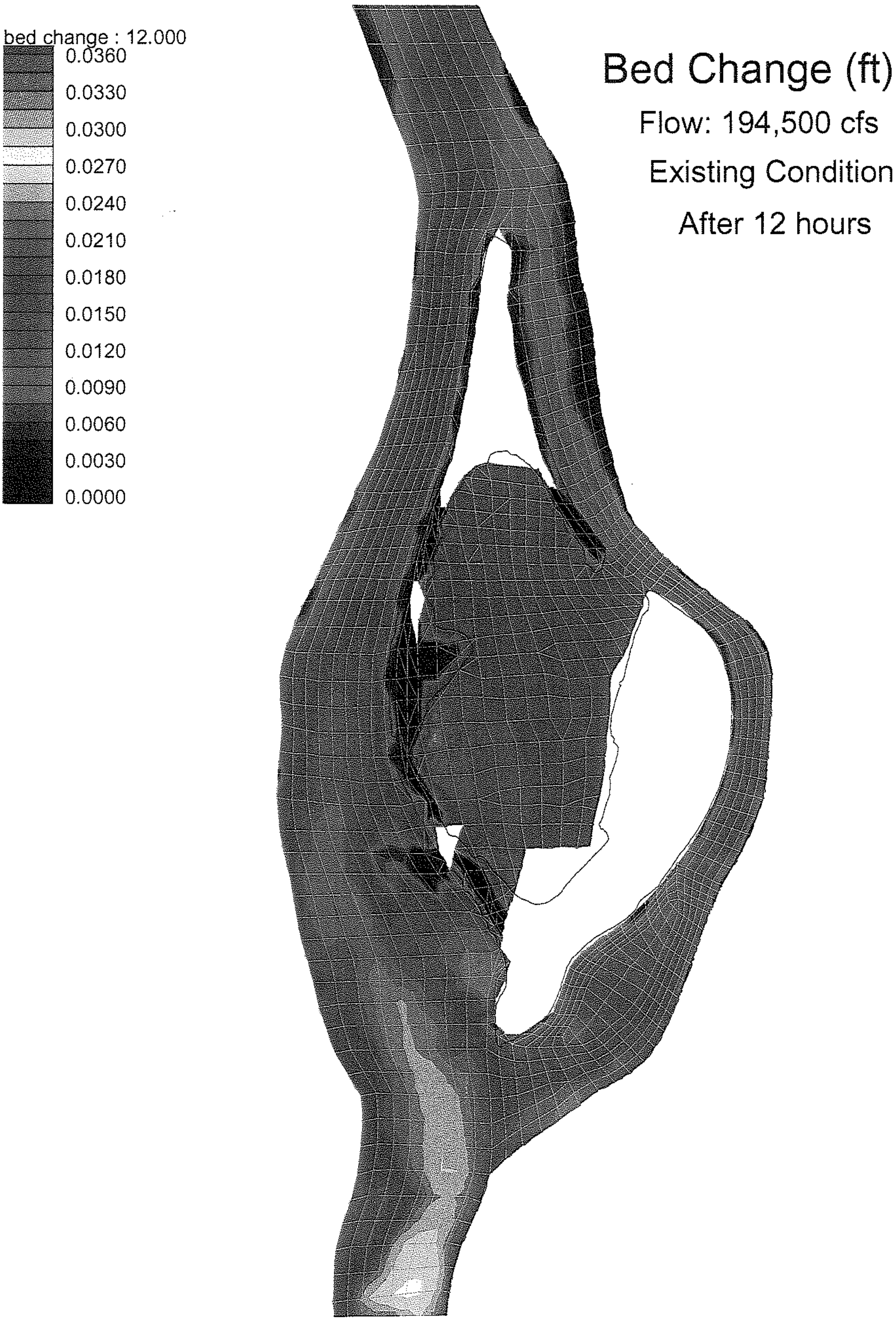
0.0150
0.0100
0.0050
0.0000
Bed Change (ft)
Existing Condition
Flow: 318,300 cfs
After 12 hours

bed change : 12.000
0.0400
0.0360
0.0320
0.0280
0.0240
0.0200
0.0160
0.0120
0.0080
0.0040
0.0000
Bed Change (ft)
Existing Condition
Flow: 223,800 cfs
After 12 hours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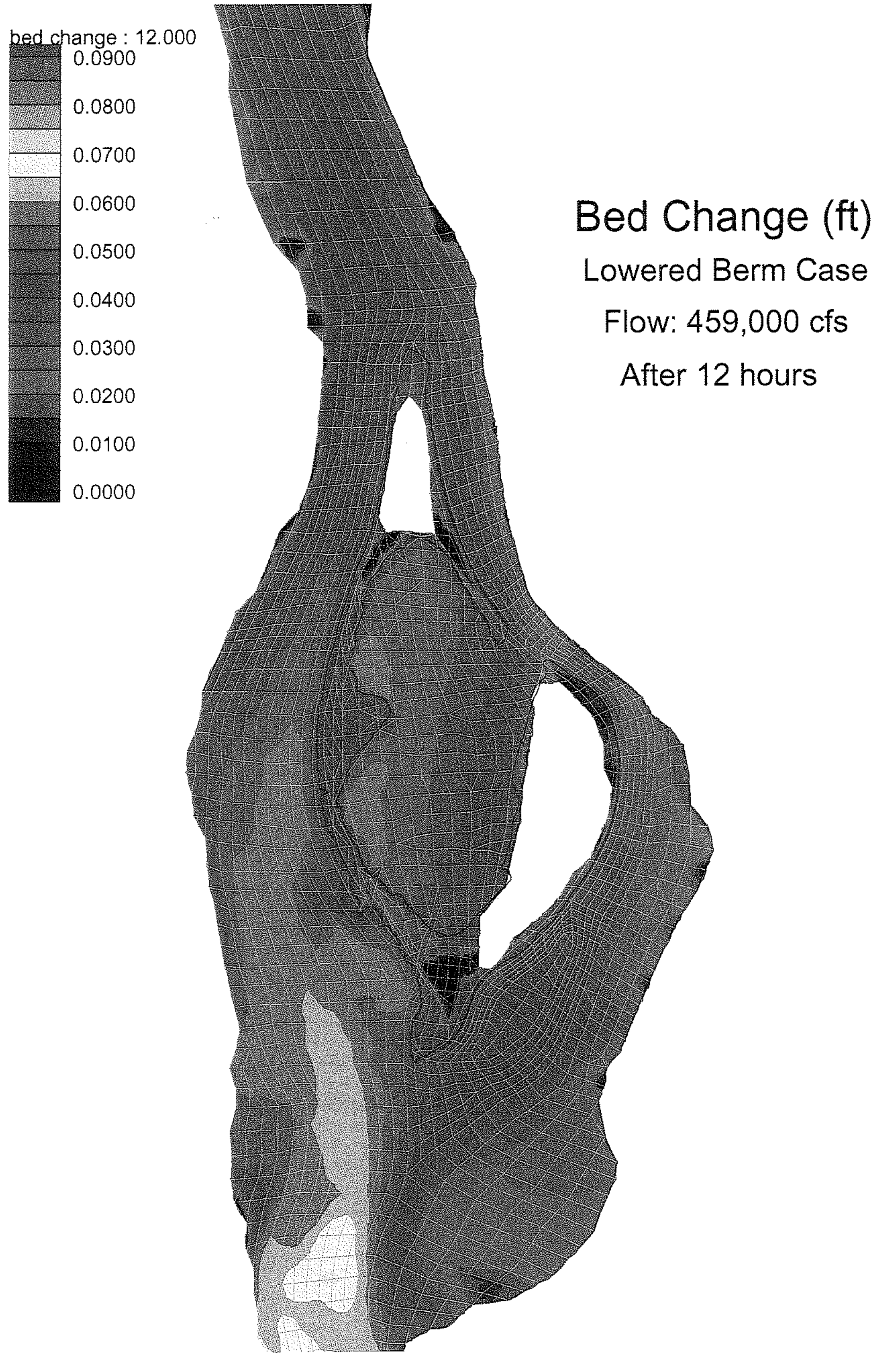
0.0030
0.0000
Bed Change (ft)
Flow: 194,500 cfs
Existing Condition
After 12 hours



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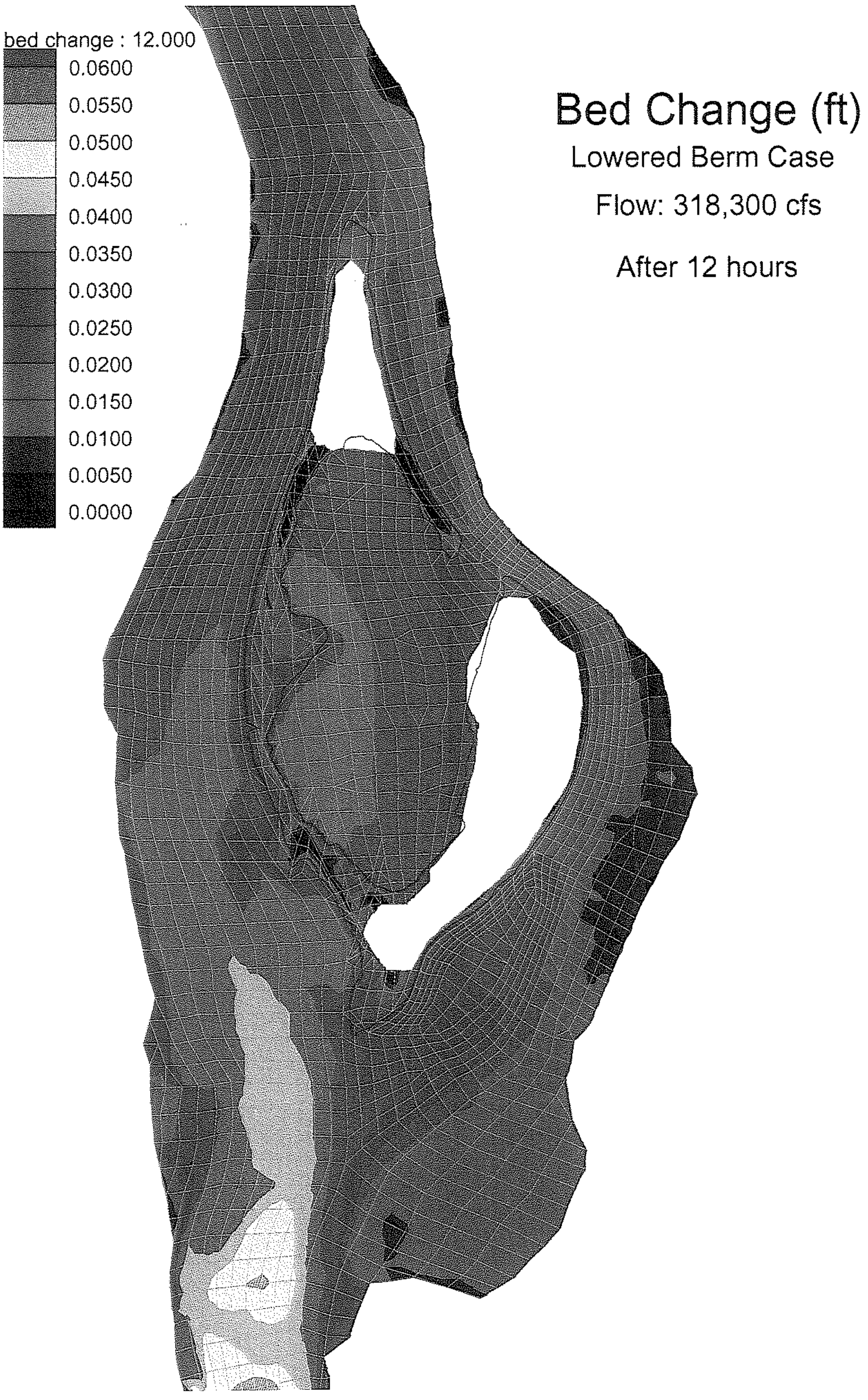
Bed Change (ft)
Lowered Berm Case
Flow: 459,000 cfs
After 12 hours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0.0350
0.0300
0.0250
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0.0150
0.0100
0.0050
0.0000
Bed Change (ft)
Lowered Berm Case
Flow: 318,300 cfs
After 12 hours

bed change : 12.000
0.0400
0.0360
0.0320
0.0280
0.0240
0.0200
0.0160
0.0120
0.0080
0.0040
0.0000
Bed Change (ft)
Lowered Berm Case
Flow: 223,800 cfs
After 12 hours

bed change : 12.000
0.0360
0.0330
0.0300
0.0270
0.0240
0.0210
0.0180
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0.0120
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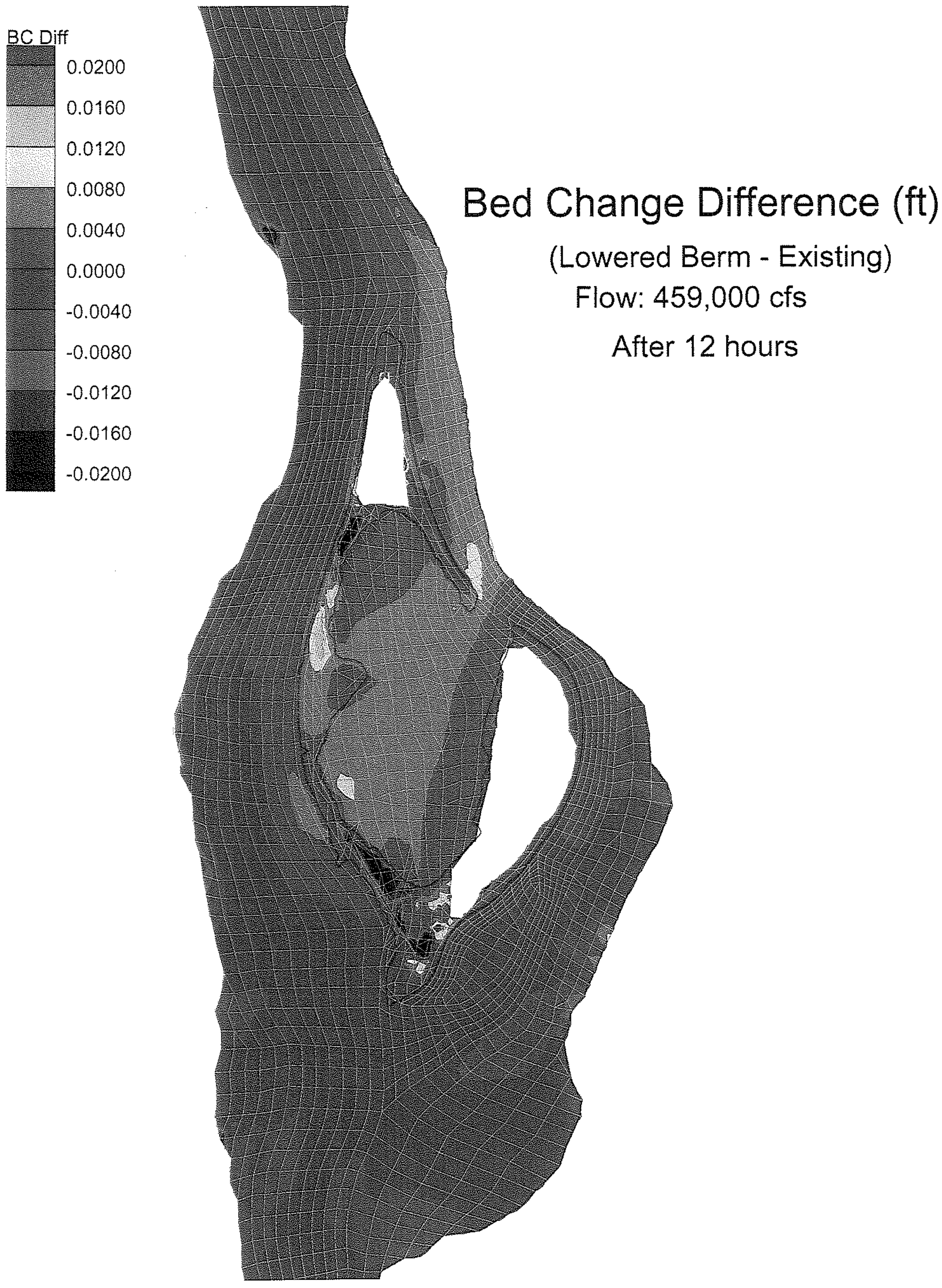
Bed Change (ft)
Flow: 194,500 cfs
Lowered Berm Case
After 12 hours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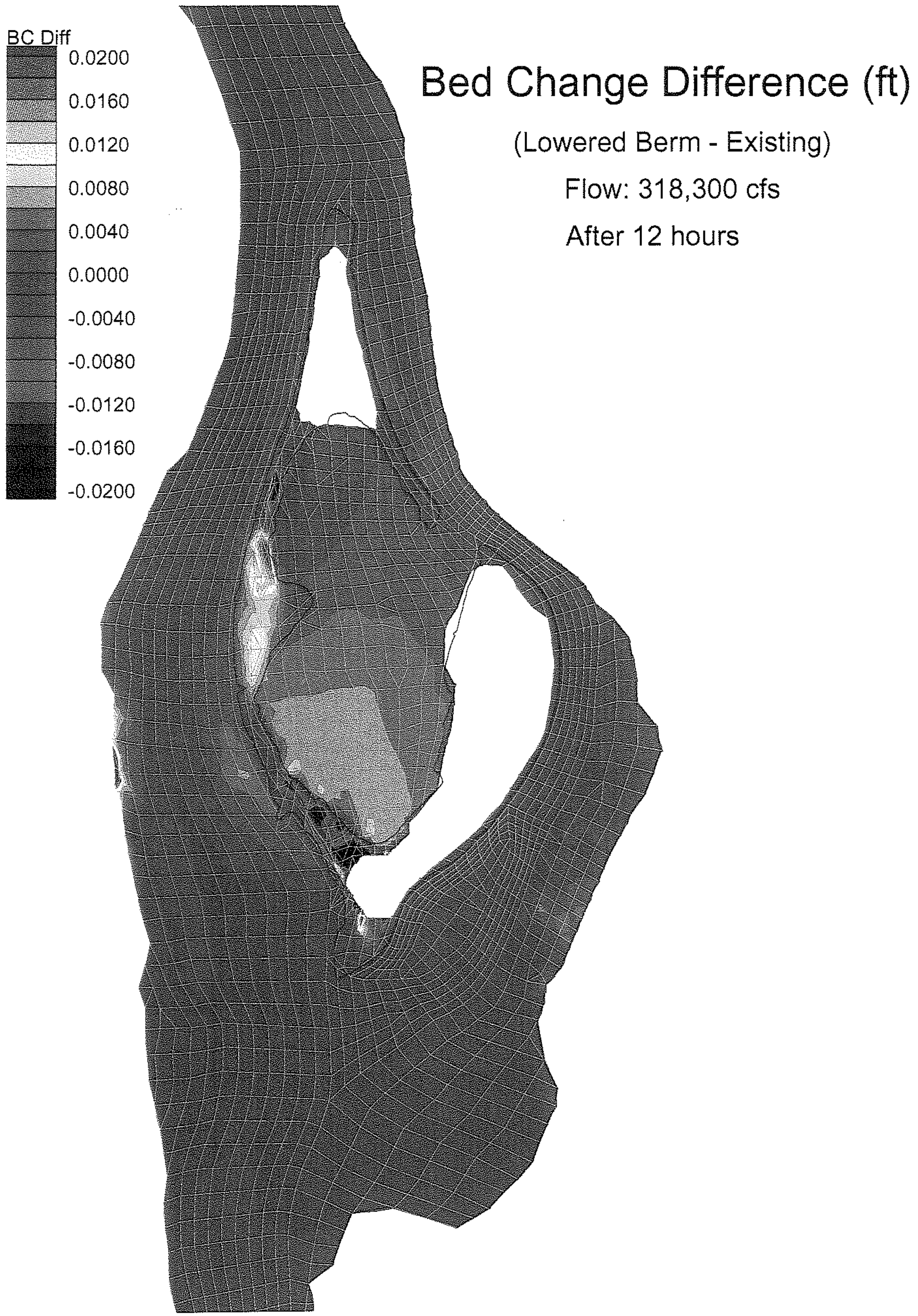
Bed Change Difference (ft)
(Lowered Berm - Existing)
Flow: 459,000 cfs
After 12 hours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Bed Change Difference (ft)
(Lowered Berm - Existing)
Flow: 318,300 cfs
After 12 hours


BC Diff
0.0200
0.0160
0.0120
0.0080
0.0040
0.0000
-0.0040
-0.0080
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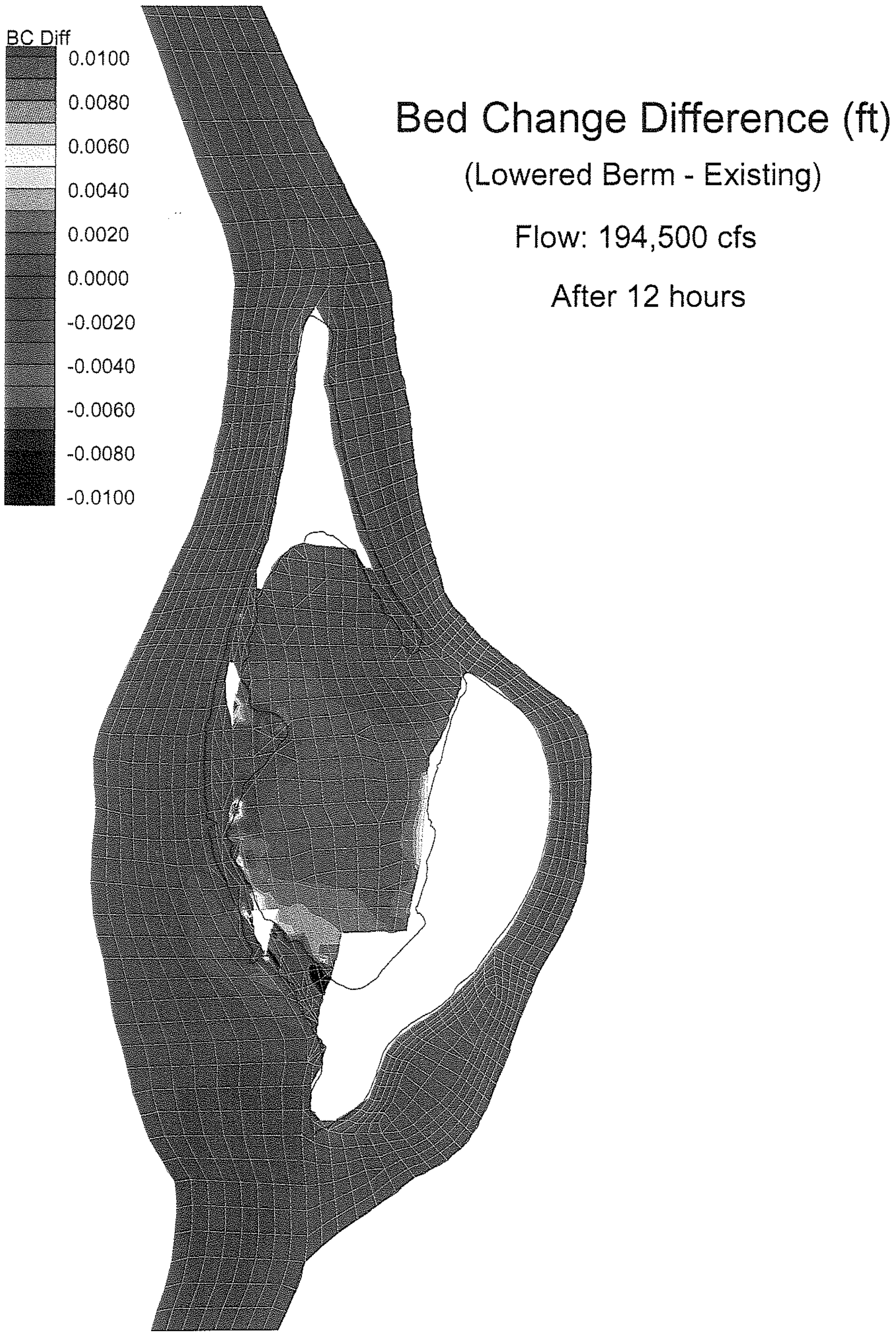
Bed Change Difference (ft)
(Lowered Berm - Existing)
Flow: 223,800 cfs
After 12 hours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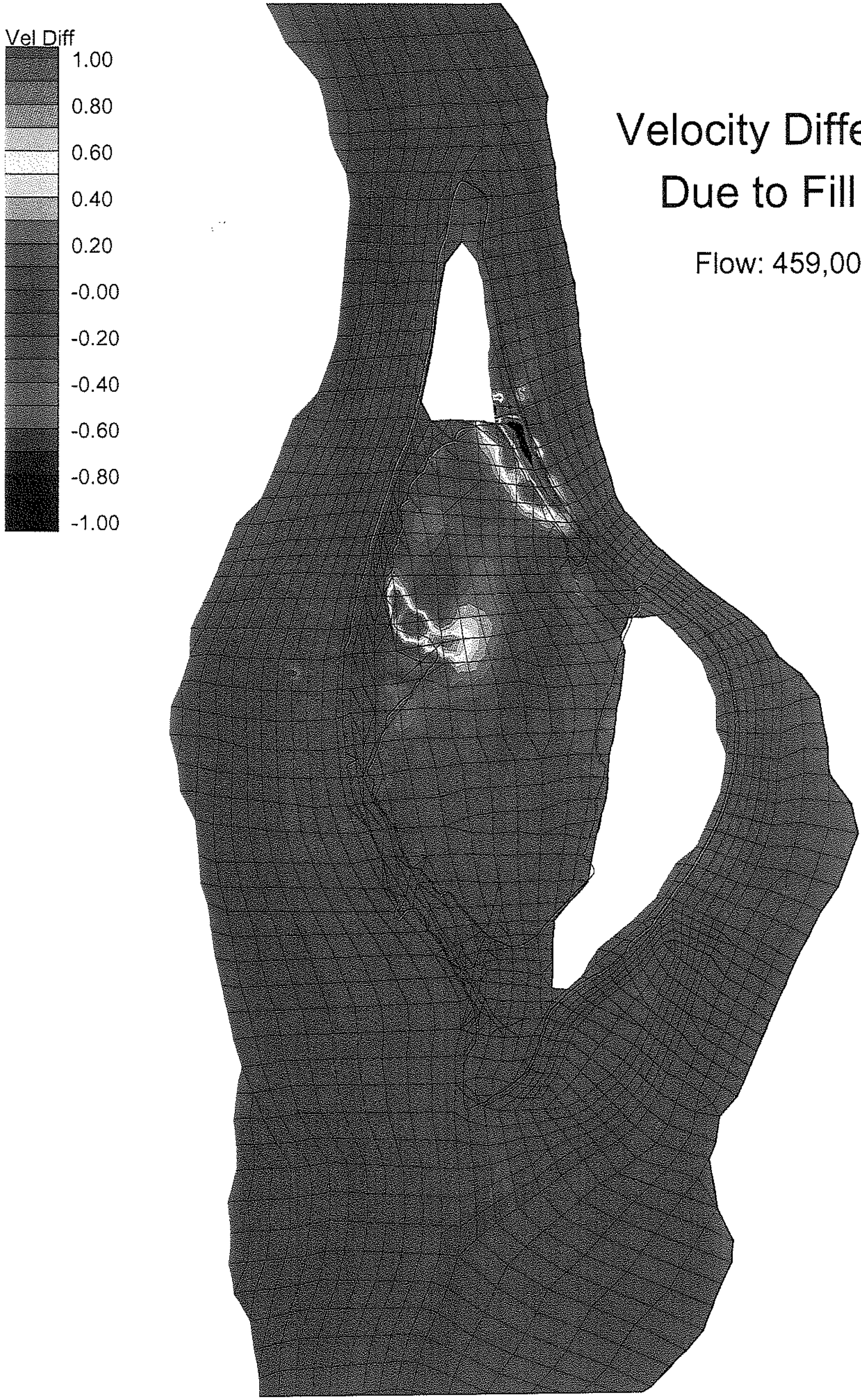
Bed Change Difference (ft)
(Lowered Berm - Existing)
Flow: 194,500 cfs
After 12 hours

APPENDIX IV

FILL SCENARIO



Velocity Difference Due to Fill (fps)

Flow: 459,000 cfs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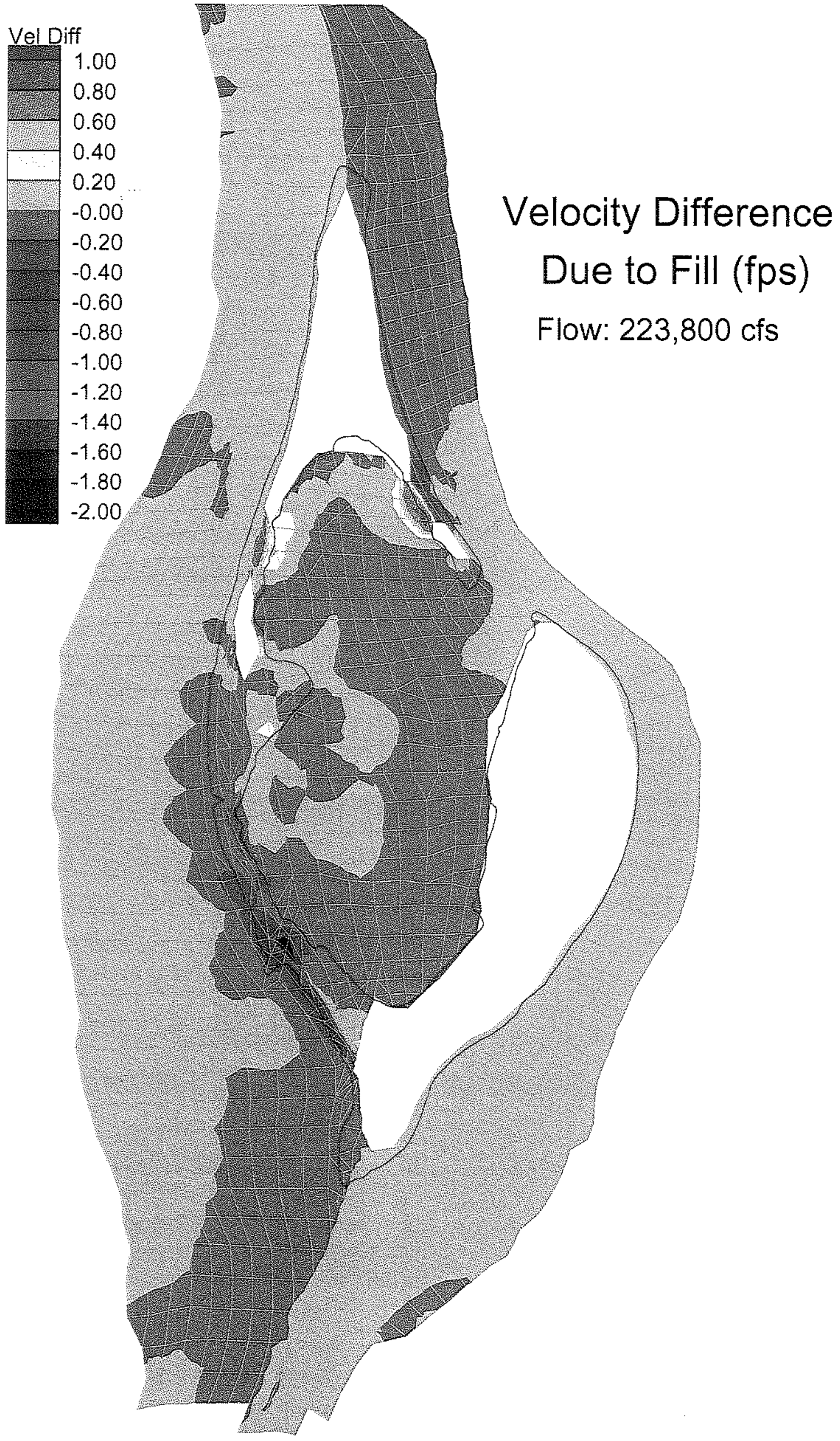
Velocity Difference
Due to Fill (fps)
Flow: 318,300 cfs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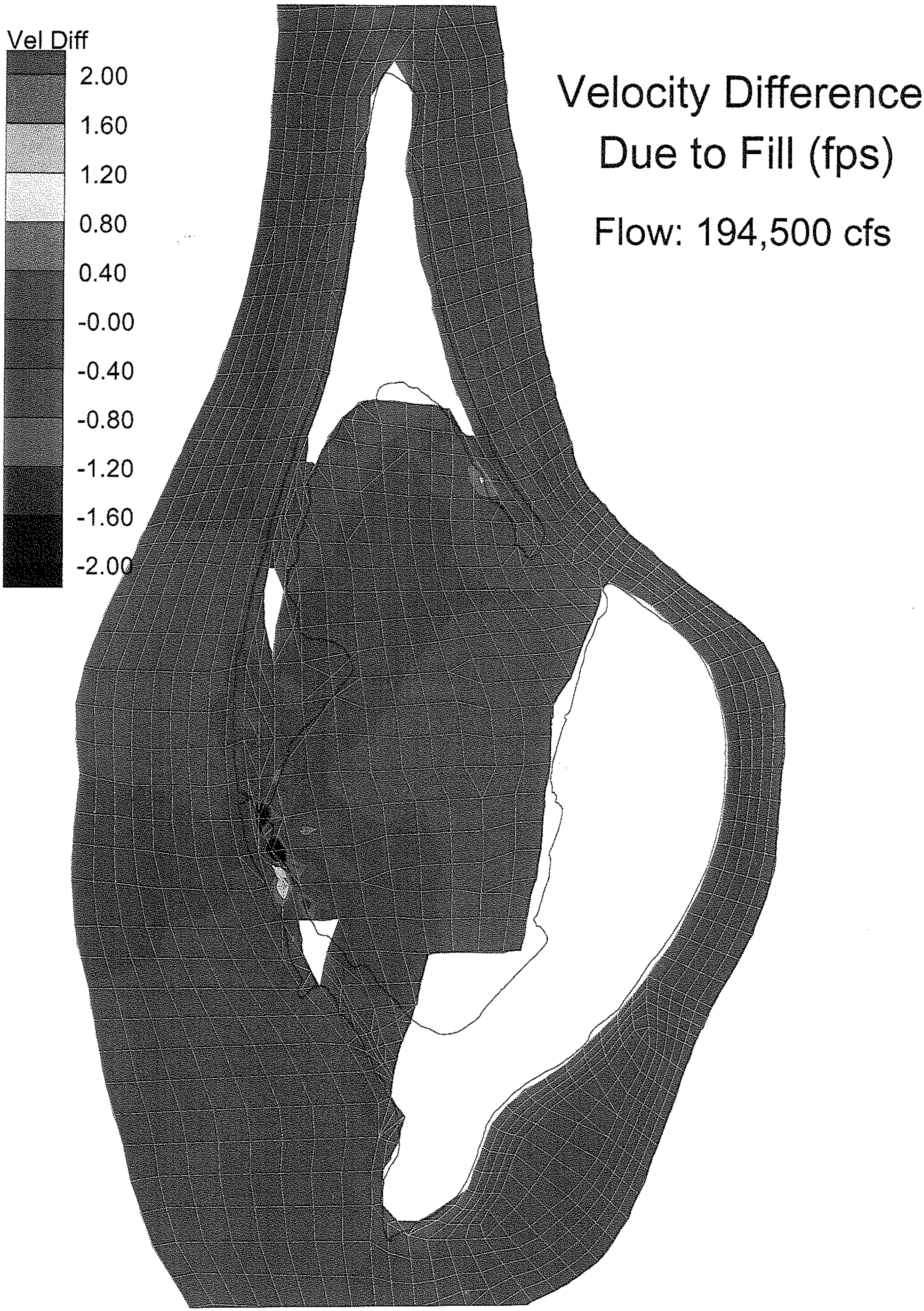
Velocity Difference
Due to Fill (fps)
Flow: 223,800 cfs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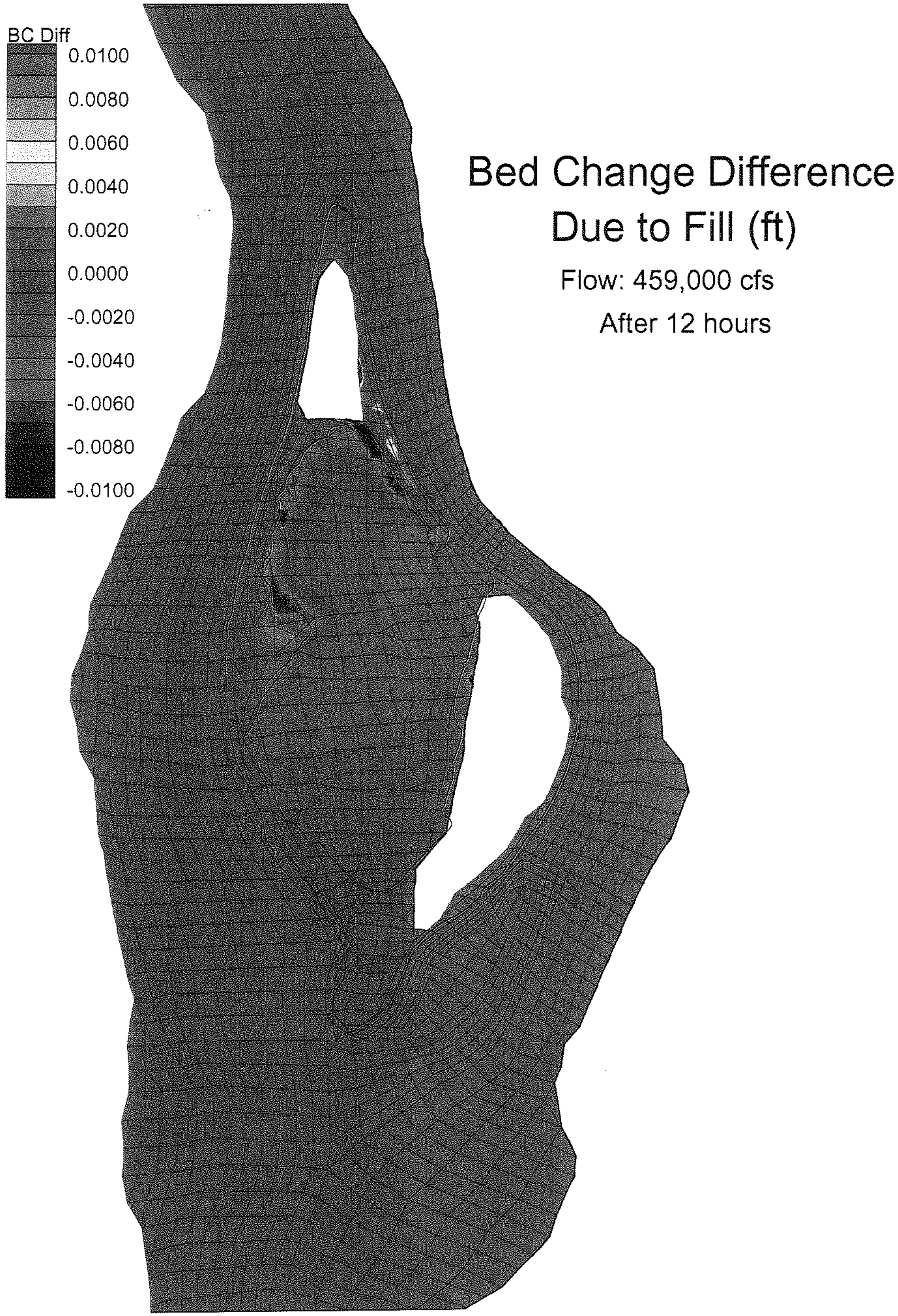
Velocity Difference
Due to Fill (fps)
Flow: 194,500 cfs



BC Diff
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-0.0100
Bed Change Difference
Due to Fill (ft)
Flow: 459,000 cfs
After 12 hours


BC Diff
0.0100
0.0080
0.0060
0.0040
0.0020
0.0000
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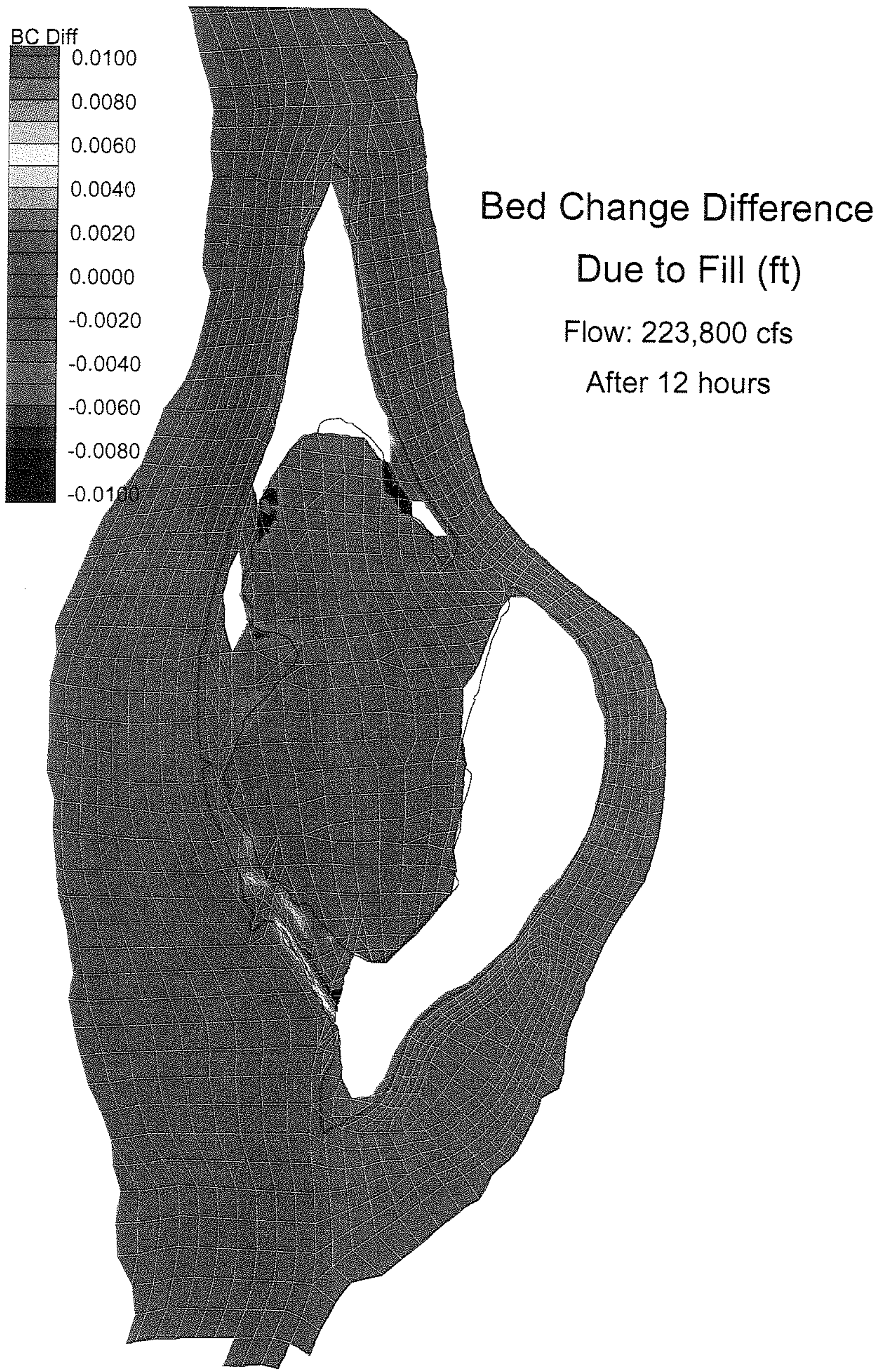
Bed Change Difference
Due to Fill (ft)
Flow: 318,300 cfs
After 12 hours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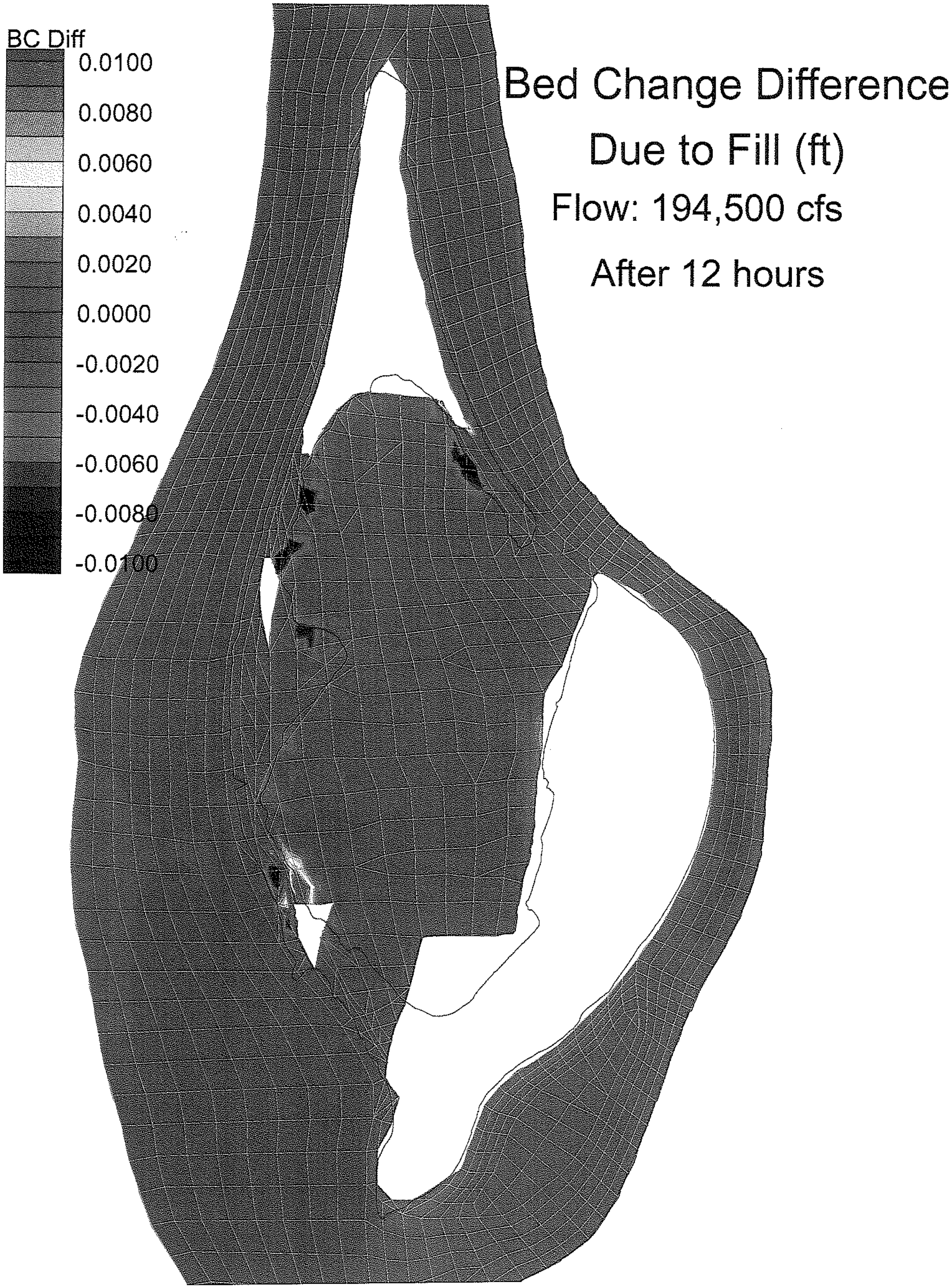
Bed Change Difference
Due to Fill (ft)
Flow: 223,800 cfs
After 12 hours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-0.0080
-0.0100
Bed Change Difference
Due to Fill (ft)
Flow: 194,500 cfs
After 12 hours

APPENDIX D

Slope Stability Evaluation

APPENDIX D

Slope Stability Evaluation

General

We performed geotechnical stability analyses to evaluate the factor of safety of the submerged slopes with the built-up 3H:1V (horizontal to vertical) and 33H:1V slopes proposed for the reclamation plan as well as resultant slopes from buildup of shallow water habitat. Cross section locations of the stability analyses are shown in Figure 6-1. Cross-sections were developed using the 2001 bathymetric survey by Minister-Glaeser and proposed locations for the built-up slopes discussed in Section 5.2.1.

The computer program "XSTABL" was used to perform stability analyses. XSTABL is a two-dimensional, fully integrated slope stability program with features for modeling submerged slopes. Stability analyses were performed for cross sections shown in Figure 6-1.

Cross sections are shown in Figures 6-2 through 6-6. Cross sections are configured for each of the slopes where proposed fill is to be placed to accommodate a longer minimally sloped bench extending away from the area of the cells of confined fill. Fill configurations are shown as the shaded areas of Figure 6-1.

Subsurface information shown in the cross sections is based on borings conducted for our Phase II Remediation Investigation (RI) Report, and supplemented by cross sections developed in Hart Crowser's (HC) Site Investigation Report for the Port of Portland, and Cornforth Consultants' Stability Analysis Letter Report for the Ross Island lagoon. Material strength used in the analyses were developed based on Standard Penetration Test correlations and laboratory testing summarized in the HC report and the RI report. Soil strength parameters used in the analyses are summarized in the following table.

Soil Unit	Description	Friction Angle, ϕ' (degrees)	Cohesion, c' (psf)	Unit Weight, γ (pcf)
GM/GP	Loose sandy gravel with silt to gravel with sand and silt.	30	0	125
ML/CL	Silt with fine sand and clayey silty fine sand.	28	0	110
SM/SP	Fine sand with varying amounts of silt.	30	0	125
Port Fill	Confined cells of port fill.	28	0	110
Native Alluvium	Native dense sandy gravel.	38	0	130
Troutdale Gravel	Native dense gravel.	38	0	135
Proposed Fill	Barge-placed fine to medium sand with silt.	30	0	120

Analyses were conducted based on fill material consisting of fine to medium sand with silt. It was assumed that fill would be placed by barge dumping or pushing material from a barge deck into the proposed fill area with sufficient construction control to build the proposed slopes to the proposed grades or flatter. Assumed soil strength properties are based on values at the lower end of the range for this type of material including the effects of the placement method on the geotechnical behavior of hydraulic fill sands (Lee and others, 1999).

Static Stability Analysis

XSTABL was used to estimate the factor of safety (FOS) against failure for many potential failure surfaces. A FOS is an index of the relative stability of the slope, or the capacity of a slope to resist slope failure relative to the forces driving failure. Failure surfaces for the lowest ten FOS are determined for each slope and load configuration. The surface with the lowest calculated FOS is considered the critical failure surface. The critical failure surface under the static load condition is shown on each cross section in Figures 6-2 through 6-6 and summarized in the table below.

Static Slope Stability Analysis Results	
Cross Section	Calculated Factor of Safety
A-A' (Lower Slope)	1.9
A-A' (Upper Slope)	1.8
B-B'	1.8
C-C'	2.4
D-D'	1.8
E-E'	1.7

Cross section E-E' is an area of existing underwater slopes where no fill is proposed to be placed.

Proposed fill slopes were extended in the area of cross sections A-A' and B-B' to extend the length of the relatively flat area in front of the confinement cells and extend the length of the critical failure surface, as well as to move the critical failure surface location out from the area of the confined cell material.

Seismic Stability Analysis

The seismic stability of the proposed reclaimed slope configuration was evaluated for cross sections A-A' to D-D' using a magnitude 7.0 earthquake located 7 kilometers from the site. The prescribed magnitude and distance correspond to a crustal fault rupture approximately 48 kilometers long and 15 kilometers deep, and result in a peak ground acceleration of 0.36g. This is an extremely conservative design recommended for use based on uncertainties associated with the confined fill material.

The HC study includes pseudo-static slope stability analyses for the submerged slopes and concluded that existing submerged slopes were vulnerable to failure during a design seismic event. However, Seed (1979) indicates that pseudo-static analyses are not typically used for cohesionless slopes. Also, liquefaction of soil layers in a slope results in an infinite failure surface, and not a finite failure surface, which is a necessary assumption for HC pseudo-static analyses.

Our analyses indicate a potential for shallow surficial sloughing, however, based on the proposed method of slope construction and SPT information from existing fill slopes, liquefaction will likely occur during a design seismic event. During liquefaction, lateral spreading will likely occur along the constructed slope. We estimated liquefaction-induced lateral ground displacement based on the Transportation Research Board (TRB) method from their workshop on new approaches to liquefaction analysis. The TRB method is based on the Youd's (1996) method developed from emperical data. Lateral displacements were estimated to be on the order of 2 to 4 feet with decreasing effect of lateral movement with increased distance from the top of the slope. These results are consistent with those developed in Cornforth Consultants' study and similar studies conducted by DOGAMI.

These levels of lateral displacement are not likely to affect the overall stability of the island's upland slopes, or compromise or significantly breach the existing confined cells. In the event of these levels of lateral displacement, the material capping the confined cells would likely deform and ravel and fill in voids that would form in the cap.

APPENDIX E

Ross Island Sand & Gravel Draft Fill Evaluation Scope of Work

ROSS ISLAND SAND AND GRAVEL

DRAFT FILL EVALUATION SCOPE OF WORK

I. SCHEDULE

Ross Island Sand and Gravel Inc. (RISG) shall submit for DEQ review and approval fill sampling plans and reports which address all elements of this Scope of Work (SOW).

All work completed under this SOW shall proceed in accordance with the schedule below for individual fill proposals where confined disposal is planned:

Project description, initial sampling results and proposed placement method for fill and cap, and cap design	To DEQ a minimum of three (3) months prior to the date the fill is planned to be brought to Ross Island Lagoon.
DEQ Review and Comment	To RISG within 30 days of receipt of the report.
Draft Report - Confined Placement Documentation	To DEQ within 30 days of completion of the action or receipt of analytical results.
DEQ Review and Comment	To RISG within 30 days of receipt of draft report.
Final Report	To DEQ within 30 days of receipt of DEQ comments on draft report.
Progress Reports	To DEQ by the 10th day of June annually.
DEQ Review/Comment	To RISG within 30 days of submittal of Progress Report.

II. OBJECTIVES

A. Work performed under this SOW shall be completed to meet the goals of the reclamation plan as described in *DSL Permit (RF-)* The Reclamation Plan specifies that fill placed in the lagoon must not pose an unacceptable short or long-term risk to human health and the environment. The objectives of the tasks described in this SOW are:

1. To ensure that fill containing hazardous substances above screening levels is managed as necessary, based on evaluation of initial data and any subsequent testing, to keep it isolated from the surrounding aquatic habitat.

2. To confirm that fill determined not to require management or to require minimal management, was adequately evaluated and managed as appropriate.

III. FILL CATEGORIES - IN-WATER FILL

Fill destined for placement in Ross Island Lagoon will generally fall into four categories based on the presence of hazardous substances:

1) Class "A" Fill - Material with concentrations of hazardous substances less than both toxicity and bioaccumulation screening levels (see Table 1), or for which toxicity and bioaccumulation testing demonstrate no toxicity and no detectable concentrations of bioaccumulative hazardous substances (see Attachment 1 - Ross Island Fill Evaluation Fact Sheet). This material will not pose an unacceptable risk to human health or the environment and will require no management after placement.

2) Class "B" Fill - Material with concentrations of hazardous substances no more than five (5) times toxicity screening levels and no more than two (2) times bioaccumulation screening levels, or for which toxicity and bioaccumulation testing demonstrate toxicity and concentrations of bioaccumulative hazardous substances below acceptable screening levels in tissue (see Table 1). This material may pose an unacceptable risk to human health or the environment and will require capping with a three (3) foot cap after placement.

3) Class "C" Fill - Material with concentrations of hazardous substances no more than ten (10) times toxicity screening levels and no more than five (5)times bioaccumulation screening levels, or for which toxicity and bioaccumulation testing demonstrate toxicity and detectable concentrations of bioaccumulative hazardous substances no more than two (2) times the acceptable tissue level (see Table 1). This material is likely to pose an unacceptable risk to human health or the environment and will require capping with a minimum five (5) foot cap and long-term monitoring and maintenance after placement.

4) Class "D" Fill - Material with concentrations of hazardous substances greater than ten (10) times toxicity screening levels and greater than five (5)times bioaccumulation screening levels, or for which toxicity and bioaccumulation testing demonstrate toxicity and detectable concentrations of bioaccumulative hazardous substances more than two (2) times the acceptable tissue level (see Attachment 1), or fill containing free product or radioactive compounds. This fill contains contaminants in a form or at a concentration that pose a significant risk to human health and the environment such that it cannot safely be managed in Ross Island lagoon.

A. CLASS "A" FILL DETERMINATION

The following information must be documented to support a finding that the proposed fill material will not pose an unacceptable risk to human health or the environment without capping:

1. The source area from which the fill is obtained must be described. This description shall include at a minimum:

   a) Area and depth over which fill will be removed and estimated fill volume. A map depicting the site and surrounding areas should be provided.
   b) Nature of the material; e.g., general consistency, particle size, heterogeneity.
   c) Historical activities at the site and any surrounding areas (a minimum of .25 miles up and downstream) that may have impacted the site.
   d) Any existing chemical or physical sampling data for the site.

   If the information provided above is sufficient to determine that hazardous substances are not present above the concentrations for Class A materials, a "clean fill" determination can be made at this point and further testing is not necessary. Under this scenario, approval from DEQ prior to placement in Ross Island Lagoon is not required. However, the basis for the clean fill determination must be documented for future submittal in the Annual Progress Report, described in Item V. of this SOW.

2. Chemical analyses for substances likely to be present in the potential fill material must be provided. Testing protocols are described in Attachment 1. (Ross Island Fill Evaluation Fact Sheet). If testing indicates that concentrations of hazardous substances in the proposed fill are less than both toxicity and bioaccumulation screening levels (see Table 1),

or for which subsequent toxicity and bioaccumulation testing demonstrate no toxicity and no detectable tissue concentrations of bioaccumulative hazardous substances (see Attachment 1), the fill can be placed in Ross Island Lagoon. Under this scenario, approval from DEQ prior to placement in Ross Island Lagoon is not required. However, the basis for the clean fill determination must be documented for future submittal in the Annual Progress Report, described in Item V. of this SOW.

B. CLASS "B" FILL DETERMINATION

The following information must be documented to support a finding that the proposed fill material will not pose an unacceptable risk to human health or the environment if covered with a three (3) foot cap of clean material:

1. The source area from which the fill is obtained must be described. This description shall include at a minimum:

    a) Area and depth over which fill will be removed and estimated fill volume. A map depicting the site and surrounding areas should be provided.
    b) Nature of the material; e.g., general consistency, particle size, heterogeneity.
    c) Historical activities at the site and any surrounding areas that may have impacted the site.
    d) Any existing chemical or physical sampling data for the site.

2. Chemical analyses for substances likely to be present in the potential fill material must be provided. Testing protocols are described in Attachment 1. Ross Island Fill Evaluation Fact Sheet. If testing indicates that concentrations of hazardous substances are no more than five (5) times toxicity screening levels and no more than two (2) times bioaccumulation screening levels, or for which subsequent toxicity and bioaccumulation testing demonstrate toxicity and concentrations of bioaccumulative hazardous substances are below the acceptable tissue level, the fill can be placed in Ross Island Lagoon with a cover[1] as described in item IV.C. Under this scenario approval from DEQ prior to placement in Ross Island Lagoon is not required; however, DEQ must be notified a minimum of 30 days prior to the planned placement. Also, the basis for the Class "B" fill determination must be documented for future submittal in the Annual Progress Report, described in Item V. of this SOW.

[1] Note that a cover is not necessary if subsequent testing, as described in the fill evaluation protocols (described in Attachment 1) indicates that the material does not pose toxicity or bioaccumulative threats.

3. Documentation of cap placement. Once sufficient time has passed for the fill material to have settled adequately, based on evaluation of the characteristics of the fill and no longer than 6 months from the date of the last fill placement at this location or 2 years from the date of the first fill placement, the fill shall be covered with a minimum of three (3) feet of clean material. Bathymetric surveys shall be conducted before fill placement, after fill placement, and after cap placement to assure all fill material is adequately covered. The source and nature of the cap material and the associated documentation that it is clean shall be documented as described in Item IV.A. of this SOW. Documentation associated with capping shall be provided in the Annual Progress Report, described in Item V of this SOW.

C. CLASS "C" FILL DETERMINATION

Any material with concentrations of hazardous substances no more than ten (10) times toxicity screening levels and no more than five (5) times bioaccumulation screening levels, or for which subsequent toxicity and bioaccumulation testing demonstrate toxicity and detectable concentrations of bioaccumulative hazardous substances no more than two (2) times the acceptable tissue level are acceptable only in conjunction with capping, monitoring, and management. The following submittals will be required for evaluation of the suitability of placement of the material in Ross Island Lagoon with a cap and associated long-term monitoring and management:

1. The source area from which the fill is obtained must be described. This description shall include at a minimum:

   a) Area and depth over which fill will be removed and estimated fill volume. A map depicting the site and surrounding areas should be provided.
   b) Nature of the material; e.g., general consistency, particle size, heterogeneity.
   c) Historical activities at the site and any surrounding areas that may have impacted the site.
   d) Any existing chemical or physical sampling data for the site.

2. Chemical analyses for substances likely to be present in the potential fill material must be provided. Testing protocols are described in Attachment 1. Ross Island Fill Evaluation Fact Sheet. If contaminants are detected in a form or at a concentration that would characterize the material as Class "D" Fill as described in Item VI of this SOW, the material cannot be placed in the Ross Island lagoon.

3. A work plan describing the planned placement of the contaminated material must be submitted for DEQ review a minimum of 3 months prior to the date of placement. The work plan should include: identification of the location within the lagoon that the material will be placed, method of placement including techniques used to minimize turbidity, time frame for settling, source of cap material, placement method and timing for cap, thickness of cap, method for documenting that cap design has been achieved, and long-term monitoring that will be implemented to ensure that the cap is effective. DEQ will make the work plan available for public review and hold a public meeting to accept comments on the proposal as warranted. DEQ approval of the work plan is required prior to proceeding with the planned activity.

4. A report documenting the placement of the contaminated fill and associated cap shall be submitted to DEQ within 30 days of completion of the capping and receipt of any associated analytical results. Long-term monitoring and management and associated report submittal will be completed as defined in the Workplan (Item V.C.).

D. **CLASS "D" FILL**

The following materials cannot be placed in Ross Island lagoon: (a) Material with concentrations exceeding ten (10) times the toxicity screening levels, (b) material with concentrations exceeding five (5) times bioaccumulation screening levels or for which bioaccumulation testing indicates concentrations greater than two (2) times the acceptable tissue levels, (c) material exhibiting a sheen, or (d) material exhibiting radiological properties.

IV. FILL CATEGORIES - UPLAND FILL

For the purposes of this Scope of Work, "Upland" is defined as those areas on Ross and Hardtack Islands that lie a minimum of five (5) feet above the mean high water elevation and are a minimum of fifty (50) feet from the shoreline with the lagoon, the Willamette River, or the Holgate Slough. Material below this elevation or within fifty (50) feet of a shoreline must be treated as "in-water" fill and the protocols described above in Section III followed. Fill destined for placement upland on Ross or Hardtack Island will generally fall into four (4) categories based on the presence of hazardous substances:

(1) Class "A" Fill - Material with concentrations of hazardous substances that fall below the lowest applicable screening level considering: ecological terrestrial exposure, human direct contact, and potential leaching to ground or surface water at concentration that exceed aquatic screening levels (see Table 2). The leachate evaluation can be based on total concentrations or

leachate tests. This material will not pose an unacceptable risk to human health or the environment and will require no management after placement.

(2) Class "B" Fill - Material meeting the criteria for Class "A" fill described above, with the exception that the screening criteria for petroleum hydrocarbons is exceeded by no more than ten (10) times the screening concentrations. This material must be landfarmed after placement with the goal of reducing petroleum concentrations to below screening levels. Once landfarming is complete, this material must be covered with a minimum of two (2) feet of clean soil.

(3) Class "C" Fill - Material with concentrations of hazardous substances no more than five (5) times the direct contact screening levels for human or ecological receptors and meeting the leachate screening concentrations. This material may pose an unacceptable risk to human health or the environment and will require capping with a minimum of three (3) feet of clean soil and associate long term management of the cap.

(4) Class "D" Fill - material with concentrations of hazardous substances greater than five (5) times direct contact screening levels, exceeding leachate screening concentrations, exhibiting a sheen, or containing radioactive compounds. This fill contains hazardous substances at a level or in a form that cannot safely be managed on Ross or Hardtack Islands.

A. CLASS "A" FILL DETERMINATION The following information must be documented to support a finding that the proposed fill material will not pose an unacceptable risk to human health or the environment without capping:

1. The source area from which the fill is obtained must be described. This description shall include at a minimum:

   a) Area and depth over which fill will be removed and estimated fill volume. A map depicting the site and surrounding areas should be provided.
   b) Nature of the material; e.g., general consistency, particle size, heterogeneity.
   c) Historical activities at the site and any surrounding areas that may have impacted the site.
   d) Any existing chemical or physical sampling data for the site.

   If the information provided above is sufficient to determine that hazardous substances will not be present above the concentrations for Class A material, a "clean fill" determination can be made at this point and further testing is not necessary. Under this scenario approval from DEQ prior to placement on Ross or Hardtack Island is not required. However, the basis for the clean fill determination must be documented for future submittal in the Annual Progress Report, described in Item V. of this SOW.

2. Chemical analyses for substances likely to be present in the potential fill material must be provided. Testing protocols are described in Attachment 2 - Upland Fill Evaluation Fact Sheet[2]. If testing indicates that concentrations of hazardous substances in the proposed fill are less than both total and leachate screening levels (see Table 2[3]), the fill can be placed upland on Ross or Hardtack Island. Under this scenario, approval from DEQ prior to placement is not required. However, the basis for the clean fill determination must be documented for future submittal in the Annual Progress Report, described in Item V. of this SOW.

B. CLASS "B" FILL DETERMINATION

The following information must be documented to support a finding that the proposed fill material will not pose an unacceptable risk to human health or the environment if landfarmed and covered with a minimum of two (2) feet of clean fill:

1. The source area from which the fill is obtained must be described. This description shall include at a minimum:

    a) Area and depth over which fill will be removed and estimated fill volume. A map depicting the site and surrounding areas should be provided.
    b) Nature of the material; e.g., general consistency, particle size, heterogeneity.
    c) Historical activities at the site and any surrounding areas that may have impacted the site.
    d) Any existing chemical or physical sampling data for the site.

2. Chemical analyses for substances likely to be present in the potential fill material must be provided. Testing protocols are described in Attachment 2 - Upland Fill Evaluation Fact Sheet. If testing indicates that, with the exception of petroleum hydrocarbons, concentrations of hazardous substances in the proposed fill are less than both total and leachate screening levels (see Table 2); and

2 To be developed

3 To be developed

petroleum hydrocarbons are less 1,000 ppm, the fill can be placed upland on Ross or Hardtack Island. This material must be landfarmed and resampled, with the goal of reducing petroleum concentrations to less than 100 ppm. Under this scenario, approval from DEQ prior to placement is not required; however, DEQ must be notified a minimum of 30 days prior to the planned placement. Also, the basis for the Class "B" fill determination must be documented for future submittal in the Annual Progress Report, described in Item V. of this SOW.

3. Documentation of cap placement. Once landfarming is complete and no more than six (6) months following receipt of analytical results confirming treatment goals were achieved, the fill must be covered with a minimum of two (2) feet of clean soil. The source and nature of the cap material and the associated documentation that it is clean shall be documented as described in Item IV.A. of this SOW. Documentation associated with capping shall be provided in the Annual Progress Report, described in Item V of this SOW.

C. CLASS "C" FILL DETERMINATION

Any material with concentrations of hazardous substances no more than five (5) times the direct contact screening levels, but meeting leachate screening criteria, are only acceptable for upland placement in conjunction with capping, monitoring, and management. The following submittals will be required for evaluation of the suitability of placement of the material upland on Ross or Hardtack Island with a cap and associated long-term maintenance:

1. The source area from which the fill is obtained must be described. This description shall include at a minimum:

   a) Area and depth over which fill will be removed and estimated fill volume. A map depicting the site and surrounding areas
   b) Historical activities at the site and any surrounding areas that should be provided.
   c) Nature of the material; e.g., general consistency, particle size, heterogeneity.may have impacted the site.
   d) Any existing chemical or physical sampling data for the site.

2. Chemical analyses for substances likely to be present in the potential fill material must be provided. Testing protocols are described in Attachment 2 - Upland Fill Evaluation Fact Sheet. If contaminants are detected in a form or at a concentration that would characterize the material as Class "D" Fill as described in Item IV.D of this SOW, the material cannot be placed upland on Ross or Hardtack Island.

3. A work plan describing the planned placement of the contaminated material must be submitted for DEQ review a minimum of 3 months prior to the date of placement. The work plan should include: identification of the location that the material will be placed, method of placement, source of cap material, placement method and timing for cap, thickness of cap, method for documenting that cap design has been achieved, and long-term maintenance that will be implemented. DEQ will make the work plan available for public review and hold a public meeting to accept comments on the proposal as warranted. DEQ approval of the work plan is required prior to proceeding with the planned activity.

4. A report documenting the placement of the contaminated fill and associated cap shall be submitted to DEQ within 30 days of completion of the capping and receipt of any associated analytical results. Long-term maintenance and associated report submittal will be completed as defined in the Workplan (Item IV.C.).

D. **CLASS "D" FILL**

The following materials cannot be placed upland on Ross or Hardtack Island: (a) Material with concentrations exceeding five (5) times the ecological or human health screening levels (Table 2) with the exception of petroleum, (b) Material with petroleum concentrations exceeding 1,000 ppm (b) Material exhibiting a sheen, or (d) material exhibiting radiological properties.

V. PROGRESS REPORTS

On an annual basis, Ross Island Sand and Gravel shall submit Progress Reports that document fill activities for the prior year and project anticipated fill activities for the upcoming year. The following information shall be included:

A. Source, volume, fill date, fill category, and general placement location for all fill. All information used to determine fill category including sampling results and associated lab reports. For contaminated fill, simply reference the report documenting the activity.

B. Bathymetric surveys conducted before and after in-water fill requiring a cap. For contaminated fill, simply reference the associated report.

C. Source, volume, placement date, and placement method for cap material used for Class B inwater and upland fill.

D. Anticipated fill sources, including volumes, for the upcoming year and estimated schedule for placement.

VI. SUPPORTING DOCUMENTS

The following documents should be prepared in conjunction with any planned sampling activities:

A. SAMPLING AND ANALYSIS PLAN

Objective: To adequately document all sampling and analysis procedures.

Scope: In preparation of the SAP, the following guidance documents shall be utilized: Data Quality Objectives Process for Superfund, EPA 540-R-93-071, September, 1993; Test Methods for Evaluating Solid Waste, SW-846; and A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001 (OSWER Directive 9355.0-14), December, 1987. The SAP shall address all topics listed in Environmental Cleanup Division Policy #760.000, Quality Assurance Policy.

Procedures: The work plan shall include a sampling and analysis plan (SAP). The SAP shall include quality assurance and quality control (QA/QC) procedures for both field and lab procedures. The SAP shall be sufficiently detailed to function as a manual for field staff.

B. HEALTH AND SAFETY PLAN (HASP)

Objective: To establish policies and procedures to protect workers and the public from the potential hazards posed by a hazardous materials site.

Scope: The HASP portion of the work plan shall comply with 29 CFR 1910.120 and OAR Chapter 437, Division 2.

Procedures: The HASP shall include a description of risks related to RI activities, protective clothing and equipment, training, monitoring procedures, decontamination procedures and emergency response actions.

C. MAPS

The work plan shall include a map or maps of the facility which clearly shows site topography, on-site structures, waste disposal areas and proposed sampling locations.

Attachment 1 - Fill Evaluation Fact Sheet
Attachment 2 - Upland Fill Evaluation Fact Sheet

SUGGESTED APPROACH TO THE DETERMINATION AND MANAGEMENT OF FILL CLASSES

Fill Class	BASIS FOR FILL CLASS DETERMINATION – In water				
	Screening		Testing		Management Required
	Toxicity	Bioaccumulation	Toxicity	Bioaccumulation	
Class "A" Fill	SC[1] < SLV(t)	SC[1] < SLV(b)	No	No BAC detected	None
Class "B" Fill	SC ≤ 5×SLV(t)	SC < 2xSLV(b)	Yes	BAC ≤ATL	Three (3) foot, permeable cap of clean fill
Class "C" Fill	SC ≤ 10×SLV(t)	SC >5xSLV(b)	Yes	BAC detected, BAC <2x ATL	Five (5) foot, cap of clean material and long-term monitoring/management
Class "D" Fill	SC > 5×SLV(t) Free product observed Radioactive compounds	SC >5x SLV(b)	Yes	BAC detected, BAC > 2xATL	Not acceptable for fill

SC = Sediment chemistry result

SLV(t) = Screening level value for toxicity

SLV(b) = Screening level value for bioaccumulation

BAC = Bioaccumulative contaminant

ATL = Acceptable tissue level(s) for humans and wildlife

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[1] Or knowledge based on historical site use.

Fill Class	BASIS FOR FILL CLASS DETERMINATION – Upland				
	Screening		**Testing**		**Management Required**
	Direct contact	**Leaching**	**TPH**	**Other**	
Class "A" Fill	SC[2] < SLV(d)	SC[1] < SLV(l)	SC<SLV(d)	No free product No radioactive materials	None
Class "B" Fill	SC[3] ≤ SLV(d)	SC < SLV(l)	SC≤10x SLV(d)	No free product No radioactive materials	Landfarming and two (2) foot cap
Class "C" Fill	SC ≤ 5×SLV(d)	SC < SLV(l)	SC<SLV(d)	No free product No radioactive materials	Three (3) foot cap and long-term management
Class "D" Fill	SC > 5×SLV(d)	SC > SLV(l)	Yes	Free product observed Radioactive compounds	Not acceptable for fill

SC = Soil chemistry result

SLV(d) = Lowest screening level value considering direct contact – human, ecological

SLV(l) = Screening level value considering leaching to groundwater or surface water.

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[2] Or knowledge based on historical site use.

[3] With the exception of TPH

APPENDIX F

Proposed Remedial Investigation/ Feasibility Study Monitoring

APPENDIX F

Proposed Remedial Investigation/Feasibility Study Monitoring

Surface Sediment Quality

Monitoring for surface sediment quality will consist of sampling and analysis of surface sediment collected from locations within the lagoon and a location in the Willamette River. The objectives of this monitoring are:

- Document representative surface sediment chemical and physical conditions within the lagoon and provide a data set for evaluating whether surface sediment quality criteria and goals are being met.

- Document the quality of surface sediment located outside the lagoon and upstream of its entrance for comparative purposes.

The sampling would consist of three components:

- Sampling at two fixed locations within the lagoon, as shown in Figure F-1. These projected locations are RM-SS-01 and RM-SS-02. These locations are situated in areas of the lagoon where additional filling with imported material is not expected and would provide a measure of accumulating sediment quality, which has resulted from settling of particulate material from adjacent filling activities and from ambient (e.g., up river, runoff, and atmospheric) sources.

- Sampling at one location in Holgate Slough of the Willamette River for comparative purposes. This location is RM-SS-03, which is situated approximately 1,100 ft upstream of Port confined fill investigation location HC-SS03 in Holgate Slough.

The appropriateness and scope of surface sediment composite sampling will be revisited after five years.

Discrete surface sediment samples or surface sediment composite samples may be collected. Surface sediment samples will be collected from the upper 10 cm of the sediment column and undergo laboratory testing for the same set of constituents that were addressed during the RI. These include metals, semivolatile organic constituents (SVOCs), pesticides, polychlorinated biphenyl (PCB), organotins, and conventional parameters [total organic carbon (TOC), ammonia, grain size, and pH].

The surface sediment testing data will be imported to the GIS database so that data can be compared over a period of years.

Specific surface sediment quality monitoring requirements in the lagoon or the Willamette River that result from the RI/FS process may be combined with these surface sediment monitoring activities. After completion of the RI/FS and negotiation of sediment monitoring requirements, the proposed sediment monitoring in this reclamation plan may be revised, as appropriate.

The surface sediment chemical testing data collected will be compared to screening criteria from the RI work plan and potentially to risk-based concentrations developed as part of the facility Feasibility Study.

Historical sediment quality information collected during the RI and pre-RI investigations will be used to provide an additional means of comparison for the reclamation monitoring results.

Water Quality

Surface Water Quality

Monitoring for surface water quality will consist of sampling and analysis of surface water collected from locations within the lagoon and from the Willamette River. The objectives of this monitoring are to:

- Document representative chemical and physical conditions of surface water quality and provide a data set for evaluating whether reclamation criteria and goals are being met.
- Document the quality of surface water located outside of the lagoon and upstream of its entrance for comparative purposes.

Surface water monitoring will occur annually during the first two years and biennially subsequently. The sampling will consist of two components:

- Sampling at two locations within the lagoon, as shown in Figure F-1. These proposed locations are RM-SW-01 (co-located with surface sediment monitoring location RM-SS-01) and RM-SW-02 (co-located with surface sediment monitoring location RM-SS-02).
- Sampling at one location in Holgate Slough of the Willamette River for comparative purposes.

Surface water samples will be collected from the upper three feet of the water column and tested for the same set of constituents that were addressed during the RI. These include metals, SVOCs, pesticides, PCBs, organotins, and conventional parameters (turbidity, total dissolved solids, total suspended solids, conductivity, TOC, ammonia, and pH). Field parameters will also be monitored including pH, conductivity, temperature, dissolved oxygen, and turbidity.

The surface water testing data will be imported to the GIS database so that data can be compared over a period of years.

Specific surface water quality monitoring requirements in the lagoon or the Willamette River that result from the RI/FS process may be combined with the reclamation surface water monitoring activities. After completion of the RI/FS and negotiation of surface water monitoring requirements, the proposed surface water monitoring in this reclamation plan may be revised, as appropriate.

Because surface water quality monitoring during reclamation filling activities will be implemented in accordance with Clean Water Act Section 401 water quality certification requirements, surface water quality monitoring during reclamation filling is not included in this monitoring plan.

The surface water chemical testing data collected will be compared to screening criteria from the RI work plan and potentially to risk-based concentrations developed as part of the facility Feasibility Study. Surface water quality information collected during the RI and pre-RI investigations will be used to provide an additional means of comparison for the reclamation monitoring results.

Groundwater Quality

Monitoring for groundwater quality will involve sampling and analysis of groundwater collected from zone A of upland fill and non-fill locations and will be coordinated with long-term groundwater monitoring requirements negotiated with DEQ at the completion of the facility RI/FS. Groundwater monitoring locations are shown on Figure F-2, and monitoring frequency and parameters on Table F-1.

The groundwater monitoring would also provide representative monitoring information for soil, which is the source of groundwater impacts in most cases. The objectives of this monitoring are:

- Document representative groundwater quality chemical and physical conditions and provide a data set for evaluating whether groundwater quality criteria and goals are being met.
- Provide groundwater quality information at locations positioned down-gradient from historic reclamation fill areas to monitor potential impacts due to discharge of groundwater to surface water.
- Document the quality of groundwater from fill and non-fill areas and upgradient or background areas for comparative purposes.

Groundwater monitoring will take place annually during the first two years and biennially subsequently or follow the schedule of RI/FS-related monitoring, if appropriate. The groundwater sampling would consist of the following component:

- Sampling at four of the existing wells on Hardtack and Ross islands. These wells are tentatively identified to be MW01A (background location); MW04A; MW05A (shallow zone A) or MW06A (deep zone A); MW07A (deep zone A) or MW08A (shallow zone A) (Figure F-1), but may change depending on the outcome of the RI/FS process.

Groundwater samples will undergo testing for a similar set of constituents that were addressed during the RI. These include metals, volatile organic constituents, SVOCs, pesticides, PCBs, organotins, total petroleum hydrocarbons, and conventional parameters (turbidity, total dissolved solids, total suspended solids, conductivity, TOC, ammonia, and pH). Field parameters would also be monitored including pH, conductivity, temperature, dissolved oxygen, and turbidity.

The groundwater chemical testing data collected will be imported to the GIS database so that data can be compared over a period of years.

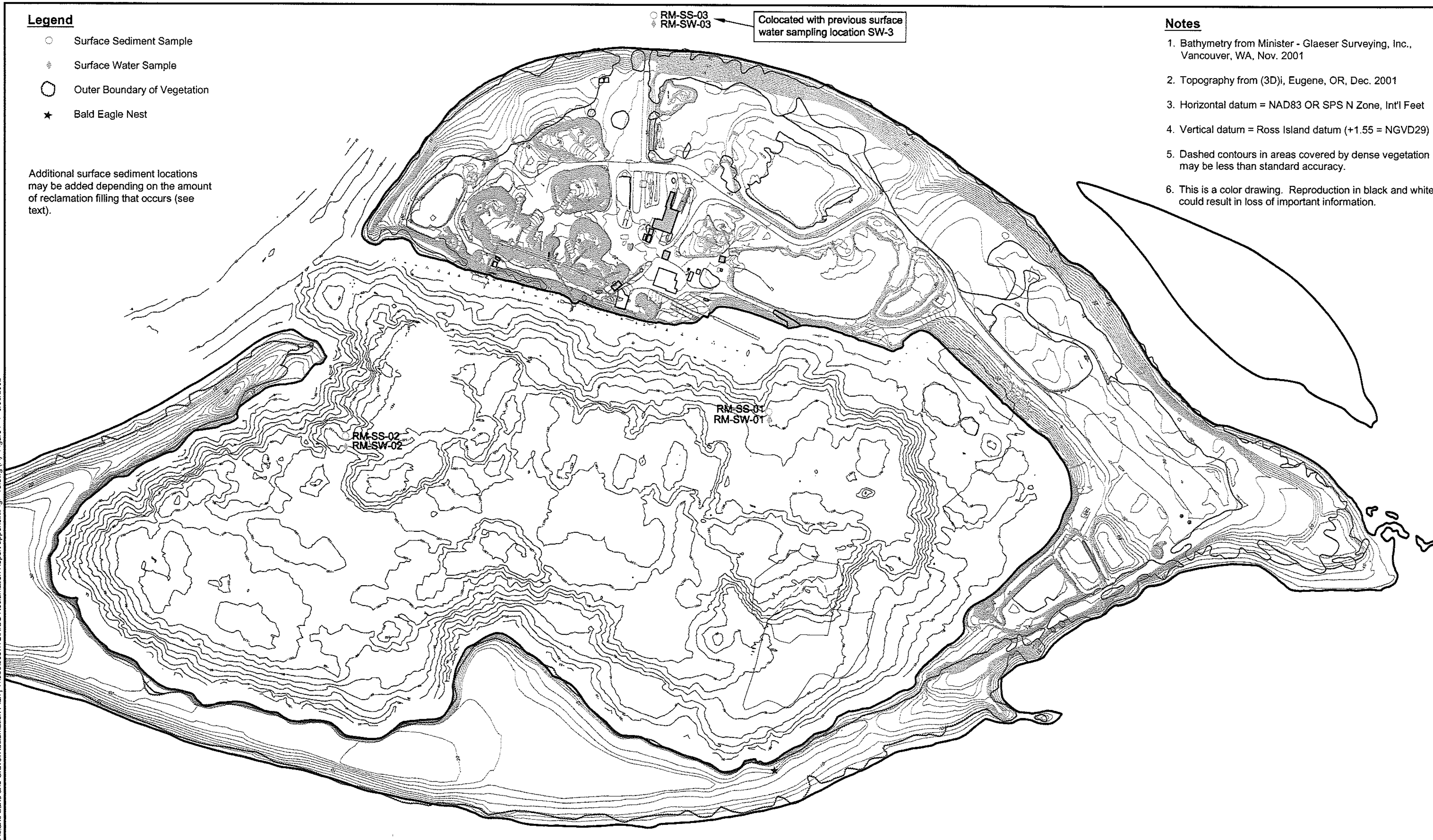
Specific groundwater quality monitoring requirements that result from the RI/FS process may be combined with the reclamation groundwater monitoring activities. After completion of the RI/FS and negotiation of groundwater monitoring requirements, the proposed groundwater monitoring in this reclamation plan may be revised, as appropriate.

The groundwater chemical testing data and field measurements will be compared to screening criteria from the RI work plan and potentially to risk-based concentrations developed as part of the facility Feasibility Study. Groundwater quality information collected during the RI and pre-RI investigations will be used to provide an additional means of comparison for the reclamation monitoring results.

TABLE F-1
SUMMARY OF GROUNDWATER ANALYSES
DECEMBER 2001 to JUNE 2002
ROSS ISLAND SAND & GRAVEL CO.

Analyses	Analytical Method	MW01A	MW01B	MW01C	MW02A	MW02B	MW02C	MW03A	MW03B	MW03C	MW04A	MW05A	MW06A	MW07A	MW08A
Organotins	Krone et al				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Volatile Organic Compounds	8260B										RIQ	RIQ	RIQ	RIQ	RIQ
Semivolatile Organic Compounds	8270 SIM				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Pesticides	8081A				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Polychlorinated biphenyl	8082				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Total Petroleum Hydrocarbons	NWTPH-Dx				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
	NWTPH-Gx				WPCFQ							WPCFQ			
Metals, Total															
Antimony	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Arsenic	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Barium	200.8				WPCFQ							WPCFQ			
Berylium	200.8				WPCFQ							WPCFQ			
Cadmium	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Chromium	200.8				WPCFQ							WPCFQ			
Copper	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Iron	6010B				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Lead	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Manganese	6010B				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Mercury	7470A				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Nickel	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Selenium	200.8				WPCFQ							WPCFQ			
Silver	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Thallium	200.8				WPCFQ							WPCFQ			
Zinc	200.8				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Total Suspended Solids	160.2				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Salinity	SM 2520B										RIQ	RIQ	RIQ	RIQ	RIQ
Total Organic Carbon	415.1										RIQ	RIQ	RIQ	RIQ	RIQ
pH	150.1				WPCFQ							WPCFQ			
pH	Field				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Temperature	Field				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Conductivity	Field				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Dissolved Oxygen	Field				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ
Turbidity	Field				WPCFQ						RIQ	RIQ/WPCFQ	RIQ	RIQ	RIQ

WPCFQ=Water Pollution Control Facility Permit Quarterly Sampling, RIQ= Phase II Remedial Investigation Quarterly Sampling



Ross Island Sand and Gravel/Reclamation Plan | T:\066\035\172\RISG Reclamation Report-appendix\FigF-1b.dwg (A) "Figure F-1" 9/30/2002

Landau Associates

Ross Island Sand & Gravel
Portland, Oregon

Proposed Surface Water and Sediment Monitoring Locations

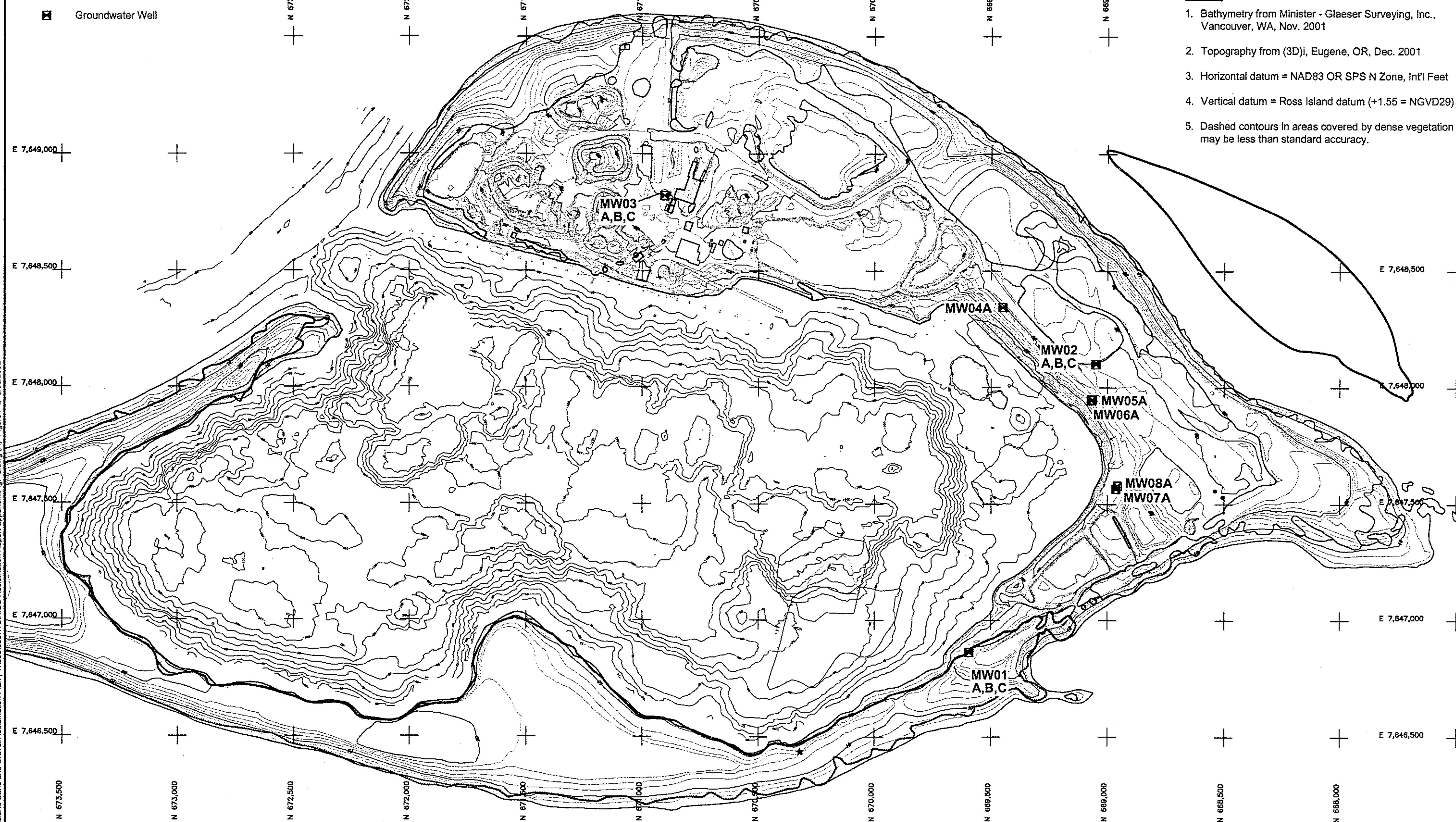
Figure
F-1

Legend

Groundwater Well

Notes

1. Bathymetry from Minister - Glaeser Surveying, Inc., Vancouver, WA, Nov. 2001
2. Topography from (3D)i, Eugene, OR, Dec. 2001
3. Horizontal datum = NAD83 OR SPS N Zone, Int'l Feet
4. Vertical datum = Ross Island datum (+1.55 = NGVD29)
5. Dashed contours in areas covered by dense vegetation may be less than standard accuracy.



Ross Island Sand and Gravel/Reclamation Plan | T:\066\035\172\RISG Reclamation Report-appendix\FigF-2.dwg (A) "Figure F-2" 9/30/2002

Landau Associates

Ross Island Sand & Gravel
Portland, Oregon

Groundwater Monitoring Locations

Figure F-2