# Deer Harbor Estuary Habitat Restoration Project Orcas Island, Washington

# Environmental Assessment and Feasibility Study Report

Prepared by:
Deer Harbor Restoration Project Team
Pursuant to IAC/ SRFB Grant No. 02-1577N
October 2005

*An Early Watch*

*As I stand on the hill by the Lookout Post,*
*And gaze on the scene below,*
*In the early morn as the sun comes up,*
*And the stars fade out and go,*
*I can hear the meadowlarks sing from the trees,*
*And the roosters awake at the farms,*
*The seagulls soar high over the bay,*
*The cowbells ring at the barns.*

*The tide goes out under the bridge,*
*And the boats are left high and dry,*
*A farm dog gives a warning bark,*
*At a pheasant that crows nearby,*
*To the south the mountains have turned to pink.*
*When kissed by the morning sun,*
*From the chimneys smoke begins to creep,*
*A new day has begun.*

*If I look to the East or to the West,*
*It is only beauty I see.*
*As I stand by the hill by our Lookout Post,*
*How I wish all the world could be,*
*Peaceful and calm and happy – as this spot by the*
*Deep, blue sea.*

Olive McLachlan, Deer Harbor, 1941

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# 1 Introduction

## *1.1 Purpose and Scope*

The purpose of the *Deer Harbor Estuary Habitat Restoration Draft Environmental Assessment and Feasibility Study* (the "Study") is to characterize ecological conditions in the Deer Harbor Estuary and to evaluate engineering alternatives to support two inter-related goals:

1. Restoration, to the extent practicable, of the ecological process and conditions that supported the historic salmon habitat in the estuary; and

2. Replacement of the existing Channel Road Bridge in a manner that mitigates the present structure's detrimental impacts to the estuary ecosystem.

The scope of the study includes characterization of the affected environment; identification of specific restoration objectives and alternatives for achieving the objectives; and evaluation of the environmental impacts expected to result from the recommended alternative. The content of this study is intended to satisfy the requirements of the National Environmental Policy Act (NEPA), even though at this stage the project described in the study is not a "federal action."

## *1.2 Need for the Project / Policy Background*

Two public policy issues motivate the preparation of this study. First and foremost, the 1999 listing of the Puget Sound chinook salmon evolutionary significant unit (ESU) as "threatened" under the federal Endangered Species Act focused federal and Washington State government attention on the recovery of native salmon stocks and their habitat in the Puget Sound and Straight of Georgia Basin, including in the San Juan Islands.

While the San Juan Islands[1] may never have supported large natal populations of native salmon stocks, evidence suggests that WRIA 2's offshore as well as nearshore areas contribute significantly to the regional salmon ecology by providing feeding habitat during migration to and from the open ocean. In addition, some of WRIA 2's few natural estuaries, including the Deer Harbor Estuary, also historically supported small populations of coho and perhaps other salmonid species. While probably never numerically large, it is conjectured that these local stocks may represent populations that were genetically-distinct from the larger populations of the mainland rivers, having evolved in adaptation to the unique dry-summer hydrologic conditions in the Islands. The ecological value of Deer Harbor's salmon population in terms of genetic diversity, therefore, may have greatly exceeded its value in terms of sheer numbers.

Recognizing the ecological value of WRIA 2 salmon habitat in relation to the broader goal of the recovery of ESA-listed salmonids in the Puget Sound / Straight of Georgia Basin, the Washington State Salmon Recovery Funding Board (SRFB) awarded funding under Grant No. 02-1577N for assessing salmon habitat in the Deer Harbor Estuary and identifying and evaluating alternatives for restoring historic habitat functions and values.

[1] For the purposes of salmon recovery, the archipelago is collectively referred to as Water Resources Inventory Area No. 2 (WRIA 2) by Washington State government resource management agencies.

The second policy issue that motivates the preparation of this report is San Juan County Department of Public Works' need to replace the Channel Road Bridge across the outlet of Cayou Valley Lagoon. The current wooden bridge, which was constructed in 1970, needs continual maintenance and the County is concerned that it will soon no longer be able to provide the necessary level of service for the public. Shortly after the construction of the bridge, the US Fish and Wildlife Service and U.S. Environmental Protection Agency cited the County for not conducting adequate assessment of the bridge's long-term impacts to the Deer Harbor ecosystem.[2] As detailed in Chapter 2, the construction of the bridge has, in fact, resulted in detrimental impacts to the estuary. In order to replace the bridge, therefore, it is likely that federal and state resource agencies will require that impacts of the existing structure be mitigated. This study is intended to provide data and analysis that can be used for designing the replacement of the bridge.

## 1.3 Project Location and Overview of the Study Area

The Deer Harbor Estuary is the largest estuary on Orcas Island, Washington. Located at the southwest corner of the island in the community of Deer Harbor, the estuary drains a watershed of about 740 acres. Figure 1.1 shows a site location map.

The geographical scope of this study encompasses Inner Deer Harbor, the Cayou Valley Lagoon and the tidally-affected reaches of Fish Trap Creek and a smaller unnamed creek, which are the two tributaries that flow into the lagoon. Channel Road crosses the study area from east to west, crossing the outlet of Cayou Valley Lagoon over the Channel Road Bridge. The boundaries of the study area and key land features are shown in Figure 1.2.

## 1.4 Historical Background

Reports by 19-Century white explorers and settlers document native residents using the Deer Harbor Estuary as a salmon fishery. In his 1860 report, Dr. C. B. R. Kinnerly of the Northwest Boundary Commission wrote of Deer Harbor, "… the inhabitants … call it (the lagoon) 'Fish Trap' because at the mouth of the stream emptying into it there is an old weir in which the natives have been in the habit of taking salmon." (Suttles, 1998). A local historian refers to Indians "living in long houses close to the beach where the bridge now crosses the slough." (McLachlan, undated).

The first documented settler in the study area was Louis Cayou, a Hudson Bay Company employee of Saanich Indian ancestry, who homesteaded the land around the lagoon in 1859. Cayou's son Henry Cayou later cleared and planted a homestead just south of the present Channel Road Bridge. Both tracts are visible on 1895 USCGS chart RN2229 "Washington Sound Orcas Shaw and Other Islands," which is shown in Figure 1.3. According to their descendent John Cayou, Louis Cayou caught salmon there (Samish Nation, 2001). "The slough, which was much deeper prior to the construction of the (Channel Road) bridge, was navigable, so Cayou built a dock for boats to load and bring in supplies." (Deer Harbor Planning Committee, 1998).

[2] A more detailed discussion of agency concerns is presented in Chapter 2.

**Figure 1.1 Site Location Map**

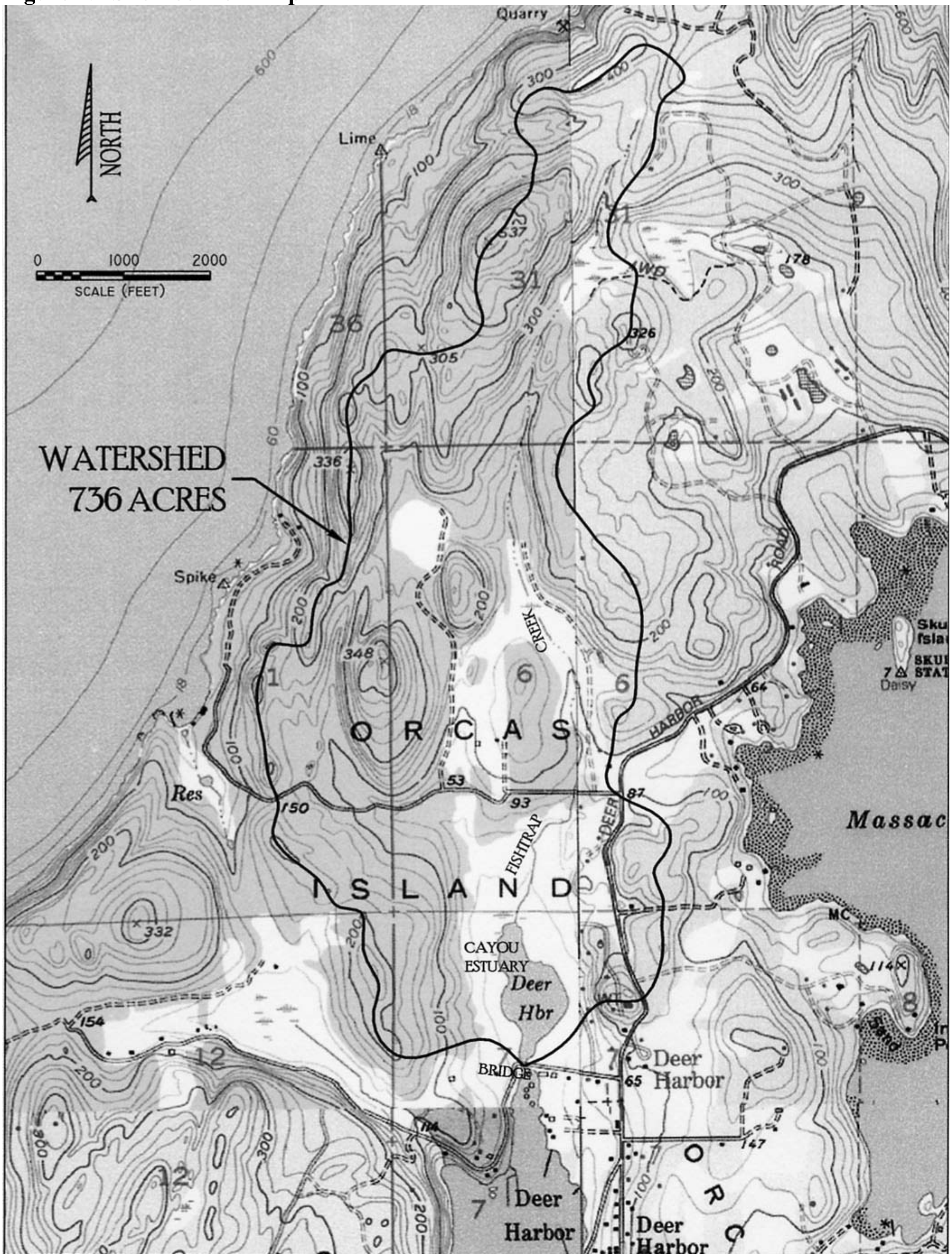


**Figure 1.2 Bathymetry and Key Land Features of the Study Area**

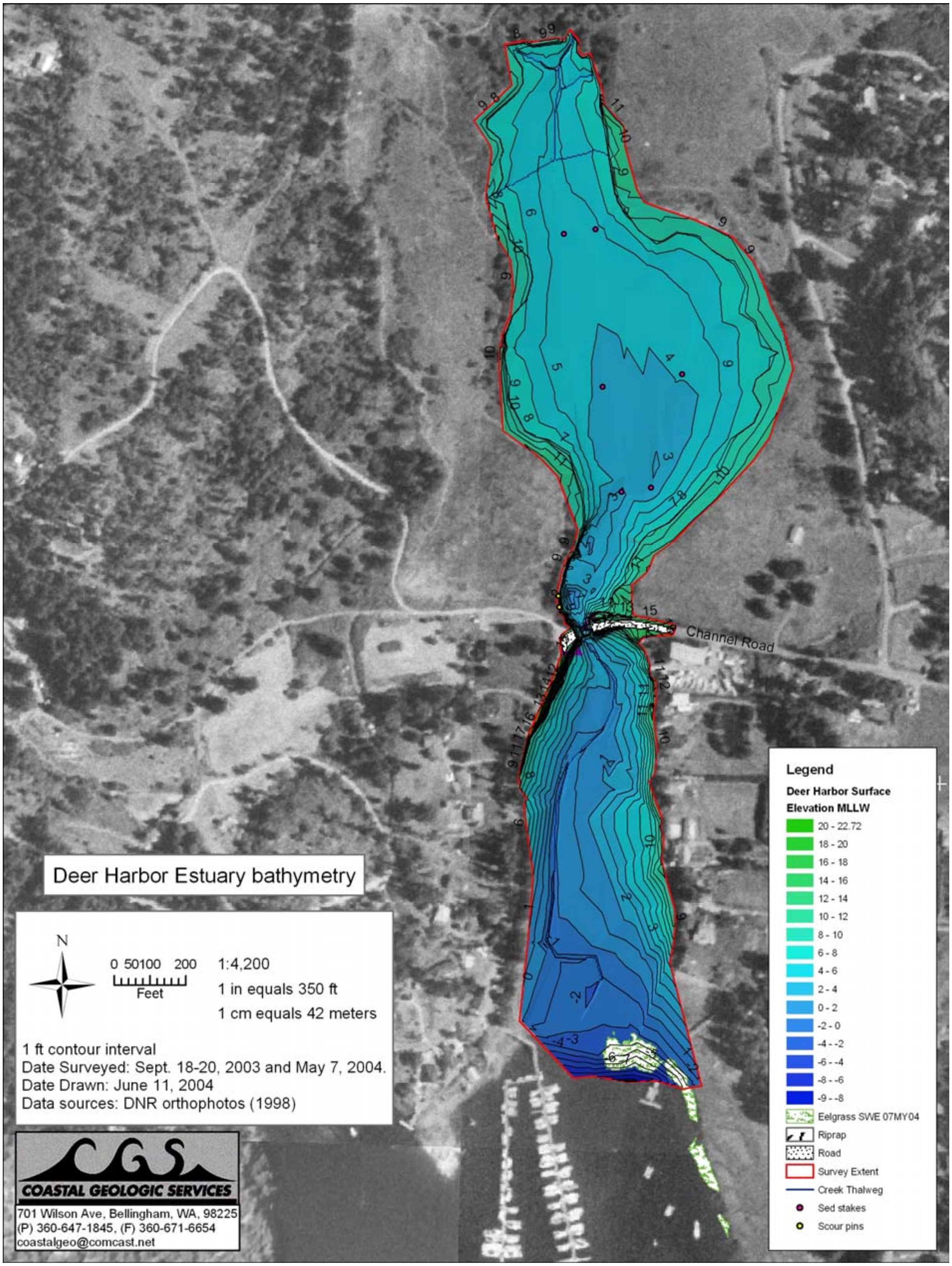
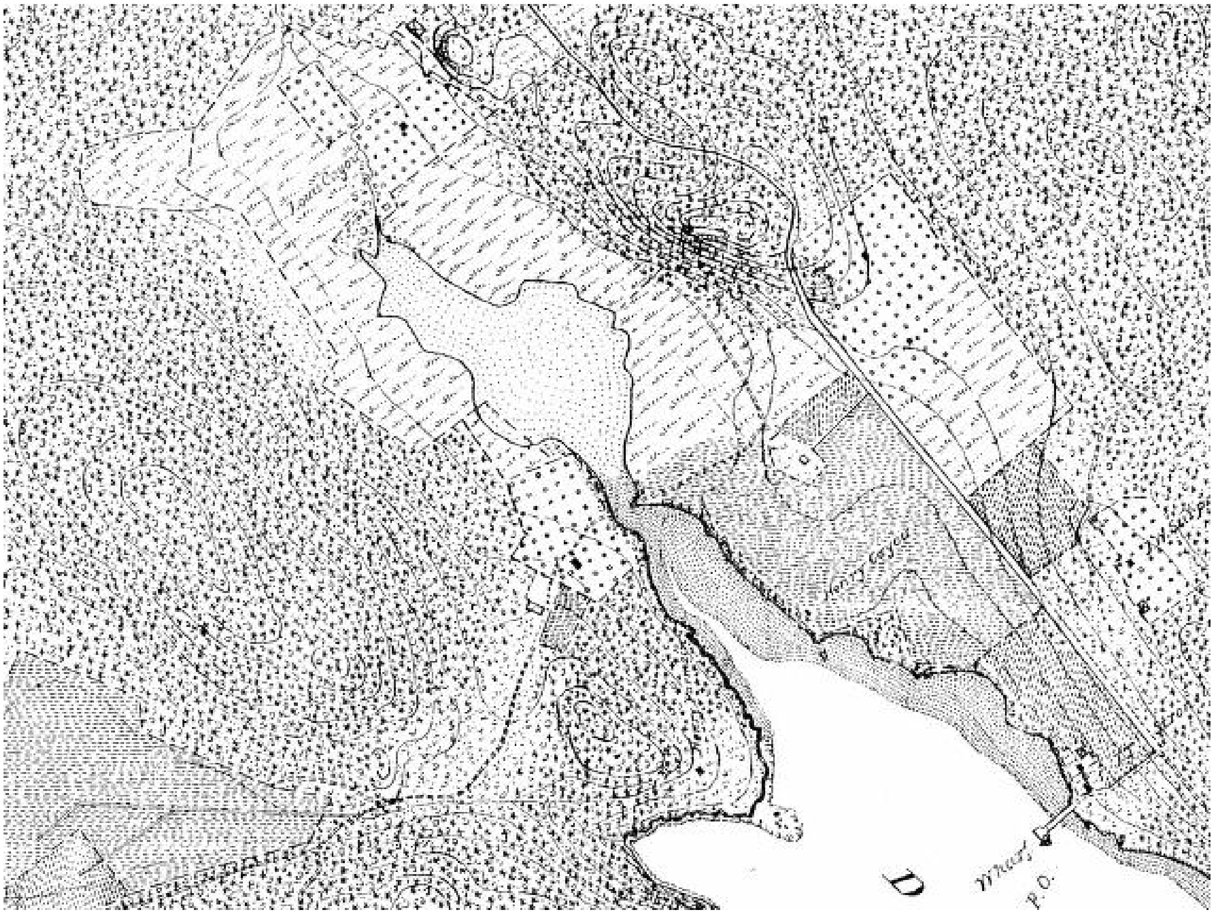


**Figure 1.3 1895 USCGS Map of Deer Harbor Area**



Late 19th Century economic activities included extensive logging and clearing of the watershed and construction of a salmon cannery by the Great Northern Fisheries Company near the present-day location of Cayou Quay Marina. A sawmill operated from 1943 until the 1960s on the east shore of the inner harbor, just downstream of the lagoon outlet, at the property presently occupied by the Deer Harbor Boat Works. Longtime residents recall harvesting native oysters, Dungeness crab, and shiner perch in the lagoon, but few reportedly remained by 1970 (Samish Research Center, 2002). The Deer Harbor Corporation proposed an extensive waterfront residential development in the Cayou Valley Lagoon in the early 1970s, but the development was never built (Williams, 2003).

## 1.5 Problem Statement

Land development activities in the Deer Harbor watershed, manipulation of the tributary streams and, especially, the construction of the Channel Road Bridge have altered the freshwater hydrology, sediment transport patterns, and tidal flow patterns in the estuary. It is believed that these impacts have in turn led to the elimination of shellfish populations in the lagoon, elimination of salmonid rearing and spawning habitat in the tributaries, and degradation of salmonid feeding habitat in the estuary. Each of these impacts is discussed in detail in Chapter 2.

# 2 Affected Environment

## *2.1 Socio-Economic Profile*

### 2.1.1 Jurisdictional Boundaries and Zoning

Figure 2.1 shows an overlay of jurisdictional boundaries and comprehensive plan land use designations within the Deer Harbor Estuary study area. All of the land in the study area is zoned as the "Deer Harbor Hamlet Activity Center." The Shorelines Master Program designation for all of the land lying within 200 feet of Cayou Valley Lagoon is "Conservancy." The designation for the land within 200 feet of the shoreline of the inner harbor is "Rural." (SJ County Planning Dept., 2005).

### 2.1.2 Demographic Profile

1990 U.S. Census Bureau data for Census Tract 90-9601, Block 90-5 are used to approximate demographic conditions for the Deer Harbor community and surrounding area.[3] The available data list a total population of 682 people, with median age of 47 years old. The median age is considerably older than the median age of 29 years for the State of Washington as a whole, reflecting the relatively small number of families with children and the relatively large number of retired people living in the community. Nearly half of the households in the census block reported that they had moved to the community only within the last five years, reflecting mobility into and out of the area.

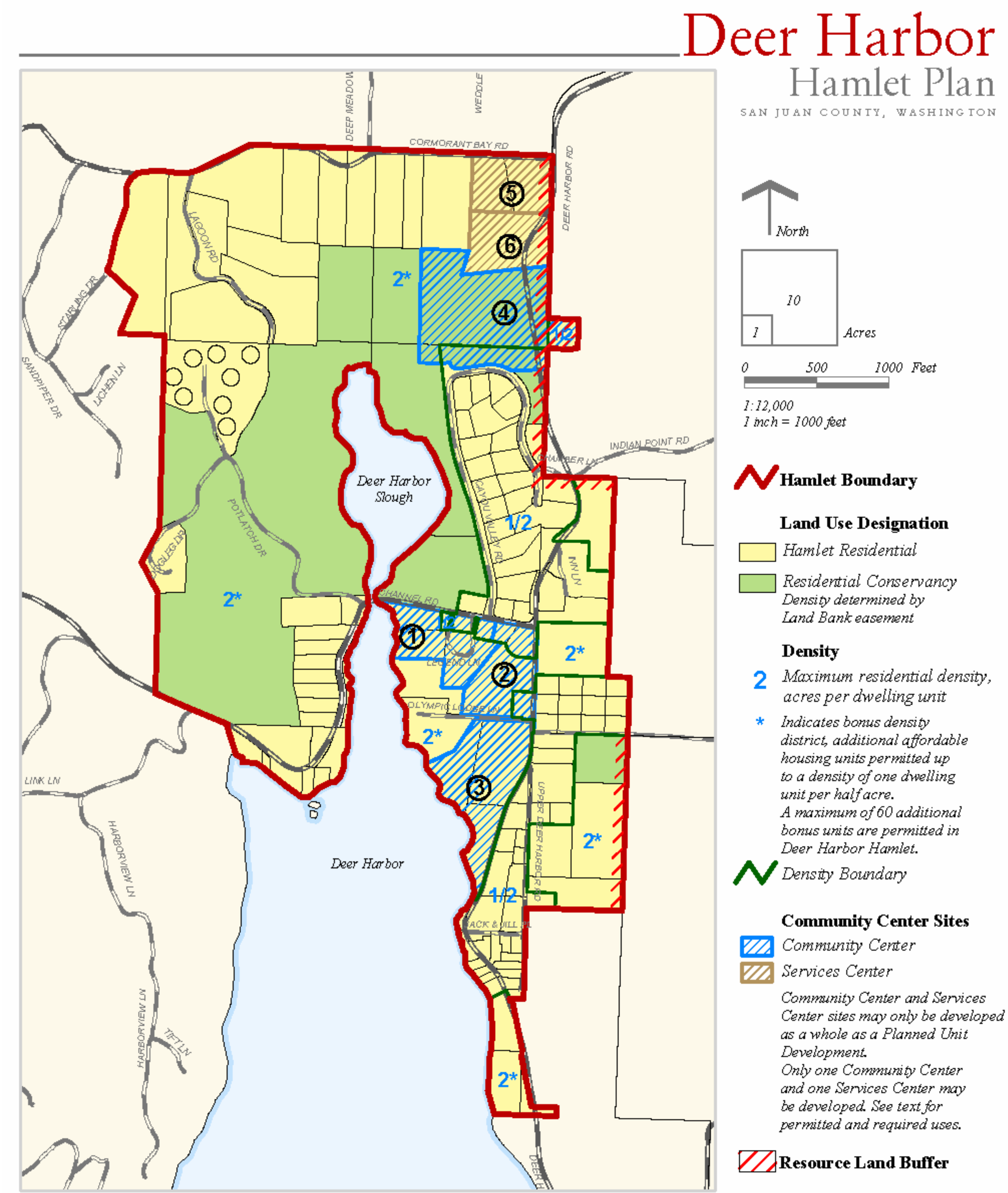
The majority of residents in the census block who are employed work in the retail trade, personal services, or construction trades. Much of the employment is seasonal, taking advantage of the busy summer tourism and summer construction season. The 1990 median income for the area was $33,897 per household, which is slightly higher than the state median income of $31,183 per household. In summary, the available census data suggest a community characterized by a high proportion of relatively affluent retired people who have recently settled in the area and a primarily seasonal economy focusing on construction, retail, and personal services.

### 2.1.3 Property Ownership

Property ownership parcel maps on the land in the vicinity of the study area are shown in Figure 2.1. With the exception of about twenty 0.5 to 0.8 acre lots in the Cayou Valley Road subdivision platted immediately east of the Cayou Lagoon, the majority of the lot sizes in the study area range from 2 to 20 acres in size. The primary land use types in the study area are residential, agriculture and open space, boatyard/marina activities.

[3] While the population of the area immediately surrounding the Deer Harbor Estuary study area is considerably less than for the entire census block, the general demographic conditions are believed to be representative. All data is quoted from the 1999 Deer Harbor Hamlet Comprehensive Plan.

**Figure 2.1 Property Parcels and Jurisdictional Boundaries**



Residential Land Use

Currently, the primary land use in the study area is low density, single family residential. Based on a review of available aerial photographs, there are about 24 houses within the study area, half of which are in the Cayou Valley Road subdivision on the east side of the lagoon. A small hotel named "The Inn at Orcas Island" is located on Channel Road just east of the lagoon. The Cayou Valley road residences are served by a community water supply well; all others apparently rely on private wells. There are no sanitary sewer or storm sewer systems within the watershed study area; all residences use private onsite septic systems (Deer Harbor Planning Commission, 1999). Although current zoning allows for two houses per acre, recent unofficial drafts of the county comprehensive plan propose raising the zoning to minimum two-acre lots (SJ County Planning Dept., 2002).

Agriculture and Open Space

About twenty acres of the gently-sloping land surrounding Cayou Lagoon is still managed for low intensity, non-commercial orchard and haying. Most of this acreage is encumbered with permanent conservation easements owned by the San Juan County Land Bank, which require it to remain as open space. In 1985, about 0.7 acres of this land was converted to a shallow wildlife pond by constructing an earth dam across the small creek that drains the west-central part of the watershed, about seventy feet upstream of its mouth at Cayou Lagoon (USDA SCS, 1985).

Boatyard and Marina

The Deer Harbor Boat Works operates a boat repair facility on the east shore of the inner harbor, adjacent to the outlet of the lagoon. The boatyard has dry storage space for about thirty relatively small boats. On the west shore at the mouth of the inner harbor, the Cayou Quay Marina operates an approximately 60 slip marina, primarily for recreational boats.

Shellfish Cultivation

The beds of Cayou Lagoon and most of the inner harbor are subdivided into seven privately-owned parcels. San Juan County assesses these parcels as "oyster lands," reflecting the formerly rich shellfishery that once characterized the area. Recently, some tideland parcels at the outlet of the lagoon were re-planted with native oysters as part of a pilot study to evaluate the feasibility of reestablishing native oyster populations in the area (Puget Sound Restoration Fund, 2005).

## 2.2 Channel Road Bridge

San Juan County constructed the current Channel Road Bridge in 1970, replacing the previous bridge across the outlet of Cayou Lagoon. Little documentation is available regarding previous bridges at the site, but it is known that the lagoon outlet had been narrowed with fill material prior to construction of the current bridge (Comp Plan, 2002). An 1895 Coast and Geodetic Survey chart shows the lagoon outlet without a bridge. The outlet shown on the chart is about 85 feet wide, compared to its current width of about 50 feet. The general trend of the east shoreline of the lagoon outlet and inner harbor suggest an original outlet width of about 120 to 130 feet at the mean higher high water (MHHW) tide level. It is unknown what accounts for the difference between the general trend of the shoreline and the outlet shoreline in 1895 chart. It's possible that the chart depicts the shoreline at low tide, with inter-tidal mudflat or sand spit accounting for the difference.

The new bridge was aligned about 20 feet south of the previous bridge alignment to allow the old bridge to be used while the new one was built. Granite abutment blocks from the old bridge are still in place at the site. At some time in the past, either during construction of the 1970 bridge or of previous bridges, the bed of the channel was partially filled with rock armoring, resulting in the two-foot change of grade between the outlet and the inner harbor that presently exists. While no precise measurement of the quantity of rock armoring is available, field observations indicate that an estimated 200 to 250 cubic yards of 12” to 24” rock have been placed in the channel below the existing bridge (SJCCD, 2003).

The existing bridge has a 50-foot span and is constructed of creosoted timbers supported by two rows of creosoted wood pilings. The depth of the pilings has not been determined. In addition to providing the primary traffic access to the southwest tip of Orcas Island, the bridge also serves as the crossing for three utility conduits. Figure 2.2 shows plan and profile views of the bridge. Figure 2.3 is a photograph of the lagoon outlet channel under the bridge.

## *2.3 Cultural Resources*

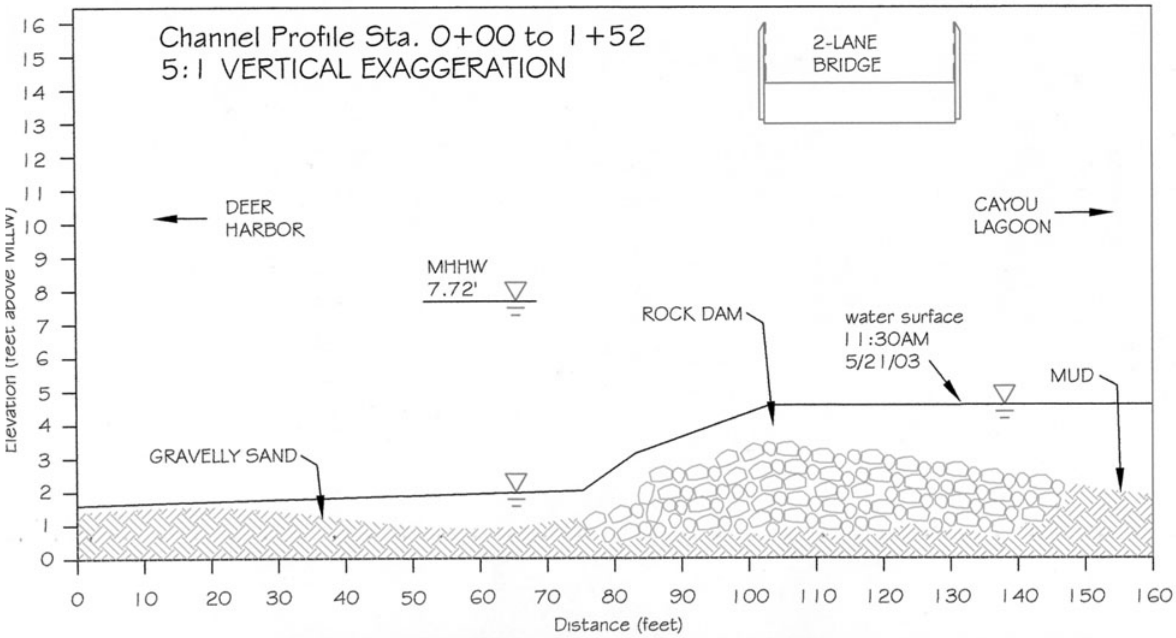
Four prehistoric archaeological sites are recorded in Deer Harbor (45SJ138, 45SJ139, 45SJ227, and 45SJ358). While detailed faunal analyses have not yet been conducted, the preliminary survey data on file at the Washington State Office of Archaeology and Historic Preservation (OAHP) indicate that remains of salmonids, seals, clams, mussels, and sea urchins dominated the middens, and so, presumably, the diets of prehistoric residents of the area. There are other prehistoric shell middens within or near the study area that have not been formerly documented or investigated. The assemblage of faunal remains in the middens is consistent with the rocky, inter-tidal character of the inner and outer harbor as well as use of the estuary by salmon and sea-run cutthroat trout.

Ruins of a cabin believed to have been built by Louis Cayou remain on tax parcel number 260634004, located a few hundred feet northeast of the north end of Cayou Valley Lagoon. Near the north end of the lagoon are the remains of wooden piers. It is not conclusively know whether these are associated with the dock built by the first settler, Louis Cayou (*Deer Harbor Hamlet Interim Comprehensive Plan*, 1998), but their location roughly matches the historical record.

The bathymetric survey and investigation of lagoon sediments completed for this study in 2003-2004 identified rocks placed in the lagoon in a pattern typical of a pre-settlement native fish weir. To date, no detailed archaeological assessment and documentation of this feature has been completed.

Debris ranging from old bottles to rusted machinery remain in the inter-tidal and shoreline area of the inner harbor in the vicinity of the Deer Harbor Boat Works property (tax parcel number. 260724003). It is believed that this material dates from the 1940s through 1960s, when a saw mill occupied the site.

## Figure 2.2 Channel Road Bridge Plan and Profile Views




(The profile view elevation datum is approximate and does not correspond with the plan view's precise datum.)

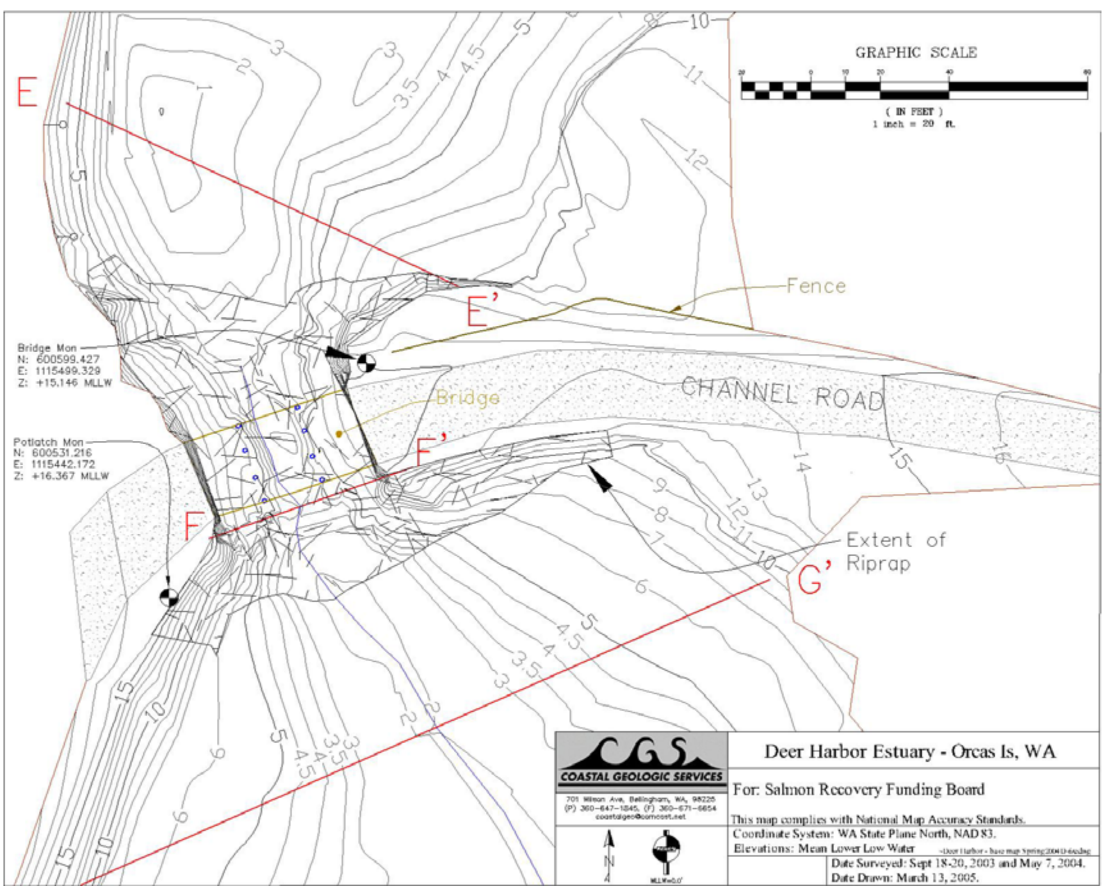


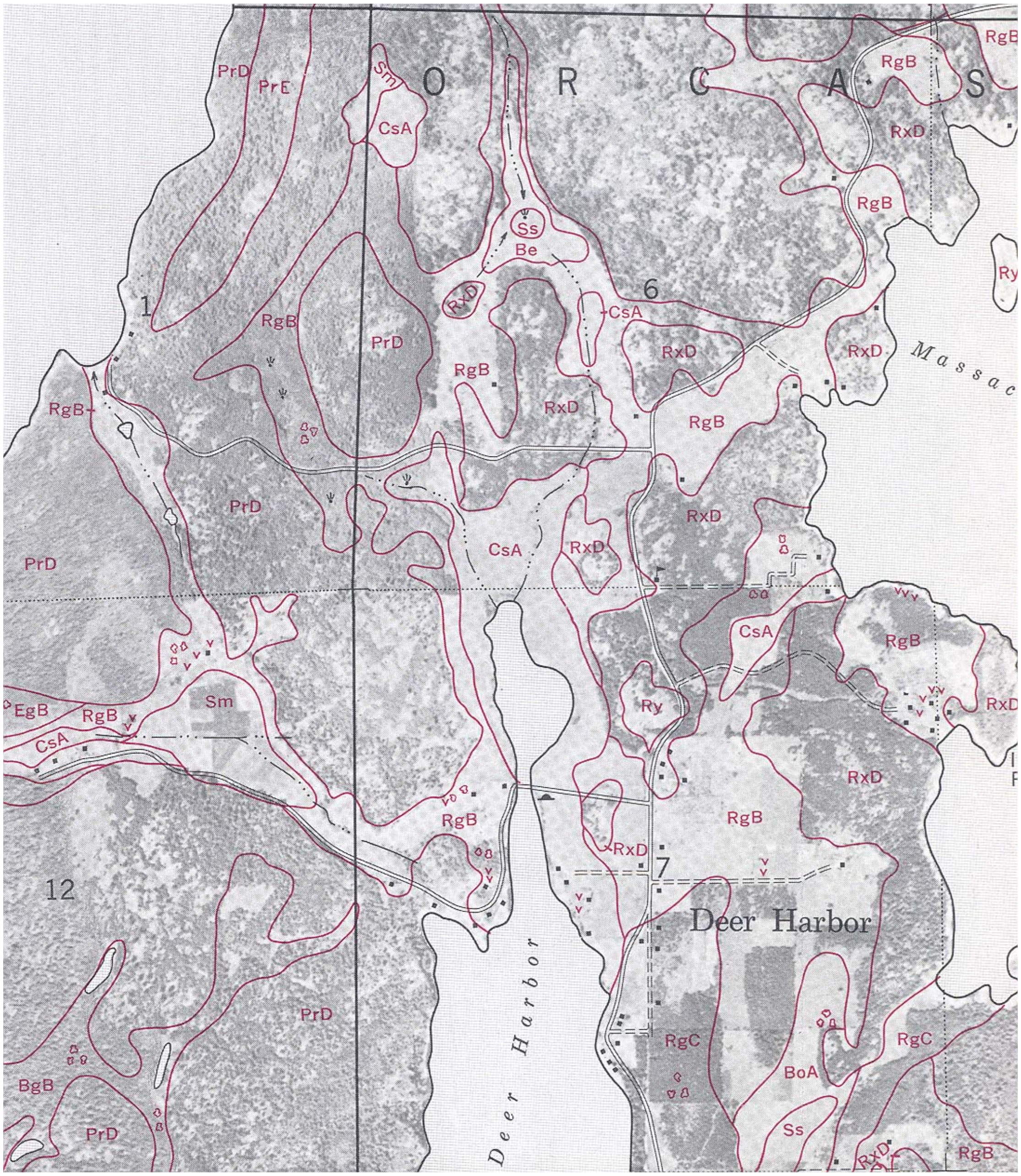
**Figure 2.3 Channel Road Bridge and Cayou Valley Lagoon Outlet Channel**

The existing Channel Road Bridge is supported by two sets of timber piling. The outlet channel at low tide clearly shows the rip rap "sill" that forms a permanent pool in the lagoon upstream of the bridge. An area of the lagoon bank that is actively eroding is seen in the background.

## *2.4 Project Site Soils*

Figure 2.4 shows the mapped soils in the Deer Harbor watershed, including the estuary study area. (USDA SCS 1962). The soil type on most of the land surrounding the estuary is "Coveland silt loam, 0 – 3 percent slopes." This soil type features a shallow surface layer of moderately permeable silt loam, underlain by gravelly sandy loam or gravelly sandy clay loam to a depth of about 18 inches, then underlain by relatively impermeable layers of mottled, gray and olive-gray clay to depths of 60 inches or more. The distinct difference in permeability between the gravelly layer and the deep clay layer results in a perched water table during the west season, when the water table is at or near the surface. The soil is classified as "hydric" under the current USDA classification scheme (NRCS, 2005).

**Figure 2.4 Soil Types of the Deer Harbor Watershed**




LEGEND

| | |
|---|---|
| Be = Bellingham silt loam | CsA = Coveland silt loam 0-3% slope |
| PrD = Pickett rock outcrop 0-30% slope | RgB = Roche gravelly loam, 3-8% slope |
| RxD = Roche rock outcrop, 8-30% slope | Ry = Rock land, rolling     Rz = Rock land, steep |
| Sm = Semiahmoo muck | Ss = Semiahmoo muck, shallow |

A few hundred feet upslope of the estuary, the soil type changes to “Roche gravelly loam 3-8 percent slope.” This soil type, which derives from glacial till, tends to have slow permeability in the upper strata and very slow permeability in the lower strata. Like the Coveland soils, water tends to stand on the surface during the wet season and the soil becomes very dry and hard during the dry season (SCS, 1962). On the west side of the inner harbor, Roche gravelly loam extends to the shoreline.

A review of available field logs from the drilling of water wells in the vicinity of the Deer Harbor Estuary tends to corroborate the geology and soils literature. The logs record ten to twenty-foot thick strata of gray or blue clay underlying shallow topsoil, then alternating strata of shale, limestone, "shale-quartz" and unspecified "hard rock" extending to depths of 200 feet below mean sea level or more (WDOE, 2005). Profiles of selected water well logs from the vicinity of the site are included in Appendix A. Of particular relevance to the Deer Harbor Estuary ecosystem is the presence of bedrock ledges trending east to west in the vicinity of the lagoon outlet and upper inner harbor.

## *2.5 Estuary Geomorphology and Sediments*

### 2.5.1 Morphology

The Deer Harbor Estuary is composed of the inter-tidal Inner Deer Harbor and Cayou Valley Lagoon as well as the tidally-affected reaches of Fish Trap Creek and a smaller unnamed creek, which are the two tributaries that flow into the lagoon. Bottom elevations range from about 5.5 feet above MLLW (NAVD 88) at the mouth of Fish Trap Creek to about 3.0 feet below MLLW at the mouth of the inner harbor, a distance of about 3,100 feet. The elevation of MHHW in the estuary is estimated to be 7.72 feet (CGS, 2004).

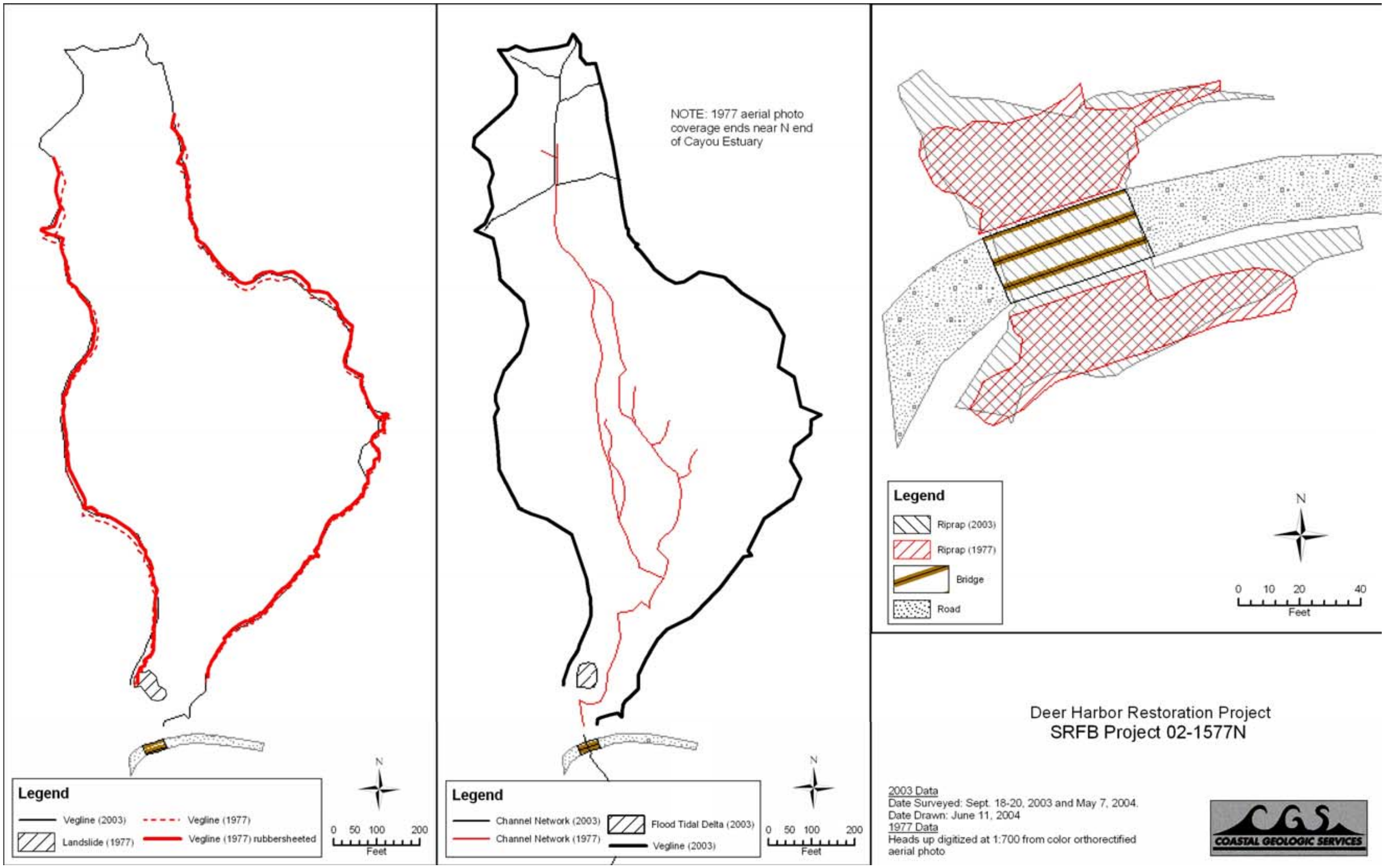
Rock fill under the Channel Road Bridge forms a significant artificial grade control, effectively dividing the estuary into three distinct reaches. From the mouth of Fish Trap Creek to the crest of the rock fill under the bridge, the bottom profile falls only about 1.3 feet over a 1800-foot distance (average gradient 0.0007 ft/ft). The widest part of the estuary in this reach is up to 680 feet wide. Below the bridge, the outlet channel drops steeply from about 4.2 feet above MLLW to about 1.8 feet above MLLW over a distance of about 43 feet (gradient 0.056 ft/ft). The narrowest point in this reach, under the bridge, is 50 feet wide. Below the steep drop, the channel falls at a gradual slope for another about 1,250 feet to a depth of about -3.0 ft MLLW at the mouth of the inner harbor (average gradient 0.0046 ft/ft). A typical width in this reach is about 350 feet. The bridge fill at the outlet channel is shown in Figure 2.5. Several cross sections of the estuary are shown in Appendix B.

While the presence of the rock fill has disrupted natural estuary channel formation, remnants of first and second-order channels can be seen in aerial photographs of the Cayou Valley Lagoon. Below the lagoon outlet, a well defined, meandering first order drainage channel meanders through the inner harbor (Figure 2.6). Figure 2.7 shows the channel network in the lagoon in 1977 as compared with the existing channel network.

**Figure 2.5 Channel Road Bridge and Fill at Lagoon Outlet**

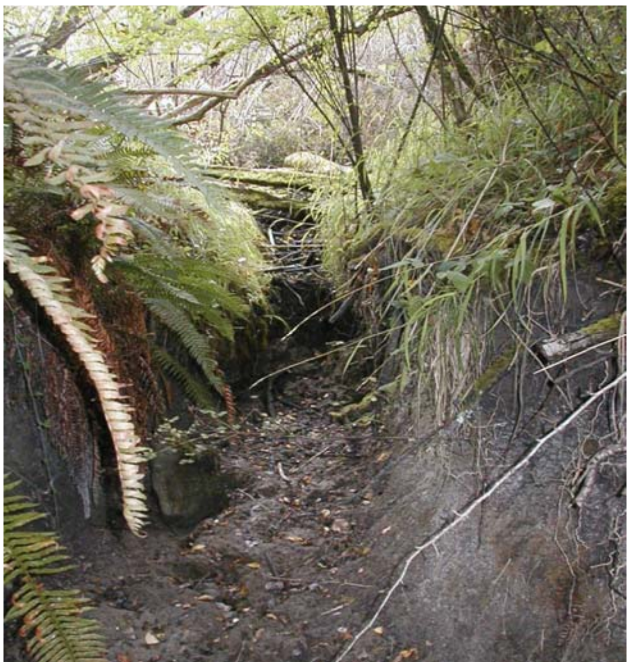
**Figure 2.6 Natural Estuary Channel Downstream of Bridge**

**Figure 2.7 1977 and 2005 Channels in Cayou Valley Lagoon**



The lowest, tidally-affected reaches of the two tributary creeks have been significantly altered by development activities in the watershed. Fish Trap Creek, which is the larger of the two creeks, flows into the estuary through a steep, narrow ravine eroded out of the native clay soil. The ravine extends about 200 feet upstream to a 5 foot-high vertical head cut, which marks the end of the zone of tidal influence. Although the history of the head cut is not documented, it is conjectured that it originated with dredging of the mouth of the creek in the late 19th Century for a dock, and then unraveled upstream during extreme runoff conditions in the first decades after the surrounding forest was logged and cleared for agriculture. Figure 2.8 shows the head cut.

**Figure 2.8 Fish Trap Creek Head Cut**



The second, smaller tributary flows into Cayou Valley Lagoon about 150 feet west of the mouth of Fish Trap Creek. This seasonal stream is blocked by an earth dam about 70 feet upstream of the mouth. The dam impounds a shallow, 0.7-acre wildlife pond constructed in 1985. A small amount of flow from the creek still enters the estuary through the pond's overflow structure and from seepage through the dam, but the former creek mouth has filled-in with sediment, drift logs, and shrubs.

### 2.5.2 Sediment Characteristics

The three reaches of the Deer Harbor Estuary have distinct sediment characteristics. Typical sediments in upper Cayou Valley Lagoon and the mouth of Fish Trap Creek consist of soft, gray clay mud extending down at least five feet below the current bottom level. Further down the lagoon towards the Channel Road Bridge, thin layers of sands and gravels up to 5 mm in diameter begin appearing from one to three feet below the surface. These localized gravelly areas are believed to be the location of former estuary channels, where the increased velocity of flowing water scoured away the lighter silt and clay particles that are present further north in the lagoon. Figure 2.9 is a schematic diagram summarizing the main sediment types in the lagoon.

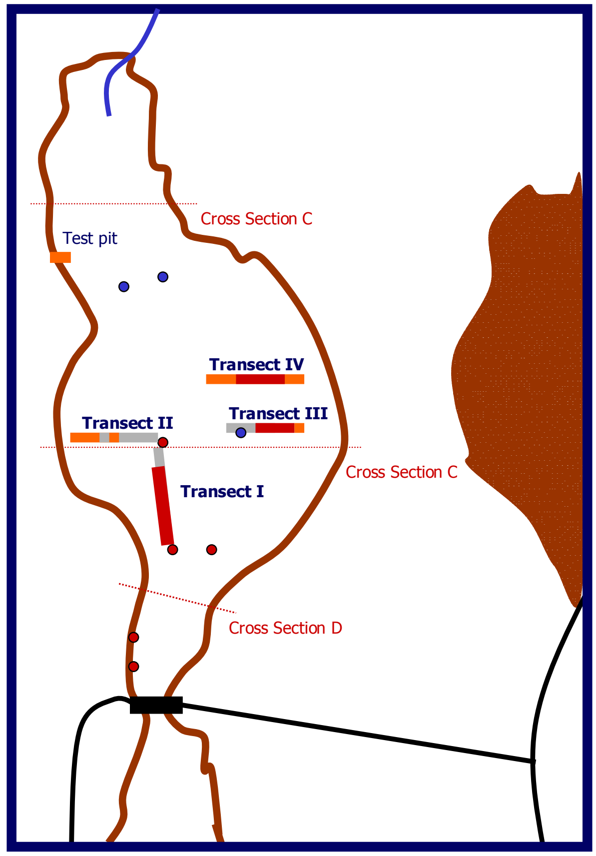
## Figure 2.9 Schematic of Sediment Characteristics in Cayou Valley Lagoon

### Cayou Lagoon
Sediment data synthesis

- Gravel layer ~1 foot from surface
- Gravel layers 2-3 feet from surface
- Soft mud or silty sand up to 5 feet
- Current scouring
- Current accumulation

The thickest accumulation of clasts was found along Transect I. Along Transects III and IV the hard layers were both thinner and deeper in the sediment profile. Only mud was found between sediment stakes 3 and 4, up to 5 ft.

The test pit profile suggests that there have been alternating periods of scouring and re-deposition, as evidenced by some variations in the proportion of water-worn gravels and pebbles embedded in redeposited silty clays.

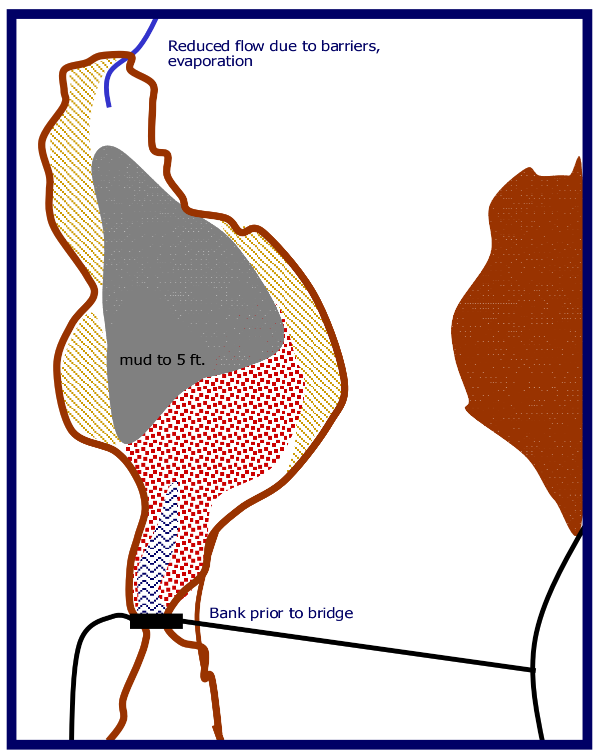



### Cayou Lagoon
Interpretation of recent changes

- Recent bank recession
- Hard substrate on/near surface
- Ongoing sediment accumulation
- Scour channel due to bridge

Cayou Lagoon was carved from finely bedded glacial clays that can still be seen 3 feet below the present surface. Over millennia, scouring resulted in the accumulation of gravel/pebbles excavated from the clays, creating a relatively firm bottom. There is also evidence of periods of re-suspension and re-accumulation of clays.

Channel constriction has increased scouring in the lower lagoon, while diminished streamflow has increased mud accumulations in the upper lagoon. In response to sediment accumulation the lagoon has been cutting a wider basin.



At the lagoon outlet, bottom sediments consist of both angular rock rip rap ranging in size from 12 to 24 inches to natural cobble and gravels. In the inner harbor below the outlet, the bottom is a mix of gravel and cobble along the main course of the main drainage channel, with mud and sand flats at higher elevations. Shoreline areas in the inner harbor are a mix of sand, mudflat, gravel and rock outcrop.

### 2.5.3 Sediment Dynamics

Monitoring of sediment dynamics in Cayou Valley Lagoon from September 2003 through May 2004 indicated a distinct pattern of sediment deposition in the upper half of the lagoon and sediment erosion in the lower half. Over the eight-month period, which roughly corresponded to the wet season, sediment accumulated are rates ranging from 1.6 cm at the a sediment stake placed near the northern end of the lagoon to 0.9 cm at a stake placed near the middle of the lagoon. Decrease in sediment depth was observed at stakes in the lower part of the lagoon ranging from 0.7 cm near the middle to 1.6 cm about 400 feet upstream of the outlet. During this time period, erosion rates 1.8 to 3.0 cm were measured at scour pins placed in an actively eroding section of the lagoon's western shoreline located about 70 feet north of the outlet. This rate of erosion is not characteristic of most of the shoreline of the lagoon, which in general appears to have changed little if at all from its outline shown in a 1977 aerial photo. Sediment monitoring locations and data are included in Appendix B.

In addition to the short-term sedimentation monitoring during the winter of 2004, a limited number of sediment cores were analyzed to evaluate longer-term trends in the sediment dynamics of Cayou Valley Lagoon. A distinctive spike in the sulfur concentration of a stratum buried 21 to 24 cm below the surface is conjectured to be correlated with the start of operations of the Deer Harbor sawmill in the 1940s. Using this stratum as a marker, it is estimated that sediment has been accumulating at an average rate of about 0.4 cm per year since roughly the time of white settlement in the 1860s. Sediment core logs are presented in Appendix C.

The sediment core data suggest that deposition of sediments in the lagoon has occurred in distinct phases in the last 150 years. Prior to the deposition of sulfur-laden sediment, presumably in the 1940s through 1950s, the trend in sediment deposition is the gradual burial of post-glacial, 1 mm to 8 mm diameter sands and gravels by the fine silt and clay eroding from the shoreline of the lagoon. The presence of charcoal in a stratum correlated to the late 19$^{th}$ Century suggests that the increased erosion and sedimentation may be related to burning and clearing of the native forests on the west side of the lagoon.

After the 1950s, there is an increase in the relative abundance of fine (less than 0.1 mm diameter) beach sand in the lagoon. The cause of this change in sediment composition is unknown. It is possible that the change represents a decrease in erosion of Coveland clay soils from the shoreline of the lagoon and the lower watershed. This change can be associated with the gradual decrease in runoff from the watershed due to construction of farm ponds in the creek channel and isolation of wetlands. On the other hand, the increase in fine sand may have been caused by a change in sediment deposition patterns due to the disruption of the tidal cycle resulting from the placement of fill across the lagoon outlet.

## 2.6 Hydrology and Hydraulics

### 2.6.1 Tidal

The hydrology of Deer Harbor Estuary is dominated by the daily fluctuation of the tides. Table 2.1 shows the range of tidal elevations estimated for Deer Harbor (local tidal datum).

**Table 2.1 Tidal Elevations**

| Tide Stage | Elevation (local MLLW Tidal Datum) |
|---|---|
| Mean higher high water (MHHW) | 7.72 feet |
| Mean high water (MHW) | 7.11 feet |
| Mean tide level (MTL) | 4.70 feet |
| Mean low water (MLW) | 2.29 feet |
| Mean lower low water (MLLW) | 0.00 feet |

With bottom elevations ranging from a high of about 5.5 feet above MLLW at the upper end of the lagoon to a low of about 3.0 feet below MLLW at the mouth of the inner harbor, the majority of the area in the Deer Harbor Estuary is located within the elevation range of the tide.

Placement of rock armoring in the lagoon outlet channel, and in particular the rock sill under the bridge reduces the range of tidal fluctuation in the lagoon. Figure 2.10 plots the difference in tidal stage in the inner harbor and in the lagoon for the period between 0ctober 9, 2003 and November 8, 2003. The data show that the stage in the lagoon tracks the stage in the inner harbor very closely until the harbor level drops below about 5.0 feet above MLLW. At this point, the rock sill under the bridge (average elevation of about 4.2 feet above MLLW) controls the stage in the lagoon.[4] Even on the lowest tides, the water surface in the lagoon generally does not drop below about 3.5 feet. Consequently the lowest areas in the lagoon never drain completely.

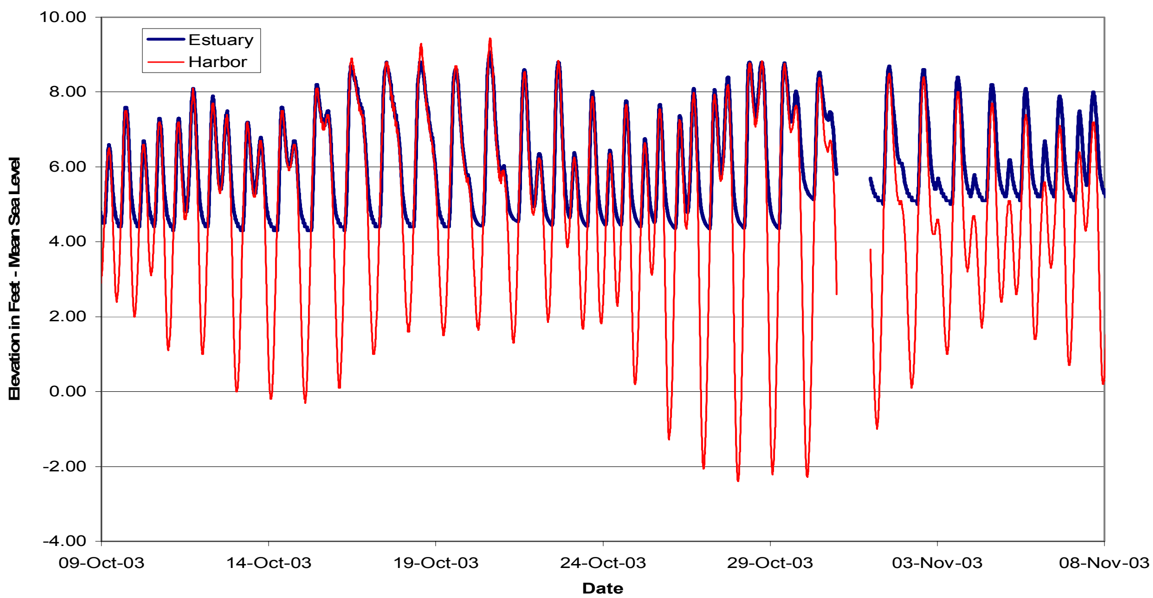
Appendix D evaluates the historic (i.e. pre-1970s) and current hydrologic and hydraulic conditions of the Cayou Valley Lagoon. Prior to the placement of bridge fill in the lagoon outlet channel (in particular, the rock sill under the bridge), the original tidal prism between MLLW and MHHW in the estuary is estimated to have been about 41.7 acre-feet. Currently, the tidal prism between MLLW and MHHW is estimated to be about 41.2 acre-feet. The placement of fill, therefore, is estimated to have reduced the total tidal prism in the lagoon by about 1.2 percent. Calculations of the tidal prism at various tidal elevations are included in Appendix D.

While the rock sill slightly reduces the total tidal prism, its more significant impact is the skewing of the natural hydraulic patterns in the lagoon. Hydraulic patterns are impacted in two ways. First, by dampening the range of the tide, the rock sill hinders the natural transport of sediment out of the lagoon. It is probable that prior to placement of the fill, the bottom elevation dropped in a uniform grade from the upper end of the lagoon to the mouth of the inner harbor. Historically, much of the sediment entering the lagoon from the watershed would have eventually moved out into the outer harbor. The rock sill effectively has formed a grade control

[4] The deviation is more pronounced during more extreme tides, when the stage in the lagoon begins deviating when the stage in the harbor drops below about 6.0 feet above MLLW.

that has blocked transport of sediment, allowing it to accumulate in the lagoon. Comparison of the pattern of distributory channels in the lagoon in 1977 with the lack of such channels today (Figure 2.7) illustrates the relatively quick accumulation of sediment following construction of the rock sill.

**Figure 2.10 Tidal Stage in the Inner Harbor and Cayou Valley Lagoon, Oct. - Nov. 2003**




The second hydraulic affect of the rock sill and the general constriction of the outlet channel with bridge fill is the increase in the tide's flow velocity through the lagoon outlet channel. The smaller cross section of the channel forces the tidal prism to accelerate through the outlet on both ebb and flood tides. This has resulted in scouring of the bottom at both ends of the channel as well as active erosion along about 200 feet of the west bank of the lagoon immediately upstream of the outlet. Flow velocities of up to 2.8 feet per second have been measured in the outlet channel during the peak ebbing and flooding tides, while velocities of up to 1.4 feet per second have been measured along the west bank of the lagoon during these times. The scouring effect may also have formed the distinctive localized deeper area in the lagoon bottom about 75 feet upstream of the bridge (see Figure 1.2).

### 2.6.2 Freshwater

The primary source of freshwater flowing into the Deer Harbor Estuary historically was Fish Trap Creek. This seasonal creek drains roughly three quarters of the land area of the 740-acre watershed. Standard hydrologic modeling using "StormShed" software estimates a two-year recurrence interval peak flow of 17.6 cfs and a 100-year recurrence interval peak flow of 89.2 cfs. It is likely, however, that the actual flow rates in Fish Trap Creek are significantly less than those predicted by the model. Direct measurements of creek flows just above the confluence with the estuary during winter and fall of 2004 indicate that the flows in the range of 0.1 to 1.0 cfs, which is an order of magnitude less than predicted under typical conditions by the model.

The severe reduction in natural flow rate is probably due to development activities in the watershed. From its headwaters to its mouth, Fish Trap Creek is blocked by three ponds, including a 5-acre artificial reservoir constructed in 1999 at the very top of the watershed. These ponds intercept creek flow, allowing it to evaporate in summer and percolate into the soil during winter. In addition, construction of Deep Meadow Road in the upper watershed has likely diverted runoff from over one hundred acres away from the creek's current catchment area. The effect of these development activities is that Fish Trap Creek likely contributes far less freshwater to the Deer Harbor Estuary than it did in historical times.

Flow to the estuary from the smaller, western tributary has likewise been severely reduced. Even though the effective catchment area of this tributary probably has been increased by the construction of Deep Meadow Road, all flow is intercepted in a 0.7-acre artificial pond located just above the confluence with the estuary. During most of the year, little if any surface water flows over the pond's spillway and into the lagoon.

Due to the interception of the majority of the flow from Fish Trap Creek and the western tributary, it is believed that groundwater seepage is currently the primary source of freshwater input into the Deer Harbor Estuary. During the rainy winter months, it is likely that much of the runoff from the watershed eventually enters the perched water table typical of the Coveland silt loam soils surrounding the lagoon. Enough fresh water seeps from the lagoon's shoreline to have a measurable effect on the salinity concentration of the (tidal) water in the estuary. This effect is particularly pronounced in the northern third of the lagoon, where salinity concentrations along the shoreline were measured in the range of 5 to 22 parts per thousand (ppt) during a December 2003 sampling event, compared with typical salinity concentrations of 28 to 30 ppt in the center of the lagoon. Figure 2.11 shows seepage patterns along the eastern shore of the lagoon.

Appendix D contains the hydrologic and hydraulic data and analysis used to characterize the baseline conditions in the estuary as well as the expected conditions following implementation of the recommended restoration alternative.

### 2.6.3 Wetlands

The 1977 USFWS National Wetland Survey (NWI) classifies the entire Deer Harbor Estuary study area as palustrine, estuary, or marine wetland. Starting from the upper end, the area around the mouths of the two tributary creeks is classified as palustrine scrub shrub or palustrine emergent, seasonally saturated wetland (PSS1Y and PEM1Y). Cayou Valley Lagoon and the mudflats at the upper end of the inner harbor are classified as either inter-tidal emergent or inter-tidal flat estuary wetland (E2EM1P and E2FLN). The lower inner harbor is classified as marine sub-tidal open water (M1OWL) (USFWS, 1977). A map showing demarcation of the wetland zones is shown in Figure 2.12. The biological characteristics in each of these wetland zones are discussed in Sections 2.8 and 2.9. For the purpose of compliance with San Juan County's critical areas ordinance, the entire estuary study area is considered to be a Category 1 wetland.

In addition to the wetlands in the estuary, several palustrine emergent, scrub shrub, and open water wetlands are present in the upper part of the Deer Harbor watershed. While these are outside of the boundary of the study area, they have a significant affect on the estuary's freshwater hydrology and anadromous fish habitat conditions.

**Figure 2.11 Seepage From the Eastern Shore of Cayou Valley Lagoon - July 2003**

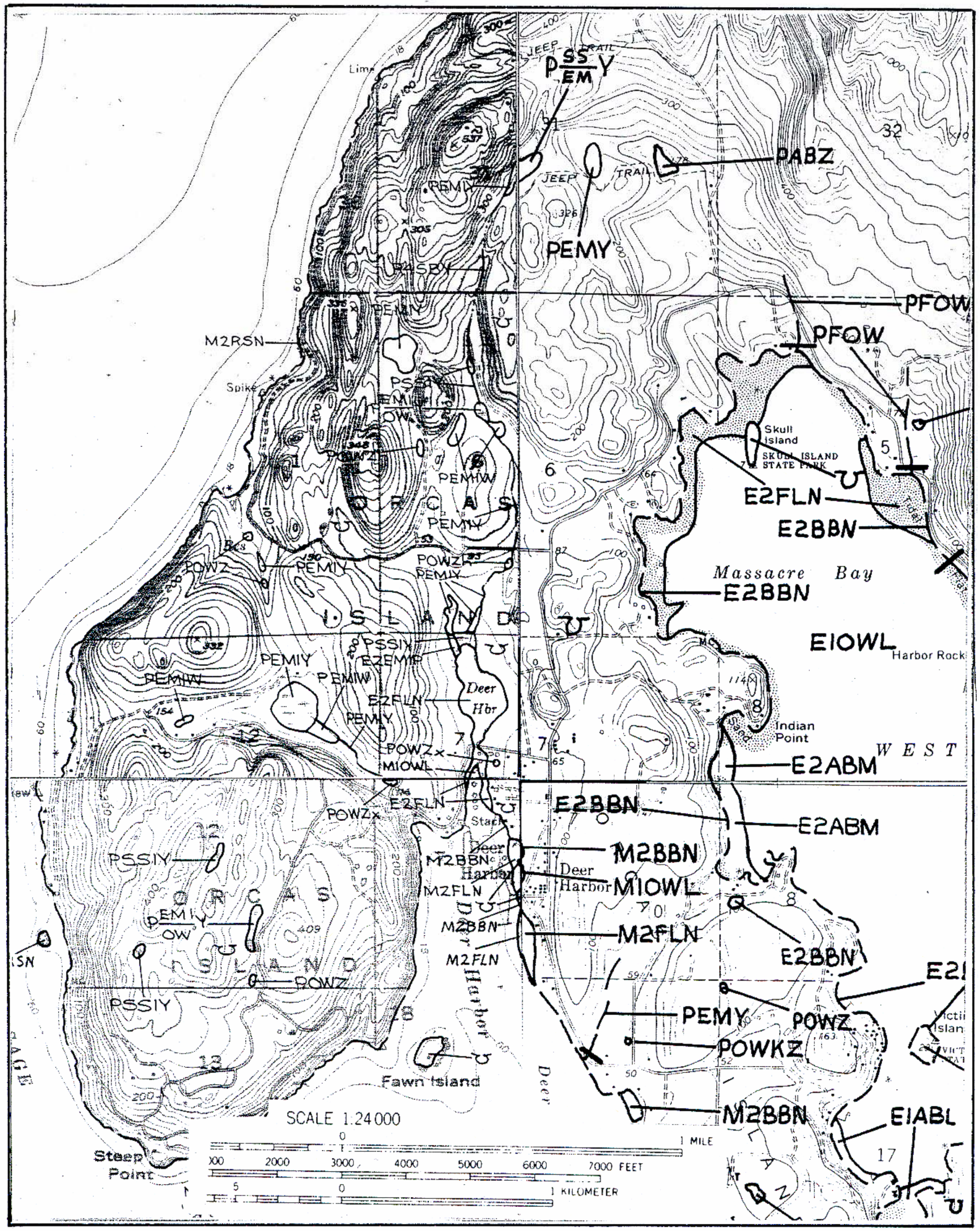
Freshwater seepage into Cayou Valley Lagoon is most obvious along the eastern shore, as seen here during July 2003. *Salicornia* low salt marsh is visible to the left. Monitoring of lagoon water quality in this area on weak ebb tides after rain events in December 2003 measured salinities in the range of 8 to 18 parts per thousand, compared with concentrations of about 30 ppt near the lagoon outlet. The green seaweed (*Ulva sp.)* may be associated with the brackish water.

## 2.7 Water Quality

The available water quality data for the Deer Harbor Estuary indicate that the water body is generally in compliance with Washington State Water Quality Criteria (WQC). The estuary is not listed on the federal Clean Water Act Section 303(d) list of impaired water bodies. A limited monitoring program consisting of testing samples for pH, dissolved oxygen, and fecal coliform was conducted for this study in December 2003. Individual grab samples were collected at four locations in the estuary during a weak ebb tide following a rain event. All except one sample met the Washington Class A Marine WQC for each parameter.

The sample collected near the east shore of the upper lagoon had a fecal coliform count of 47 colonies per 100 ml. The fecal coliform WQC requires that a geometric mean of all samples not exceed 14 colonies per 100 ml, with no more than ten percent of samples exceed 43 colonies per

**Figure 2.12 National Wetland Inventory Sites in the Deer Harbor Watershed**



100 ml. Even though the number of samples in the monitoring study was too small to determine whether the elevated coliform count in the upper lagoon constituted a violation of the WQC, the results suggest that coliform contamination may be a concern. Two typical sources of fecal coliform contamination that are present in the vicinity of the lagoon are water fowl and septic systems. Local residents plan to continue monitoring fecal coliform in seepage in this area and may attempt to do a pilot study of reducing fecal contamination through passive treatment measures (Brown, 2005).

## *2.8 Vegetation*

### 2.8.1 Terrestrial

In general, the terrestrial vegetation communities in the Deer Harbor Estuary study area have been simplified by a century of agricultural land use. Most of the land adjacent to Cayou Valley Lagoon was cleared for pasture and orchards and presently the main plant species are pasture grasses. Dense thickets of native rose, snowberry, and other shrubs grow along the banks of the tributary creeks. Invasives such as Canadian thistle, Himalayan blackberry, and Scotch broom have begun taking over some pasture areas. The pasture adjacent to the northwest corner of the lagoon has recently been reforested with young spruce and firs. Cattail, willow shrubs, and a few black cottonwood trees dominate the freshwater wetland areas near the mouths of the two creeks. In contrast to the open meadow habitat adjacent to the lagoon, the rocky ledges that form the shoreline of the inner harbor support small groves of mature madrona trees.

### 2.8.2 Inter-tidal and Sub-tidal

Along the shoreline of the lagoon, and particularly on the more gently-sloping east shore, an extensive pickleweed (*Salicornia virginica*) and salt grass (*Distichlis spicata*) low salt marsh community dominates from about 7.5 feet above MLLW to about 10.5 feet above MLLW. The total area of low salt marsh surrounding the lagoon is estimated to be 3.4 acres.

Below roughly 7.5 feet elevation, mud flat predominates, supporting a sparse community of macroalgae (primarily *Ulva sp.*). A key exception is four patches of eelgrass (*Zostera marina*) growing at the mouth of the inner harbor, starting at elevation about -3.0 MLLW and extending south out to depths of about -6.0 MLLW. The eelgrass beds cover a combined area of about 0.53 acres. Another very small (about 1 $m^2$) patch of eelgrass occurs in the Cayou Valley Lagoon "scour hole" located about 75 feet north of the Channel Road Bridge. While the elevation of this area (about 2 feet above MLLW) is not typically associated with eelgrass, it is believed that the "sill" effect of the rock armoring below the bridge causes this area to have more-or-less permanent sub-tidal conditions that can support eelgrass. The distribution of low salt marsh and eelgrass beds are plotted in Figure 1.2.

The condition of the eelgrass beds in the study area was correlated with the level of submarine light (photosynthetically active radiation (PAR)) at various water depths. Variation in PAR can be equated with relative levels of dissolved and suspended particulates in the water column and thus can be used as an indicator of impact from sedimentation or other human-caused disturbance. Based on comparisons with eelgrass and PAR conditions at a relatively pristine reference site on nearby Shaw Island, it was determined that PAR currently is not a significant limiting factor for eelgrass ecology in the Deer Harbor study area. A report of the eelgrass monitoring activities completed as part of this study is presented in Appendix E.

## *2.9 Fisheries*

### 2.9.1 Marine

Longtime Deer Harbor residents claim that the Deer Harbor Estuary historically supported rich shell fish and fin fish resources. Residents recall harvesting native oysters (*Ostrea lurida*), Dungeness crab, and shiner perch in the lagoon (Barsh, 2002). Even as late as the 1940s, residents remember seeing salmon "running thick" in the lagoon and swimming up the creek (Williams, 2003).

Since that time, the utilization of the estuary by native marine life has decreased significantly. Currently, most of the area in the lagoon and inner harbor consists of mud flat habitat. Predominant species are mud snails (*Batilaria japonica*), tube worms, and similar hardy invertebrates. The remaining areas of gravel substrate, along the thalweg of the inner harbor, support a modest population of cultivated oysters (Puget Sound Restoration Fund, 2005). Although the type of shaded, gravel beaches that are present on the east shore of the inner harbor have been identified as "potential" surf smelt and Pacific sand lance spawning habitat, no spawning has actually been documented there (Friends of the San Juans, 2004).

Despite the degraded condition of the habitat, small numbers of salmon and other native marine fish species do utilize the Deer Harbor Estuary. Fish utilization was monitored during sampling events in October 2003, March 2004, and June 2004. Fyke netting in the lagoon outlet channel and beach seining from the shore of the lower lagoon resulted in the species distribution listed in Table 2.2.

The data indicate that resident and migratory fish utilize the Cayou Valley Lagoon to a limited extent. Local Deer Harbor residents report that it is a common site to see herons feeding in the lagoon, further supporting the conclusion of the monitoring study that the lagoon still supports a modest population of fish. A report of the fish monitoring that was completed for this study is included in Appendix F.

It should be noted that a distinct, isolated patch of rocky inter-tidal habitat has developed on the rock armoring that was placed in the lagoon outlet channel under the Channel Road Bridge. This small (approx. 0.1 acre) area supports anemones, sea stars, barnacles, and other animals typical of rocky inter-tidal habitat.

### 2.9.2 Fish Trap Creek Habitat

As part of this study, salmon habitat conditions were evaluated in Fish Trap Creek, the main tributary of the Deer Harbor Estuary that once supported a salmon run. While the restoration of habitat in Fish Trap Creek is outside the scope of this study, habitat conditions in the creek directly impact habitat conditions in the estuary. A complete report of the Fish Trap Creek habitat assessment is included in Appendix G.

**Table 2.2 Results of 2003-2004 Fish Utilization Monitoring in Cayou Valley Lagoon (selected species)**

| Species | Oct. 19, 2003 Sample Count | Mar. 22, 2004 Sample Count | June 15, 2004 Sample Count | Average Total Length |
|---|---|---|---|---|
| ***Salmon (juvenile)*** | | | | |
| Chinook | | | 3 | 95 mm |
| Pink | | 1 | | 59 mm |
| Chum | | 1 | | 60 mm |
| ***Sculpin*** | | | | |
| Staghorn | 20 | 77 | 147 | 87 mm |
| Other sp. | 32 | | 6 | 148 mm |
| ***Surf perch*** | | | | |
| Shiner | 94 | | 2904 | 98 mm |
| Hexagrammids | 6 | | 16 | 125 mm |
| ***Flat Fish*** | | | | |
| Starry flounder | 6 | 2 | 2 | 100 mm |
| English sole | 22 | 5 | 118 | 88 mm |
| Sand sole | | 1 | 16 | 54 mm |
| ***Gunnels*** | | | | |
| Crescent | 40 | | | 97 mm |
| Saddleback | 10 | | 6 | 94 mm |
| ***Other species*** | | | | |
| Herring | 3 | | 2 | 63 mm |
| Surf smelt | 2 | 1 | 18 | 162 mm |
| Pipefish | 4 | 8 | 2 | 143 mm |
| Stickleback | 22 | 10 | 1 | 39 mm |
| Snake pickle back | 2 | | 897 | 150 mm |

## 2.10 Threatened or Endangered Species

According to the US Fish and Wildlife Service, five species listed as "threatened or endangered" under the federal Endangered Species Act may occur in San Juan County, including the vicinity of the Deer Harbor Estuary. These species include wintering concentrations of bald eagle (*Haliaeetus leucocephalus*), bull trout (*Salvelinus confluentus*) and marbled murrelet (*Brachyramphus marmoratus*) in marine waters. Marsh sandwort (*Arenaria paludicola*) and golden paintbrush (*Castilleja levisecta*) may also occur in the county. (USFWS, 2005).

In addition to the federally-listed species, several other species that are classified by USFWS or Washington Department of Fish and Wildlife as either candidates for listing or of other concern include Pacific herring (*Clupea pallasi*), Puget Sound ESU coho salmon (*Onchorhynchus kisutch)*, common murre (*Uria aalge)* and several others (WDFW, 2005). A complete list of species reported on agency websites for San Juan County is included in Appendix H.

## 2.11 Potential Sources of Toxic Substances

A preliminary (Level 1) assessment of potential sources of toxic and hazardous substances was conducted for the Deer Harbor Estuary study area. The complete text of the assessment report is included in Appendix I. As of April 2005, there are no records of hazardous substance releases in the vicinity of the study area listed on public databases maintained by the Washington Department of Ecology and the U.S. Environmental Protection Agency.

Field observations showed the presence of several old creosote timbers accumulated above the mean tide level at the north end of Cayou Valley Lagoon. While the origin of these timbers is unknown, it is believed that they floated to the site from another location on very high tides. A local environmental advocacy group "Restoring the Ecosystem of Deer Harbor" (REED) has contacted Washington Department of Natural Resources (WDNR) regarding participating in WDNR and the Northwest Straights Commission's "regional creosote project" to collect and dispose of the timbers at an approved off-site location (WDNR, 2005). To date, however, no definite plans have been made for removing the timbers.

No other field observations or documentation of hazardous and toxic waste releases within the project study area were found.

# 3 Development of Restoration Alternatives

## *3.1 Identification of Restoration Objectives*

### 3.1.1 Description of Problems

Over the years, land development activities in the Deer Harbor watershed, manipulation of the tributary streams and, especially, the construction of the Channel Road Bridge have altered the freshwater hydrology, vegetation communities, sediment dynamics, and tidal flow patterns in the estuary. It is believed that these impacts have in turn led to the elimination of shellfish populations in the lagoon, elimination of salmonid rearing and spawning habitat in the tributaries, and degradation of salmonid feeding habitat in the estuary. The primary problems that are impacting the quality of the estuary habitat are discussed below.

Freshwater Hydrology

The construction of ponds, road fill, and other development activities in the Deer Harbor Estuary watershed has interfered with surface water flow in the estuary's tributary creeks. While not enough historical data is available to verify long-term residents' claims that "fresh water ran through the valley and into the slough year round," (McLachlan, undated), it is clear that the quantity and seasonal timing of flow in the two creeks is greatly reduced from pre-settlement times. Both creeks are dry from late spring to late autumn and the rainy season flows are an order of magnitude lower than that predicted by standard watershed hydrologic modeling.

In-stream flow blockages also prevent passage for salmonids and other migratory fish into the two tributaries. For the purposes of this study, the blockages at the mouths of the two creeks are most important. Passage from the estuary into the west creek is blocked by an earth dam constructed in 1985 to form a shallow wildlife pond. Passage into Fish Trap Creek is blocked by a five-foot high head cut. On Fish Trap Creek, a farm pond dam and two partially-blocking culverts also obstruct fish passage to spawning habitat upstream of the head cut, but are outside of the geographical study area. Full description of the blockages is contained in Appendix G.

Vegetation Communities

An 1895 USCGS chart shows virtually all the land surrounding Cayou Valley Lagoon cleared of forests. While it is unknown whether the wet, Coveland soils surrounding the lagoon ever supported a continuous canopy of forest, it is clear from the chart that much of the area around the lagoon had been cleared for orchard and pasture use following settlement in the 1860s (USCGS, 1895). The condition of the current vegetation community is described in Section 2.8.1. The absence of trees along the shoreline accounts for a complete lack of shading that is associated with typical natural estuary ecology in the Puget Sound / Straights of Georgia region.

No documentation is available regarding the species composition of the original salt marsh and other inter-tidal vegetation community in the estuary prior to settlement in the 1860s. It is unknown whether the existing *salicornia* low salt marsh and the sparse algae beds in the lagoon and inner harbor represent natural conditions. Based on the existing distribution of eelgrass at the southern end of the inner harbor at depths between -3 to -6 feet MLLW, it is likely that the lagoon and upper reach of the inner harbor (bottom elevation range +7 to 0 MLLW) did not support eelgrass in pre-settlement times.

Sediment Characteristics / Lagoon Bottom Substrate

Analysis of sediment cores indicates that sediment has been accumulating in the upper half of Cayou Valley Lagoon at a rate of about 0.4 cm per year since the settlement in the 1860s. It is believed that in the decades after the forests were cleared, soil eroding from the watershed blanketed the diverse gravel, sand, and mudflat bottom of the lagoon with a thick layer of fine clay sediment. This change in the lagoon substrate eliminated shell fish habitat in the lagoon and possibly changed the original inter-tidal vegetation community as well. It is unknown whether the accumulation of sediment in the lagoon has impacted the inter-tidal ecology of the inner harbor.

While the most extreme erosion and deposition of sediment in the estuary apparently stabilized several decades ago, on-going erosion of the southwest bank of the lagoon and at the Fish Trap Creek head cut continues to add clay and silt to the estuary.

Tidal Hydraulics

The vertical and, to a lesser-extent, the horizontal constriction of the lagoon outlet channel with fill material for the Channel Road Bridge construction has skewed the original tidal hydraulics in the lagoon. Currently, the tide flows into the lagoon only when the stage in the inner harbor rises above about 4.0 feet above MLLW and ceases flowing out of the lagoon when the stage in the lagoon drops below 4.0 feet. While preliminary assessment of the tidal hydraulics indicates that the total quantity of the lagoon's tidal prism is not much less than prior to construction of the bridge, the duration of the tidal cycle is significantly shortened.

One impact of the shortened tidal cycle is that the peak flow velocity in the outlet channel is increased. While the increased velocity is not believed to be enough to affect fish passage, it has apparently caused increased scour of the lagoon bottom and west shore of the lagoon immediately upstream of the outlet.

The other, more significant, impact of the bridge fill is that it has effectively made a rock sill that prevents sediment from being transported from the lagoon and out into Deer Harbor. The natural network of drainage channels typical of estuaries is almost completely absent in the Cayou Valley Lagoon, indicating that natural sediment transport is severely disrupted.

Table 3.1 summarizes the primary problems that are impacting the quality of estuary habitat in the Deer Harbor Estuary.

**Table 3.1 Summary of Environmental Problems in the Deer Harbor Estuary**

**Freshwater Hydrology**
- Reduction in quantity and duration of stream flow
- Fish passage blockages at the mouths of both tributaries

**Vegetation Communities**
- Lack of shading vegetation around shoreline of the lagoon

**Sediment Characteristics / Lagoon Bottom Substrate**
- Accumulation of clay sediment in the lagoon has buried original substrate, eliminating shellfish habitat and perhaps changing the inter-tidal vegetation community

**Tidal Hydraulics**
- Artificial fill at the Channel Road Bridge has skewed the tidal hydraulics, causing increased flow velocity and interrupting natural sediment transport dynamics

### 3.1.2 Objectives for Addressing the Problems

The general goal for restoring estuary habitat functions at the Deer Harbor Estuary is to correct, to the extent practicable, the man-made conditions that have caused the ecological problems listed in Section 3.1.1. Specific objectives for meeting the general goal are identified as follows.

Objective #1: Remove fish passage blockages at the mouths of the tributary creeks
The physical barriers at the mouth of Fish Trap Creek (the head cut) and the west creek (the wildlife pond dam) will be removed or mitigated so that adult coho salmon can migrate upstream in the fall and juveniles can migrate downstream in the spring during years when there is sufficient stream flow in the watershed. The priority creek for removing barriers is Fish Trap Creek, which was known to historically support a salmon run.

Other full and partial barriers block passage to potential salmon spawning habitat on Fish Trap Creek upstream of the head cut, including a farm pond located about 1,500 feet upstream of the mouth. Mitigation of these barriers, as well as restoration of spawning and rearing habitat in the creek, is necessary for restoration of the full range of salmon habitat in the Deer Harbor watershed and estuary system. While such problems in the upper watershed clearly must be resolved, they are beyond the scope of the present study.

Objective #2: Restore natural shading along the shoreline of the lagoon
Some degree of the shading that natural forest once provided to the shoreline of the lagoon will be restored. The priority area for improving shading will be along the west shore of the lagoon, which is subject to the most heating affect from summer sunshine.

Objective #3: Eliminate on-going accumulation of fine sediment in the lagoon
The current rate of soil erosion and subsequent accumulation of sediment in the lagoon will be significantly reduced. The top priority for controlling erosion will be at the head cut near the mouth of Fish Trap Creek and along the western shoreline of the lagoon immediately upstream from the outlet. The second priority will be controlling ongoing erosion at other locations along the shoreline of the lagoon. It is believed that elimination of on-going accumulation of sediment, in combination with restoration of freshwater and tidal hydraulics in the lagoon, will allow for the natural re-development of distributory channels in the lagoon. Local areas of gravel sediment that are currently buried by a bed of finer sediment will likely be re-exposed.

Objective #4: Restore tidal hydraulics in the outlet channel
The tidal prism and tidal flow characteristics will be restored as close as practicable to the conditions that existing prior to the placement of fill in the lagoon outlet channel. It is believed that restoration of tidal hydraulics will also restore the natural sediment transport and detritus exchange, which are essential for maintaining high value estuary habitat.

The objectives identified in this section are not mutually exclusive, but instead tend to overlap and support each other. For example, the restoration of tidal hydraulics at the outlet channel will positively affect the restoration of sediment dynamics in the lagoon. Table 3.2 is a summary of the specific objectives for the project.

**Table 3.2 Summary of Specific Restoration Objectives**

| |
|---|
| Objective #1: Remove fish passage blockages at the mouths of the tributary creeks |
| Objective #2: Restore natural shading along the shoreline of the lagoon |
| Objective #3: Eliminate on-going accumulation of fine sediment in the lagoon |
| Objective #4: Restore tidal hydraulics and sediment transport in the lagoon |

Another important factor in restoring estuary habitat functions at the Deer Harbor Estuary is improving the quantity and duration of freshwater stream flow in the two tributary creeks. In particular, sufficient stream flow must be restored to allow for fish passage during the fall up-stream migration and spawning for adult salmon, over-winter rearing of juveniles, and spring out-migration of smolts in Fish Trap Creek. Based on analysis discussed in Appendix G, the minimum in-stream flow necessary for fish passage in Fish Trap Creek is about 1.0 cfs.

While restoration of in-stream flow is a crucial for the overall restoration of the estuary habitat, the private ponds and reservoirs, roads, and other development that has disrupted the natural hydrology in the upper watershed are outside of the geographic boundaries of the study area and, therefore, cannot be addressed within the scope of this study.

### 3.1.3 Specific Project Criteria

Specific criteria were identified to guide in the development of alternatives for achieve the project objectives. The project criteria include the following.

<u>General Criteria</u>

- The recommended plan will achieve the goals and specific objectives of the project and will be sustainable over the long term.
- The recommended plan will be economically justifiable in terms of demonstrating a favorable balance of benefit to cost.
- The recommended plan for the restoration of estuary habitat will be consistent with San Juan County Department of Public Work's obligation to maintain traffic access across the lagoon outlet along Channel Road.

<u>Engineering Criteria</u>

- The project will be designed to minimize on-going maintenance requirements.
- Implementation of the recommended plan will minimize disturbance of existing soil and vegetation to the extent practicable.

<u>Social Criteria</u>

- Elements of the recommended plan that may occur on private property will be done with the support of and after consultation with the affected property owner(s).
- Implementation of the plan will minimize disruption of community affairs, including traffic, utilities, residential use, summer tourism, and other local business use.
- The recommended plan will not detract from, and preferably will enhance the unique aesthetic beauty of the estuary

<u>Regulatory Criteria</u>

- The recommended plan will comply with all regulatory requirements, including but not limited to requirements under the Washington Hydraulics Act, federal Clean Water Act, and federal Endangered Species Act.

## *3.2 Identification of Restoration Alternatives*

Various alternative measures were identifying for achieving the project objectives. The suite of alternative measures represents a range of the technically-feasible actions that, when implemented individually or in combination with other actions, would likely achieve the four project objectives. Each alternative will be evaluated in Section 3.3.

### 3.2.1 No Action

The No Action alternative, in which no project actions are implemented, represents the "future without the project" condition. It is included in the study as a basis of reference for comparing the benefits and costs of other alternatives. Under the No Action alternative the sediment accumulation and degradation of habitat conditions in the estuary would remain the same or gradually degrade as the watershed above the estuary develops further.

### 3.2.2 Alternatives For Restoring Tidal Hydraulics

Tidal Hydraulics Measure No. 1: Remove the Rock Sill Under the Bridge

About 200 to 250 cubic yards of 12” to 24” angular rock rip rap would be removed from the outlet channel under the Channel Road Bridge. The rock armoring covers an area of about 4500 square feet and is assumed to extend down about 2 feet, i.e. to the probable elevation of the original channel. The rock would be disposed of at an off-site location. Natural daily tidal exchange would eventually form the resulting channel into an equilibrium cross section of about 185 square feet at the mean higher high tide elevation, compared with the existing channel area of about 100 square feet.

This alternative would be implemented in conjunction with the replacement of the Channel Road Bridge with a new structure having approximately the same dimensions (50’ long x 29’ wide) as the existing bridge. A schematic drawing of a bridge and the proposed removal of rock armoring is shown in Figure 3.1. The new bridge would be offset about ten feet north of the existing bridge, allowing the existing bridge to remain open during construction. Alternatively, the new bridge could utilize the same alignment and same abutments as the existing structure. In this case, during construction, traffic would be detoured on a temporary right of way along Potlatch Road and Lagoon Road west of the lagoon. A proposed conceptual bridge design is presented in Appendix K.

Tidal Hydraulics Measure No. 2: Removal of Fill to the 1895 Channel Line

In addition to removing the rock armoring sill under the bridge, about 940 cubic yards of fill material would be removed from the outlet channel to widen it to about 85 feet at MHHW, which is estimated to be the width of the channel shown in the 1895 CGS chart. Tidal exchange would eventually form the resulting channel into an equilibrium cross section of about 290 square feet at the mean higher high tide elevation, compared with the existing channel area of about 100 square feet.

This alternative would be implemented in conjunction with the replacement of the Channel Road Bridge with a new concrete bridge measuring approximately 90 feet long by 29 feet wide. The bridge would have one set of piers placed mid-span and would have approximately the same alignment as the existing bridge. The footings for the pilings and new concrete abutments would be set below the clay surface soil of the lagoon area, which is assumed to be at least 15 feet deep.[5] The new bridge would be offset about ten feet north of the existing bridge, allowing the existing bridge to remain open during construction. Alternatively, the new bridge could utilize the existing bridge’s alignment, in which case traffic would be detoured along Potlatch Road during construction. A schematic drawing of the bridge and the proposed removal of rock armoring is shown in Figure 3.1. A proposed conceptual bridge design is shown in Appendix K.

Tidal Hydraulics Measure No. 3: Removal of All Fill

The rock sill under the bridge and about 1300 cy of fill material would be removed from the outlet channel and adjacent shoreline to widen the channel to about 120 feet. The resulting

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[5] This depth is assumed based on water well drilling logs at nearby sites and limited coring data of lagoon soils. A detailed geotechnical investigation would be conducted as part of the bridge design to determine the exact soil and bedrock conditions at the site of the new bridge.

channel cross section is estimated to be the original cross section based on the trend of the shoreline to the north and south of the existing bridge fill. Tidal exchange would eventually form the resulting channel into an equilibrium cross section of about 340 square feet at the mean higher high tide elevation, compared with the existing channel area of about 100 square feet.

**Figure 3.1 Channel Restoration Measures No. 1 and No. 2**

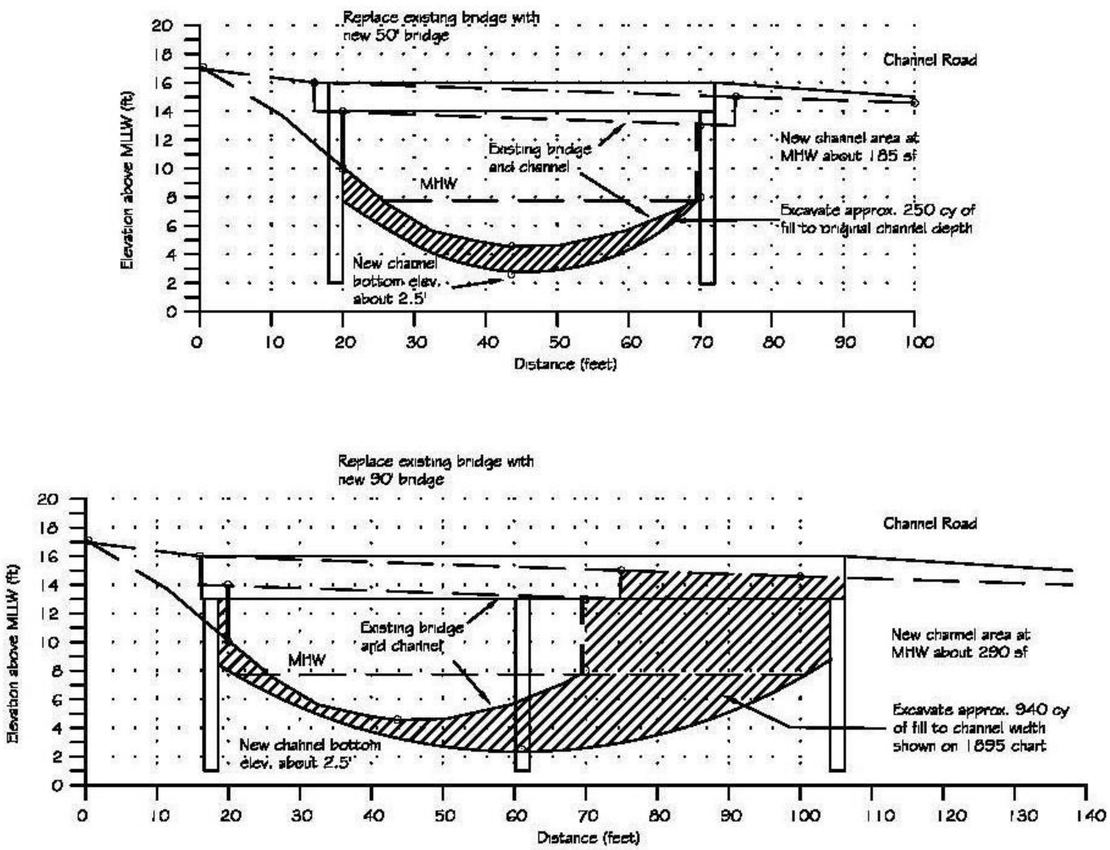


Figure 3.1: Schematic Cross Section View of Channel Restoration Measures 1 and 2

This alternative would be implemented in conjunction with the replacement of the Channel Road Bridge with a new bridge measuring approximately 120 feet long by 29 feet wide. A schematic drawing of the bridge and the proposed removal of rock armoring is shown in Figure 3.2. The new bridge would be a concrete structure supported by two sets of steel or concrete pilings. Construction methods would be the same as in Measure No. 2. A proposed conceptual bridge design is presented in Appendix K.

**Figure 3.2 Channel Restoration Measure No. 3**

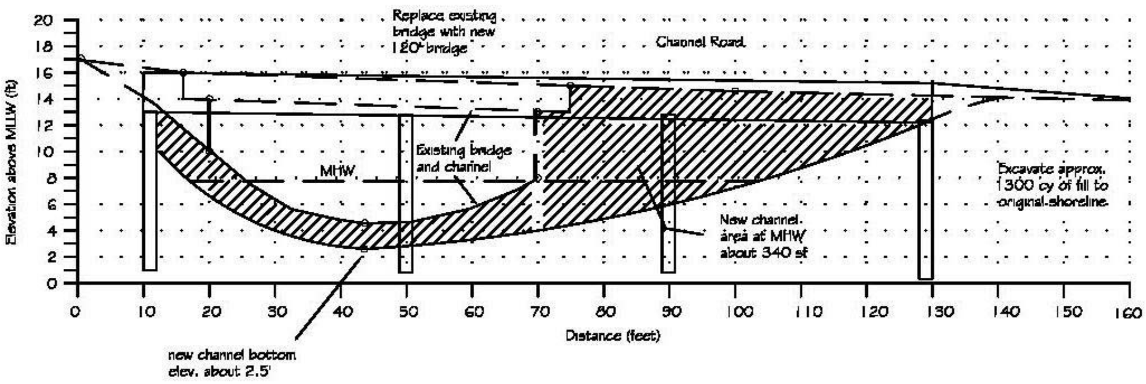


Figure 3.2. Schematic Cross Section View of Channel Restoration Measure 3

Tidal Hydraulics Measure #4: Remove Fill and Dredge Distributory Channels
In combination with one of the measures for removing fill from the outlet channel, a limited network of distributory channels would be dredged in the lagoon bottom. The design of the channel network would be based on reference conditions at an estuary lagoon of similar size and morphology as the Deer Harbor Estuary. While the design has yet to be determined, a likely scenario would include dredging about 2,000 cy of fine sediment to form 1,800 feet of meandering, first-order and second-order channels ranging from 5 to 10-feet wide and 2 to 3-feet deep. Dredging would be done by a dragline or an excavator operating from a barge. Dredge spoils would be disposed of at an upland location near the site. Following dredging, the daily tidal exchange in the lagoon would "self-adjust" the shape and depth of the new channels to an equilibrium condition over a period of several months. This measure is illustrated in Figure 3.3.

### 3.2.3 Alternatives For Removing Fish Passage Blockages

Barrier Removal Measure No.1: Fish Trap Creek Head Cut
Seven rock and/or log grade controls would be constructed along about 75 feet of Fish Trap Creek in the vicinity of the head cut to gradually raise the channel grade from elevation 6.0 feet above MLLW at the mouth to about elevation 11.0 feet above the current head cut. Each grade control would be set about 0.7 feet above the preceding one, which is the maximum vertical drop recommended by WDFW for allowing fish passage for juvenile coho and chum salmon (WDFW, 2000). Well-sorted gravel and large woody debris habitat features would be placed in the reconstructed channel. Figure 3.4 illustrates this measure.

**Figure 3.3 Conceptual Plan for Dredged Distributory Channels**

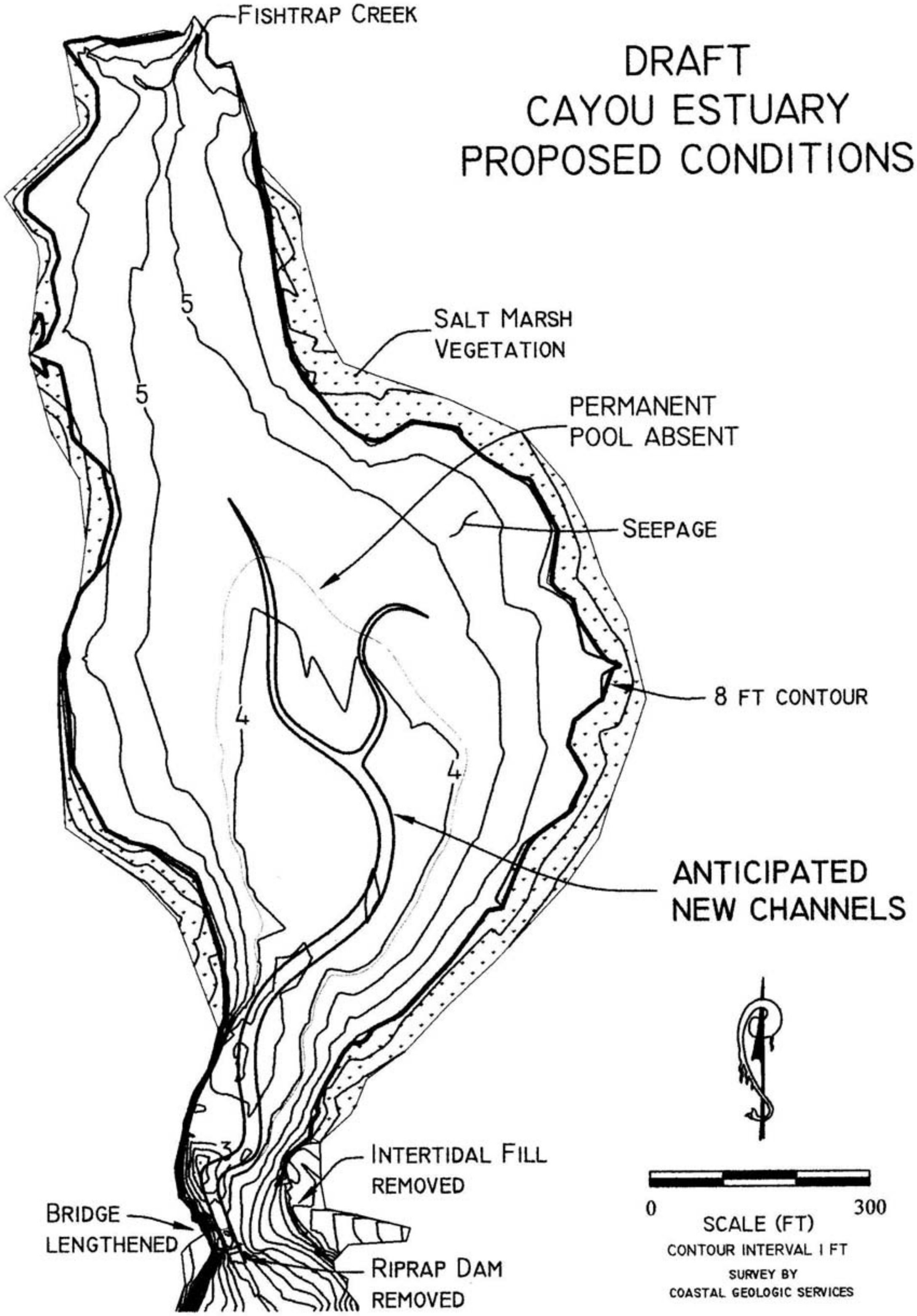

**Figure 3.4 Conceptual Design of Creek Grade Controls and Fishway**

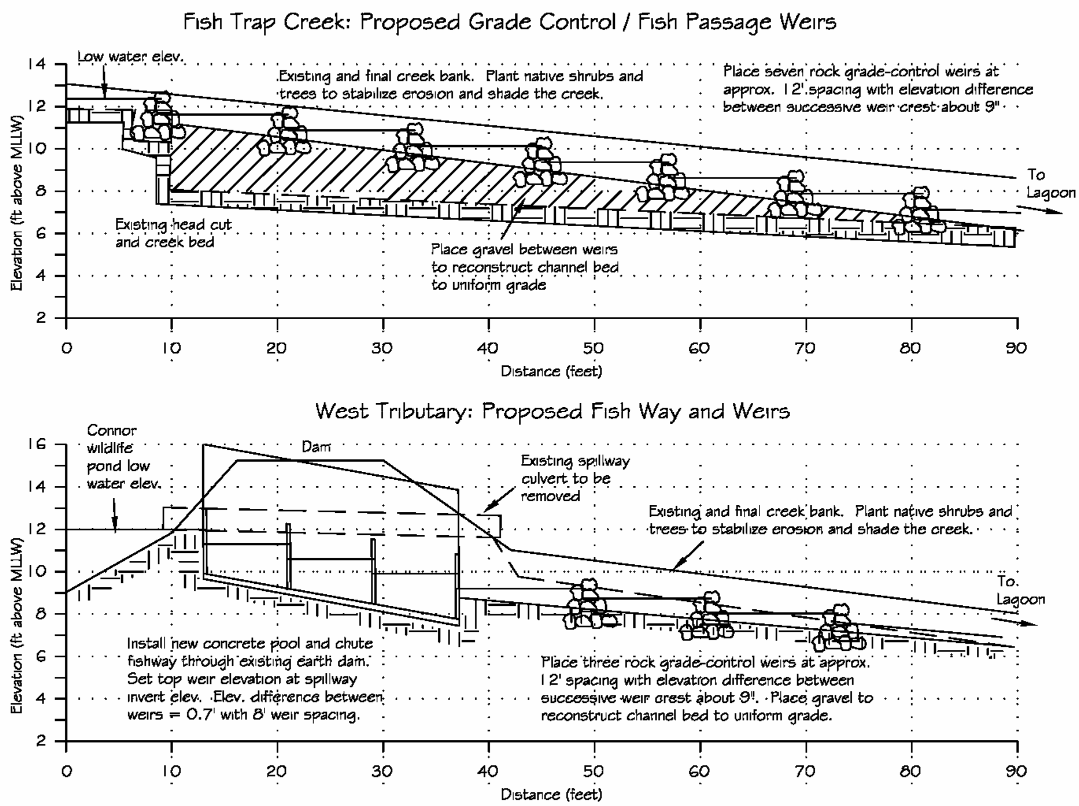


Figure 3.4: Fish Passage Barrier Removal Measures

Barrier Removal Measure #2: Fish Trap Creek Head Cut and Wildlife Pond Dam

In addition to the work on the Fish Trap Creek head cut, fish passage would be provided through the earth dam on the west tributary creek. A short pool-and-chute fishway would be constructed along the course of the creek through the outer face of the earthen dam to allow coho and chum salmon to swim from the lagoon into the wildlife pond during typical wet-season high water conditions. The fishway would consist of four V-notch weirs and pools to allow a climb from elevation about 9.0 feet above MLLW in the creek channel outside the dam to elevation about 12.0 feet above MLLW at the dam crest, which is the pond's spillway elevation. Maximum drop between weirs would be 0.7 feet.

The wooden V-notch weirs would be designed to control the pond outflow within allowable parameters for fish passage, while preserving a baseline water elevation in the pond so that it can continued to be used for water fowl and other wildlife. Depending on the condition of the creek channel downstream of the pond dam, a few log or rock grade controls may also be needed to gradually step the channel down to the level of the lagoon. Well-sorted gravel and large woody debris habitat features would be placed in the short (about 30 feet) reach of reconstructed channel. This alternative measure is illustrated in Figure 3.4.

### 3.2.4 Alternatives for Restoring Shading of Lagoon

Native trees and shrubs typical of the forest community that surrounded the lagoon prior to the 1860s will be planted along as much of the shoreline as the owner of the property is willing. The priority area for planting will be a forest buffer along the west shore, which is subject to the most heating affect from summer sunshine[6]. The buffer would start just above the elevation limit of the existing salt marsh and extend outward to a width determined either by the landowner or by the standards of a government-sponsored program

Typical plant species for the buffer would include sitka spruce, shore pine, red alder, willows, native rose, snow berry, Douglas spirea, and others. For the purposes of the evaluation of alternatives in Section 3.3, it will be assumed that 1,000 feet of shoreline on the west side of the lagoon will be planted in a 50-foot buffer, totaling 1.1 acres. Revegetation work would include five years of maintenance of the young plants, which will be particularly necessary because of the difficult tree growing conditions in Coveland soils.

### 3.2.5 Alternatives for Restoring Sediment Dynamics

On-going erosion will be substantially reduced or eliminated at the two areas that are believed to be currently the most active sources of sediment input into the estuary. The first erosion source, the headcut near the mouth of Fish Trap Creek, will be stabilized by installing grade controls and re-grading the banks, as described in Alternative 3.2.3. In addition, the steep, eroded sides of the channel downstream of the head cut would be graded back to form a more natural-appearing cross section that would accommodate expected 100-year design flows in the creek. A preliminary estimate of the quantity of grading is about 200 cubic yards. The re-graded bank areas would be planted with native shrubs to stabilize the soil.

The second erosion source, which is the cut bank along about 200 feet of the west shoreline of the lagoon immediately upstream of the outlet, will be stabilized by bank re-grading and bioengineered controls. About 125 cy of the cut bank will be excavated to grade the bank to a more gradual 2:1 slope. The new slope will be densely planted with salt-tolerant, high marsh plant species to stabilize the soil.

It is believed that the partial or complete restoration of tidal hydraulics in the outlet channel (Alternative 3.2.2) will reduce the scouring effect of the incoming tide along this cut bank area by reducing its velocity and redirecting it towards the center of the channel. The expected changes in erosion in this area would be modeled during the detailed design for the outlet restoration alternative to determine whether additional bank stabilization is necessary.

## *3.3 Habitat Benefits Analysis*

Each alternative measure was evaluated for its effectiveness in achieving the specific objectives identified in Section 3.1. The evaluation consisted of quantifying "habitat benefits" that could be expected from implementing each alternative measure, as compared with the "No Action"

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[6] The primary purpose of the tree buffer would be to shade the inter-tidal shoreline areas that are important for forage fish spawning and juvenile rearing. Because of the width of the lagoon, the trees would not be expected to have a significant shading and cooling effect on the lagoon's water itself.

alternative.[7] The evaluation was based on a methodology developed for the Skagit River estuary (Beamer et al, 2001) and subsequently used for US Army Corps of Engineers Section 206 estuary habitat restoration planning studies in the Puget Sound region (e.g. Tetra Tech, 2005).

The habitat benefits analysis followed a three-step process. In the first step, "weighted acreages" were calculated for the acreage of each habitat type in the Deer Harbor Estuary study area that would be restored or otherwise benefited by implementation of the various restoration measures. The acreage calculations were limited to the Cayou Valley Lagoon, the lagoon outlet channel, and the estuary (i.e. brackish water) portions of the two tributary creeks. The inner harbor was not included in the area calculations because none of the alternative measures would be implemented in it, even though they all would directly affect it.

**Table 3.3 Habitat Acreages Associated with Each Alternative Measure**

| Alternative Measure | Habitat Type, Weighting, and Acreage of Each Type | | | | Total Weighted Acreage |
|---|---|---|---|---|---|
| | Tidal Channel (3) | Mudflat (2) | Salt Marsh (1) | Freshwater Channel (1) | |
| No Action | 0.11 | 14.30 | 2.98 | 0.08 | 31.99 |
| 50-foot outlet channel (T1) | 0.11 | 14.30 | 2.98 | 0.08 | 31.99 |
| 82-foot outlet channel (T2) | 0.18 | 14.30 | 2.98 | 0.08 | 32.06 |
| 120-foot outlet channel (T3) | 0.26 | 14.30 | 2.98 | 0.08 | 32.14 |
| Remove channel fill and dredge new distributory channels (T4) | 0.42 | 13.88 | 2.98 | 0.08 | 32.08 |
| Remove fish passage barrier on Fish Trap Creek (FP1) | 0.11 | 14.30 | 2.98 | 0.08 | 31.99 |
| Remove fish passage barrier on both creeks (FP2) | 0.11 | 14.30 | 2.98 | 0.08 | 31.99 |
| Shoreline vegetation buffer (B) | 0.11 | 14.30 | 2.98 | 0.08 | 31.99 |
| Erosion/sediment source controls (S) | 0.11 | 14.30 | 2.98 | 0.08 | 31.99 |

Following the procedure in Beamer et al., the various habitat types were assigned a weighting factor depending on their relative productivity for salmon ecology. Tidal channel habitat was assigned a weighting factor of 3, mudflat habitat was assigned a factor of 2, and salt marsh and freshwater channel habitat were assigned weightings of 1. Table 3.3 shows the results of the calculation of weighted acreages for the study area.

The second step in the habitat benefits analysis was to assign a relative "score" to each alternative measure based upon the degree to which it would be expected to achieve the four specific habitat restoration objectives. For each objective, a numeric score ranging from 0 to 1 was assigned. The ranges of effectiveness - between the lowest score of "0" to the highest score

[7] For the purpose of this study, the four specific restoration objectives are collectively referred to as "habitat benefits."

of "1" - are defined for each specific objective in Table 3.4. Each alternative measure's scores are tabulated in Table 3.5.

**Table 3.4 Specific Objectives Scoring Criteria**

| Score | Description |
|---|---|
| | Restore Tidal Hydrology |
| 1 | Natural tidal exchange between Cayou Lagoon and the inner harbor. Sediment transport and channel formation is unconstrained. Natural transport of detritus. |
| | Tidal exchange, channel formation, and transport of sediment and detritus between the lagoon and the inner harbor is constrained by fill or other man-made obstructions. |
| 0 | No hydraulic connection between the lagoon and inner harbor. No transport of sediment or formation of tidal channels. |
| | Remove fish passage blockages at the mouths of the tributary creeks |
| 1 | Access to all aquatic habitat in the study area for both adult and juvenile fish is limited only by naturally-occurring conditions such as seasonal low flow or natural physical barriers. |
| | Aquatic habitats are infrequently accessible to fish due to high velocities, low flows, or physical barriers caused by man-made conditions. |
| 0 | Aquatic habitat within the study area is inaccessible to fish. |
| | Restore natural shading along the shoreline of the lagoon |
| 1 | The entire shoreline throughout the study area is shaded by at least a 50 foot-wide buffer of native shrub and tree species |
| | Portions of the shoreline are shaded by less than 50 foot wide buffer of native and/or non-native shrubs and trees. |
| 0 | Shoreline has little or no shading by trees and shrubs. |
| | Eliminate on-going accumulation of fine sediment in the lagoon |
| 1 | Erosion sources stabilized so that sediment accumulation in the estuary is in equilibrium with natural transport out of the estuary. |
| | Erosion in the estuary and watershed is stabilized to the extent that the rate of accumulation is substantially lower than the recent historical rate of 0.4 cm/year. |
| 0 | On-going erosion along shoreline and along tributary creeks causes accumulation of fine sediment in the lagoon and/or inner harbor at or near the recent historical rate of 0.4 cm./year. |

## Table 3.5 Habitat Units Generated by Each Alternative Measure

| Alternative Measure | Tidal Hydro-logy | Fish Passage | Shoreline Shade | Erosion / Sediment Control | Overall Quality Score | Total Weighted Acreage | Habitat Units | Change over No Action |
|---|---|---|---|---|---|---|---|---|
| No Action | 0.7 | 0.5 | 0.1 | 0.3 | 1.6 | 31.99 | 51.18 | 0 |
| 50-foot outlet channel | 0.8 | 0.6 | 0.1 | 0.45 | 1.95 | 31.99 | 62.38 | 11.20 |
| 85-foot outlet channel | 0.95 | 0.63 | 0.1 | 0.5 | 2.18 | 32.06 | 69.89 | 18.71 |
| 120-foot outlet channel | 1.0 | 0.63 | 0.1 | 0.5 | 2.23 | 32.14 | 71.67 | 20.49 |
| Dredge distributory channels* | 0.75 | 0.53 | 0.1 | 0.35 | 1.73 | 32.08 | 55.50 | 4.32 |
| Remove fish passage barrier on FT Creek | 0.7 | 0.65 | 0.1 | 0.4 | 1.85 | 31.99 | 59.18 | 8.00 |
| Remove fish barriers on both creeks | 0.7 | 0.7 | 0.1 | 0.4 | 1.9 | 31.99 | 60.78 | 9.60 |
| Shoreline vegetation buffer | 0.7 | 0.5 | 0.5 | 0.33 | 2.03 | 31.99 | 64.94 | 13.76 |
| Erosion / sediment source controls | 0.7 | 0.5 | 0.15 | 0.7 | 2.05 | 31.99 | 6558 | 14.40 |

*For the purposes of developing an incremental cost analysis, the benefits of this measure are calculated based on the assumption that it is carried out independently of any of the channel fill removal measures.

In the final step, the sum of each of each alternative measure's scores was multiplied by the measure's total weighted acreage to calculate the "habitat units" that would be expected be produced by implementing the objective. The habitat units are shown in Table 3.5. Table 3.5 also shows the change in habitat units relative to the No Action alternative that would result by implementing the various alternative measures.

# 4 Evaluation of Alternatives

## *4.1 Cost Effectiveness and Incremental Cost Analysis*

Planning-level cost estimates were developed for each of the eight alternative measures identified in Section 3.2. The cost estimates are shown in Table 4.1. Detailed cost breakdowns for each alternative are included in Appendix J.

**Table 4.1 Planning-level Cost Estimates for the Alternative Measures**

| Alternative Measure | Design & Management | Property Acquisition | Construction & Implementation | Total |
|---|---|---|---|---|
| ***Restore Tidal Hydraulics*** | | | | |
| Remove rock sill and replace existing bridge | $180,700 | $30,000 | $516,400 | $727,100 |
| Remove fill for 85’ channel and new 90’ bridge | $310,400 | $30,000 | $886,800 | $1,227,200 |
| Remove fill for 120’ channel and new 120’ bridge | $391,700 | $30,000 | $1,119,200 | $1,540,900 |
| Dredge 1800 LF of distributory channels in the lagoon | $44,500 | $11,000 | $89,000 | $144,500 |
| ***Remove Fish Passage Barriers*** | | | | |
| Grade controls at Fish Trap Crk head cut | $15,000 | $0 | $24,900 | $39,900 |
| Grade controls / fish way at Fish Trap Creek and west creek dam | $29,400 | $0 | $48,900 | $78,300 |
| ***Restore Shading around the Lagoon*** | | | | |
| Tree and shrub buffer along the west shoreline | $6,500 | $7,400 | $10,800 | $24,700 |
| ***Stabilize Erosion and Sedimentation*** | | | | |
| RE-grade and stabilize active erosion sources | $12,300 | $8,000 | $15,300 | $35,600 |

Various combinations of the alternative measures identified in Section 3.2 were evaluated for their cost-effectiveness in achieving the restoration objectives. Five alternatives that represent a range of the possible combinations from the “No Action” alternative to the most complex combination of measures are the following:

| | |
|---|---|
| NA | No Action |
| T1, FP1 | Remove riprap from outlet and install grade controls at Fish Trap Creek headcut |
| T2, FP1, B | Remove fill to widen outlet channel to 82 feet, install grade controls on Fish Trap Creek, plant tree buffer along west shore of lagoon |

T2, FP2, B, S — Remove fill to widen outlet channel to 82 feet, install grade controls at Fish Trap Creek and a fish way through the dam on the west creek, plant buffer and stabilize active erosion/sediment sources

T3, T4, FP2, B S — Remove fill to widen outlet channel to 120 feet, dredge 1800 feet of distributory channel in the lagoon, install grade controls at Fish Trap Creek and a fish way through the dam on the west creek, plant buffer and stabilize active erosion/sediment sources

For the purpose of this study, cost-effective alternatives were defined as those that can provide as much or more benefit, at lower cost, than other alternatives. "Benefit" was defined as incremental habitat units in excess of those provided by the "No Cost" alternative. Table 4.2 compares the anticipated benefits with the estimated cost associated with the five representative alternatives.

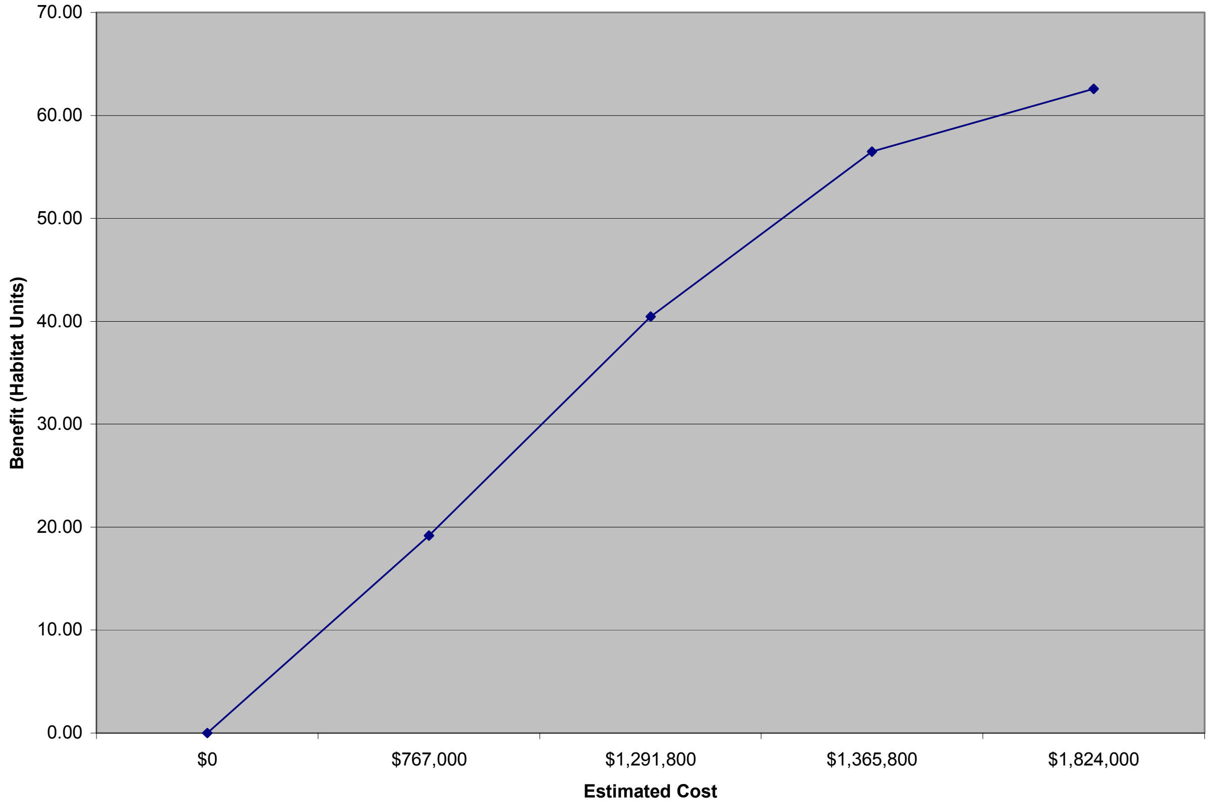
**Table 4.2 Comparison of Benefit and Cost of Five Representative Alternatives**

| Alternative Code | Description | Total Estimated Cost* | Benefit (Habitat Units) | Cost/Benefit |
|---|---|---|---|---|
| NA | No Action | $0 | 0 | NA |
| #1 (T1-FP1) | Remove riprap, new bridge, grade controls on FT Creek | $767,000 | 19.2 | $39,948 |
| #2 (T2-FP1-B) | Widen channel to 85', grade controls on FT creek, buffer | $1,267,100 | 40.47 | $31,920 |
| #3 (T2-FP2-B-S) | Widen channel to 85', grade controls and fishway on both creeks, buffer, erosion controls | $1,365,800 | 56.47 | $24,186 |
| #4 (T3-T4-FP2-B-S) | Widen channel to 120', dredge distributory channels, grade controls and fishway, buffer, erosion controls | $1,824,000 | 62.57 | $29,151 |

* The total planning-level cost estimates are listed as the sum of the cost estimates of the individual measures that make up each alternative. In reality, the total cost for implementing these combinations of measures would be somewhat less, reflecting a small savings in engineering, permitting, construction management, and mobilization / demobilization achieved by planning and implementing the measures as an integrated project, rather than as separate projects.

The costs and anticipated benefits of each alternative are plotted in Figure 4.1, below.

**Figure 4.1 Incremental Cost Analysis**




The plot shows the benefit – cost curve leveling out between the third and fourth alternative, indicating that the incremental benefit of additional output of "habitat units" peaks with the third alternative (T2-FP2-B-S). As shown in Table 4.2, the third alternative has the lowest cost to benefit ratio of $24,186 per habitat unit gained beyond the "no action" scenario.

## 4.2 Environmental Assessment of Alternatives

NEPA requires that the environmental impacts associated with implementing a range of proposed alternatives be compared with those expected from the No Action. Of the four alternatives identified in Section 4.1, three were selected for environmental assessment. These were: No. 1 (T1-FP1), No. 3 (T2-FP2-B-S) and No. 4 (T3-T4-FP2-B-S). Alternative No. 2 was dropped from consideration because its cost-effectiveness was intermediate between Nos. 1 and 3 and its components were similar in scope with Alternative No. 3.

Within the framework of the basic NEPA evaluation criteria specified in Title 40 CFR 1502.16, the following substantive issues were determined to be most relevant for comparing the impacts of the proposed Deer Harbor Estuary restoration alternatives.[8]

- Erosion and sedimentation
- Salt water intrusion in soil and drinking water supplies
- Estuary and nearshore plant life
- Fish and wildlife
- Shoreline conservation
- Land use / land ownership
- Transportation and utilities
- Historic and cultural resources
- Aesthetic qualities

Each of these issues is evaluated below.

### 4.2.1 Erosion and Sedimentation

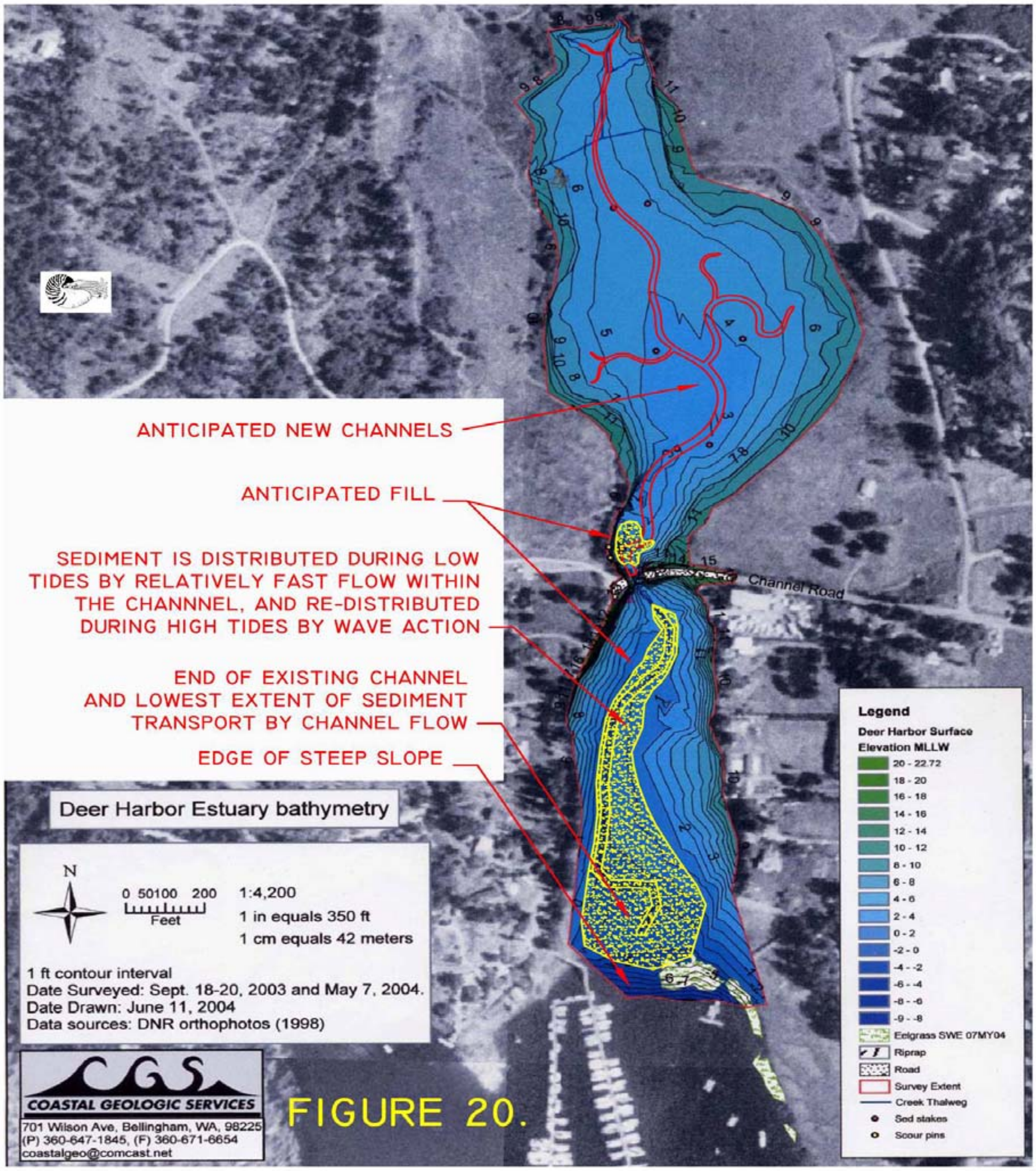
Environmental impacts resulting from erosion and sedimentation must be distinguished between on-going, long-term impacts and shorter-term impacts. Over the long term, all three alternatives will result in less bank erosion and accumulation of sediment in the Cayou Valley Lagoon than under the No Action alternative. Over the shorter term, however, the removal of fill material from the lagoon outlet will result in varying degrees of mobilization of the fine sediment that has accumulated in the lagoon over the past half century or more.

Under both Alternatives No. 1 and No. 3, the removal of the two-foot high rock sill from under the bridge will allow the outlet channel to gradually erode back up into the lagoon until it reaches a geomorphic equilibrium with the channel elevation and slope in the inner harbor. Preliminary modeling presented in Appendix D suggests that approximately 1,500 cubic yards of fine sediment would be mobilized over a period of six months to one year following removal of the rock sill. Of this, about 350 cy is expected to be silt-sized and would be transported as suspended sediment out into the Outer Harbor and beyond. The remaining 1,150 cy is expected to sand-sized or larger. This fraction would be transported as bed load into the inner harbor, where it would be expected to settle out along the edges of the main channel. The average depth of accumulation of this coarser sediment is estimated to about 0.19 feet (see Appendix D). Figure 4.2 illustrates a likely sediment mobilization scenario. The effect of this sediment on the biota of the inner harbor is evaluated in Sections 4.2.3 and 4.2.4.

Alternative No. 3 may result in somewhat less mobilization of sediment because it will result in a much larger channel cross section (approx. 290 square feet at MHHW compared with approx. 185 square feet for Alternative 1), which would allow the tidal prism to flow into and ebb from the lagoon at lower velocity and, therefore, with less scour. Likewise, the scour effect of the incoming tide along the active erosion area along the west shoreline of the lagoon would be reduced or eliminated because of the lower tidal flow velocity and the bioengineered bank stabilization included in the alternative.

[8] Analysis of these substantive issues would also be required under the Washington State Environmental Policy Act (SEPA) rules, Chapter 197-11 WAC.

**Figure 4.2 Estuary Forecast Conditions**




Alternative 4 would take a pro-active approach to sediment mobilization by dredging up to 2,000 cubic yards of fine sediment to form distributory channels in the bed of the lagoon. Temporary mobilization of sediment would be greater during construction (dredging) than the other alternatives, but the on-going mobilization of sediment from the lagoon would be minimized, since the new distributory channels would be designed to have a geomorphically stable condition.

### 4.2.2 Salt Water Intrusion

The degree of salt water intrusion caused by any of the alternatives would not be expected to increase significantly over the No Action (existing condition) scenario. Under each alternative, the tidal prism in the lagoon would not change very much. The far greater change would occur in the dynamics of the tidal flow, with the lagoon filling more gradually than it does now and emptying more quickly. The net static head of salt water in the lagoon would not differ significantly from that of the existing condition, so there would not be expected to be a significant difference in the existing degree of salt water intrusion.[9]

### 4.2.3 Estuary Plant Communities

The primary impact on estuary plant communities that would result from implementing the alternatives is the affect of increased turbidity on eelgrass beds at the mouth of the inner harbor. The short to medium-term mobilization of sediment under Alternative No. 1 and No. 3 would result in increased turbidity in the water column of the ebb tide from the lagoon. Currently, the condition of the eelgrass does not appear to be limited by level of submarine light in the water column. Based on turbidity impacts observed at other locations in the San Juan Islands, however, it is probable that sediment mobilization will result in some degree of shade-related damage to the eelgrass for a season or two until the sediment mobilization stabilizes.

Detailed modeling of sediment dynamics would be required to determine the expected turbidity concentration at the eelgrass beds, and, consequently, the expected impact on the plants. The impacts on eelgrass due to sediment mobilization would be less under Alternative No. 4, since the amount of sediment that would mobilize is expected to be far less.

Currently, a small (about 1 square meter) patch of eelgrass grows in a sub-tidal scour hole in the lagoon outlet channel just north of the existing bridge. Under all three of the alternatives, the restoration of a more-natural tidal flux and a more-natural outlet channel morphology would most likely result in the gradual filling of this scour hole and, consequently, the elimination of the artificial sub-tidal conditions that allow the existence of the small eelgrass bed at this location. The small patch of eelgrass, therefore, would be lost.

Planting of a shoreline vegetation buffer as part of Alternatives No. 3 and 4 would result in the eventual conversion of about 1.1 acres of pasture to a native shrub and tree plant community. As part of the detailed project design, a botanical survey will be done to determine whether there are any ESA-listed plants or other plant species of concern in the buffer area, and, if so, a protection and/or mitigation plan will be developed accordingly.

### 4.2.4 Fish and Wildlife

The primary adverse impacts to fish and wildlife resulting from implementation of the proposed alternatives are 1) destruction of the small rocky inter-tidal habitat that has evolved on the rip rap under the bridge and 2) temporary damage to oysters and other shellfish beds in the inner harbor due to sediment mobilization.

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[9] The exception would be at very low tide, when the lagoon would empty completely, compared to the current condition in which a small quantity of water remains trapped in the deep area just north of the bridge.

As part of each alternative, the approximately 4,500 square feet of rip rap channel armoring that was placed under the existing bridge would be removed to allow the channel to re-adjust to a more natural condition. The unique, artificial habitat that the rip rap creates for anemones, sea stars, barnacles, cultivated oysters, and other animals would be destroyed.

As with the adverse impacts to eelgrass, the impact to the cultivated oyster beds in the inner harbor and the remaining small natural beds of mussels depends on the degree of sediment mobilization that would occur under each alternative. Without implementing mitigation measures (Section 5.2), it is likely that under Alternative No. 1 and No. 3, the cultivated oyster beds, which are the beds nearest to the lagoon outlet, would be partially or wholly covered by sediment for one or two seasons after implementation of the project. The impacts due to sediment mobilization would be less under Alternative No. 4.

The excavation of the channel proposed in each of the alternatives will also temporarily impact the relatively small fish populations that currently utilize the lagoon due to general construction-related disturbance.

Alternatives No. 3 and 4 may slightly lower the level of the artificial wildlife pond on the west tributary creek during the rainy season. The fishway that is proposed as part of these two alternatives would replace the existing overflow standpipe arrangement. Although the notch elevation of the uppermost weir would be set at the same elevation as the invert of the existing overflow pipe, the fishway would have a greater flow capacity than the pipe. Consequently, during the wet season, the water level in the pond may not be as high as it is under the existing (No Action) condition. During the dry season, however, the water level would be the same as the current condition and the pond will still provide the same amount of freshwater wetland habitat to waterfowl and other wildlife.

Temporary impacts to terrestrial wildlife, including potential threatened or endangered species in the vicinity of the site, may be expected from construction-related noise and traffic. In general, Alternative No. 1 would be expected to have the lowest level of construction impacts because the scope of construction work is the least. Likewise, Alternative No. 4 would be expected to have the greatest level of construction-related noise and disturbance because its scope of construction activities is greatest.

### 4.2.5 Shoreline Conservation

Under the Washington Shorelines Management Act, land within 200 feet of the shoreline of Cayou Valley Lagoon is designated for “conservation” purposes and land within 200 feet of the shoreline of the inner harbor is designated for “rural” purposes. Each of the proposed alternatives would be expected to be consistent with the allowable uses for these two Shoreline Master Program designations.

### 4.2.6 Land Use/ Land Ownership

Each alternative might require the acquisition of about 2.0 acres of public right-of-way along Potlatch Drive and Lagoon Road in order to provide a temporary traffic detour route during replacement of the bridge. This impact can be avoided if the new bridge can be constructed offset from the existing bridge alignment, allow the existing bridge to remain open during construction. Depending on the wishes of the landowner, planting of the 1.1-acre tree buffer and stabilization of the active erosion areas under Alternative No. 3 and No. 4 may require a land rental agreement or other property use agreement. It is likely that the proposed planting of a buffer and bank stabilization activities under these two alternatives would be consistent with the permanent conservation easement that currently regulates the use of the property in question.

Operation of the fishway at the mouth of the west creek that is proposed under Alternative No. 3 and No. 4 would require a land-use agreement with the landowner to ensure that water flow in the fishway is not interrupted during fish migration season.

### 4.2.7 Transportation and Utilities

Each of the alternatives includes the replacement of the Channel Road Bridge, which currently is the only public right-of-way connecting the southwest tip of Orcas Island. Current construction plans anticipate off-setting the new bridge from the existing bridge alignment so that at least partial traffic access can be maintained throughout the project. If this alignment proves infeasible, then traffic would have to be detoured along a temporary right-of-way around the west side of the lagoon on Lagoon Road and Potlatch Road. This route is 1.4-mile longer and less convenient than the current route between the center of Deer Island community and the southwest end of the island. The residents of the three or four houses located along the detour route would be inconvenienced by traffic dust and noise during this time.

Each of the alternatives will require replacing the public utility lines that currently cross the existing Channel Road Bridge, which will involve a brief interruption of utility service.

### 4.2.8 Historic and Cultural Resources

The dredging of new estuary distributory channels as part of Alternative No. 4 potentially could impact a feature that has tentatively been identified as a rock weir for trapping fish. The rock weir, which is located in Cayou Lagoon about 250 feet northeast of the outlet, is believed to have been constructed by natives some time before white settlement of the area in the 1860s. Further research would be needed to evaluate this feature and, if warranted, the dredging plan would be designed to minimize impacts to it. Alternatives No. 1 and No. 3 would not be expected to impact any historic or cultural resources.

### 4.2.9 Aesthetic Qualities

The rustic appearance of the exiting Channel Road Bridge and the open pasture views surrounding Cayou Valley Lagoon are valuable scenic assets to the Deer Harbor community. While great care will be taken in the design of each of the proposed alternatives to ensure that the appearance of the new bridge reflects Deer Harbor's bucolic scenery, the bridge proposed in Alternative No. 1, by virtue of having the smallest footprint, will make the least change in the community scenery. Alternative No. 4, by virtue of having the largest footprint, will cause the largest change in the area's scenery.

The tree buffers proposed in Alternatives No. 3 and No. 4 will change the open pasture scenery of the west side of the lagoon when they grow to full height. While the view of the lagoon will still be unobstructed from the east side, where the majority of the existing houses and future housing lots are, the general open appearance of the fields west of the lagoon will be lost.

Restoring the natural, unobstructed ebb and flow of the tide will result in the lagoon emptying at each low tide. The existing appearance of the lagoon as a more or less permanent pool of water will change to that of a natural estuary system where mud and sand flats are exposed and flooded again during each cycle of the tide. Table 4.3 summarizes environmental impacts associated with each alternative.

**Table 4.3 Summary and Comparison of Environmental Impacts**

| Impact | Alternative 1 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Erosion and sedimentation | Potential to mobilize roughly ___ cy of fine lagoon sediment over 6 to 12 months. Reduces but does not eliminate lagoon bank erosion. | Potential to mobilize roughly ___ cy of fine lagoon sediment over 6 to 12 months. | Greater temporary sedimentation during construction, but on-going mobilization of sediments would be reduced or eliminated. |
| Salt water intrusion | Not expected to differ from the No Action alternative. | Not expected to differ from the No Action alternative. | Not expected to differ from the No Action alternative. |
| Estuary plant communities | Sediment mobilization may harm eelgrass in the inner harbor for 1 or 2 seasons. Loss of small eelgrass patch north of bridge. | Sediment mobilization may harm eelgrass in the inner harbor for 1 or 2 seasons. Loss of small eelgrass patch north of bridge. | Reduced sediment mobilization will minimize harm to inner harbor eelgrass. Loss of small eelgrass patch north of bridge. |
| Fish and wildlife | Loss of small inter-tidal habitat under bridge. Sediment may harm shellfish beds for 1 or 2 seasons. | Loss of small inter-tidal habitat under existing bridge. Sediment mobilization may harm shellfish beds for 1 or 2 seasons. | Loss of small inter-tidal habitat under existing bridge. Harm to shellfish beds will be minimized. |
| Shoreline conservation | Consistent with shoreline use classifications. | Consistent with shoreline use classifications. | Consistent with shoreline use classifications. |
| Land use / land ownership | Acquisition of 2 acres of right of way for traffic detour route. | Will require land use agreements for buffer and operation of the west creek fishway. Purchase 2 acres of ROW for traffic detour. | Will require land use agreements for buffer and operation of the west creek fishway. Purchase 2 acres of ROW for traffic detour. |
| Transportation and utilities | 1.4 mile detour around lagoon during bridge construction. | 1.4 mile detour around lagoon during bridge construction. | 1.4 mile detour around lagoon during bridge construction. |
| Historic and cultural resources | No impacts anticipated | No impacts anticipated | Dredging distributory channel may damage the rock fish weir in the lagoon. |
| Aesthetic qualities | Mud and sand flats exposed in lagoon on each low tide. Minimal other impact with aesthetic bridge design. | Mud and sand flats exposed. Larger bridge footprint will change appearance of lagoon outlet. Forest buffer will reduce open appearance of fields west of the lagoon. | Tidal flats exposed. Larger bridge footprint will change appearance of lagoon outlet. Forest buffer will reduce open appearance of fields west of the lagoon. |

# 5 Recommended Alternative

Alternative No. 3 was chosen as the recommended project alternative because it is believed to provide the best balance of cost versus benefit without causing excessive impacts to the environment. The cost benefit analysis and environmental impact assessment are detailed in Chapter 4. A detailed description of the alternative and considerations for mitigating its impact on the environment are discussed below.

## *5.1 Description of the Recommended Alternative*

About 940 cubic yards of rock rip rap and fill material would be removed from the outlet channel to widen it to about 85 feet at MHHW, which is estimated to be the approximate width of the channel shown in the 1895 CGS chart. Tidal exchange would eventually form the resulting channel into an equilibrium cross section of about 290 square feet at the mean higher high tide elevation, compared with the existing channel area of about 100 square feet. The new channel would connect with the inner harbor at the natural slope of the harbor channel, about 0.005 ft/ft. It is anticipated that over a period of six months to one year, the new channel would migrate upstream into the lagoon and eventually reach a stable, uniform slope from the head to the mouth of the estuary. Second order channels that “feed into” the main channel would eventually develop.

The Channel Road Bridge would be replaced with a new bridge measuring approximately 90 feet long by 29 feet wide. The new bridge would be a concrete structure supported mid span by one set of concrete or steel pilings and would be off-set slightly to the north of the existing bridge alignment. Alternatively, the new bridge would have the same alignment as the existing bridge, in which case traffic would be detoured on a temporary right of way along Potlatch Road and Lagoon Road during construction. A schematic drawing of the bridge and the proposed removal of rock armoring is shown in Figure 3.1. A proposed conceptual bridge design is presented in Appendix L.

Seven rock and/or log grade controls would be constructed along about 75 feet of Fish Trap Creek in the vicinity of the head cut to gradually raise the channel grade from elevation 6.0 feet above MLLW at the mouth to about elevation 11.0 feet above the current head cut. Each grade control would be set about 0.7 feet above the preceding one, which is the maximum vertical drop recommended by WDFW for allowing fish passage for juvenile coho and chum salmon (WDFW, 2000). Well-sorted gravel and large woody debris habitat features would be placed in the reconstructed channel.

Fish passage would also be provided through the earth dam on the west tributary creek. A short pool-and-chute fishway would be constructed along the course of the creek through the earthen dam to allow fish to swim from the lagoon into the wildlife pond during typical wet-season high water conditions. The fishway would consist of four V-notch weirs and pools to allow a climb from elevation about 9.0 feet above MLLW in the creek channel outside the dam to elevation about 12.0 feet above MLLW at the dam crest, which is the pond’s spillway elevation. Maximum drop between weirs would be 0.7 feet. The V-notch weirs would be designed to control the pond outflow within allowable parameters for fish passage, while allowing a baseline water elevation in the pond so that it can continued to be used for wildlife. Depending on the condition of the creek channel downstream of the pond dam, a few log or rock grade controls may also be needed to gradually step the channel down to the level of the lagoon. Well-sorted gravel and large woody debris habitat features would be placed in the short (about 30 feet) of reconstructed channel

Native trees and shrubs typical of the forest community that surrounded the lagoon prior to the 1860s will be planted along as much of the shoreline as the owner of the property is willing. The priority area for planting will be a forest buffer along the west shore, which is subject to the most heating affect from summer sunshine. The buffer would start just above the elevation limit of the existing salt marsh and extend outward to a width determined either by the landowner or by the standards of a government-sponsored program. For the purposes of this feasibility study, it is arbitrarily assumed that the buffer width will average 50 feet.

Typical plant species for the buffer would include sitka spruce, shore pine, red alder, willows, native rose, snow berry, spirea, and others. While the exact acreage of the buffer will depend on the landowner's wishes, it is assumed that about 1,000 feet of shoreline on the west side of the lagoon will be planted in buffer, totaling 1.1 acres. Revegetation work would include five years of maintenance of the young plants, which will be particularly necessary because of the difficult growing conditions in Coveland soils.

On-going erosion will be substantially reduced or eliminated at the two areas that are believed to be the most significant sources of sediment input into the estuary. The first erosion source, the headcut near the mouth of Fish Trap Creek, will be stabilized by installing grade controls and re-grading the banks. The steep, eroded sides of the channel downstream of the head cut would be graded back to form a more natural-appearing cross section that would accommodate the creek's expected 100-year design flows. A preliminary estimate of the quantity of grading is about 200 cubic yards. The re-graded bank areas would be planted with native shrubs to stabilize the soil.

The second erosion source, which is the cut bank along about 200 feet of the west shoreline of the lagoon immediately upstream of the outlet, will be stabilized by bank re-grading and bioengineered controls. About 125 cy of the cut bank will be excavated to grade the bank to a more gradual 2:1 slope. The new slope will be densely planted with salt-tolerant plat species native to high marsh habitat to stabilize the soil.

## *5.2 Mitigation Measures*

The following mitigation measures are anticipated for reducing the environmental impacts of the proposed alternative. Further mitigation measures may be developed as part of the project permitting process.

### 5.2.1 Sediment and Erosion

A detailed temporary erosion and sedimentation control (TESC) plan will be developed to minimize impacts from sediment release during construction-related earthwork. While the details of the plan will be developed during the permitting phase of the project, it is anticipated that it will include the following:

- To the extent practicable, excavation below the mean high tide elevation will be done only during low tide periods, when the outlet channel, Fish Trap Creek headcut area and other affected areas are naturally dewatered.
- Where excavation must be done while the lagoon has water in it, the outlet area will be isolated, to the extent practicable, by sheet piling coffer dams.
- Silt fencing and other BMPs will be used to isolate excavation areas.
- All disturbed bank soils will be stabilized with native grasses and/or salt marsh plants following excavation.
- Appropriate monitoring of turbidity in the estuary will be done concurrently with construction in order to determine the effectiveness of mitigation measures. Monitoring results will be used in an adaptive management process to revise the mitigation measures as needed.

### 5.2.2 Eelgrass

During and immediately after construction, the eelgrass beds at the mouth of the inner harbor will be protected by implementing temporary turbidity control measures, such as surrounding them with submerged silt curtains. For the first year following completion of construction, the eelgrass beds will be monitored for PAR and general health on a quarterly basis. If the on-going mobilization of fine sediment resulting from the process of the estuary channel re-establishing itself in the lagoon is shown to be damaging the eelgrass, appropriate adaptive management responses, such as installing long-term silt curtains, will be taken.

To compensate for the loss of the small (1 $m^2$) eelgrass bed in the lagoon north of the outlet as well as any loss that might occur in the larger beds at the mouth of the inner harbor, eelgrass will be propagated at a larger area within the estuary where growing conditions are suitable.

### 5.2.3 Fish and Wildlife

Impacts to fish and shellfish in the lagoon and inner harbor will be minimized to the extent practicable by implementing the TESC plan outlined above. Construction will be done during an appropriate "fish window" as determined by state and federal regulatory agencies during the project permitting process. Likewise, the timing and methods of construction will be designed to minimize construction-related impacts to terrestrial wildlife, such as bald eagles and other species of concern.

During and immediately after construction, the cultivated oyster beds located immediately south of the lagoon outlet will be protected by implementing temporary turbidity control measures, such as surrounding them with submerged silt curtains. For the first year following completion of construction, the condition of the shellfish beds will be monitored on a similar schedule as the eelgrass monitoring to assess damage that may occur. If on-going mobilization of fine sediment from the lagoon is shown to be damaging them, appropriate adaptive management responses, such as installing long-term silt curtains, will be taken. The owner of the oysters will be compensated for losses that may occur and will be assisted in re-establishing them after the lagoon sediments stabilize.

An attempt will be made to re-create the small area of artificial inter-tidal rocky habitat that will be removed from under the bridge as part of the channel widening task. If allowed by permitting officials, some of the riprap removed from under the bridge may be placed along a nearby mudflat area to recreate the elevation and other conditions that currently exist under the bridge.

### 5.2.4 Traffic

Ideally, construction of the new bridge would be scheduled for the winter off-season, when the volume of traffic in Deer Harbor drops significantly. However, the considerations of fish and wildlife "windows" and daylight low tide cycles probably will require that work be done during the late summer or early fall. In order to minimize the disruption of traffic, the existing bridge will be kept open during construction as much as possible. If the final construction plan necessitates detouring traffic around the west side of the lagoon, attempts will be made to reduce traffic impacts along the detour route by implementing such measures as re-grading the existing narrow and bumpy road, road watering to control dust, and/or installing temporary view fences at affected house sites.

### 5.2.5 Aesthetics

Extensive public input will be sought during the bridge design process so that the new bridge reflects the scenic aesthetic qualities of the Deer Harbor community. Likewise, input will be sought from owners of property whose views will be affected by the tree buffer, so that the tree planting scheme can be designed in a way that minimizes the blockage of views. The daily tidal exposure of the lagoon's mud flats and sand flats will be a permanent change in the area's existing aesthetic appearance for which no mitigation is proposed.

# 6 Summary and Recommendations

## *6.1 Summary*

The Deer Harbor Estuary is the largest estuary on Orcas Island, Washington. The estuary consists of four distinct areas: the mouths of two tributary creeks, the Cayou Valley Lagoon, the lagoon's outlet channel at the Channel Road Bridge, and the inner harbor. Up until the mid 20th Century, the estuary supported a chum and coho salmon run as well as native oyster beds. Beginning in the 1860s, forest clearing and development in the Deer Harbor watershed, manipulation of the tributary streams and, especially, the construction of the Channel Road Bridge altered the freshwater hydrology, vegetation communities, sediment dynamics, and tidal flow patterns in the estuary. These impacts have led to the elimination of shellfish populations in the lagoon, elimination of salmon rearing and spawning habitat in the tributaries, and degradation of salmon feeding habitat in the estuary.

The general goal for restoring estuary habitat functions at the Deer Harbor Estuary is to correct, to the extent practicable, the man-made conditions that have caused the degradation of the estuary's salmon habitat and overall aquatic ecology. Four specific objectives for meeting the general goal were identified:

1. Remove fish passage blockages at the mouths of the tributary creeks
2. Restore natural shading along the shoreline of the lagoon
3. Eliminate on-going accumulation of fine sediment in the lagoon
4. Restore tidal hydraulics and sediment transport in the lagoon

Several alternative measures were identifying for achieving the project objectives. The suite of alternative measures represents a range of technically-feasible actions that, when implemented individually or in combination with other actions, would likely achieve the four project objectives. The measures are the following:

- No Action
- Remove the rip rap sill under the bridge (T1)
- Remove bridge fill to widen the outlet channel to its 1895 width (T2)
- Remove all fill from the channel (T3)
- Remove all fill and dredge distributory channels in the lagoon (T4)
- Remove the fish passage barrier at the mouth of Fish Trap Creek (FP1)
- Remove the fish passage barriers at the mouths of both creeks (FP2)
- Plant about 1000' of shoreline in a vegetation buffer (B)
- Stabilize active bank erosion/sedimentation areas (S)

Each alternative measure was evaluated for its effectiveness in achieving the specific objectives. The evaluation consisted of quantifying "habitat benefits" that could be expected from implementing each alternative measure, as compared with the "No Action" alternative.

Various combinations of the alternative were then evaluated for their cost-effectiveness in achieving the restoration objectives. Five alternatives that represent a range of the possible combinations from the "No Action" alternative to the most complex combination of measures were evaluated. An incremental cost analysis indicated that Alternative No. 3 (T2-FP2-B-S) was optimal from a cost-effectiveness standpoint. The planning level cost estimate for implementing Alternative No. 3 is $1,365,800.

The alternatives were then evaluated for the environmental impacts that would likely be associated with their implementation. The following substantive issues were determined to be most relevant for comparing the impacts of the proposed alternatives:

- Erosion and sedimentation
- Salt water intrusion in soil and drinking water supplies
- Estuary and nearshore plant life
- Fish and wildlife
- Land use / land ownership
- Transportation and utilities
- Historic and cultural resources
- Aesthetic qualities

Alternative No. 3 was chosen as the recommended project alternative because it is believed to provide the best balance of cost versus benefit without causing excessive impacts to the environment. In brief, Alternative No. 3 consists of excavating about 940 cubic yards of rock rip rap and fill material from the outlet channel to widen it to about 85 feet at mean higher high water tidal level. The Channel Road Bridge would be replaced with a new concrete bridge measuring approximately 90 feet long by 29 feet wide. It is anticipated that over a period of six months to one year after removing the fill, natural tidal exchange would establish a geomorphically-stable network of first and second order channels in the outlet and upstream into the lagoon.

The fish passage barrier at the Fish Trap Creek head cut would be removed by constructing a series of rock and/or log grade controls along about 75 feet of the channel. The grade controls would raise the channel grade from elevation 6.0 feet above mean lower low water at the mouth to about elevation 11.0 feet above the current head cut, allowing for upstream fish passage for juvenile coho and chum salmon. Fish passage would also be restored past the barrier on the west tributary creek by constructing a short pool-and-chute fishway through the outer face of the earthen dam of the wildlife pond. The fishway's V-notch weirs would be designed to control the pond outflow within allowable parameters for fish passage, while allowing a baseline water elevation in the pond so that it can continued to be used for wildlife.

Native trees and shrubs typical of the forest community that surrounded the lagoon prior to the 1860s will be planted along approximately 1000 feet west shoreline. The buffer would start just above the elevation limit of the existing salt marsh and extend outward to a width determined either by the landowner or by the standards of a government-sponsored program. Finally, on-going erosion will be substantially reduced or eliminated at the two areas that are believed to be the most significant sources of sediment input into the estuary. The steep, eroded cut banks near the mouth of Fish Trap Creek and along the west shoreline of the lagoon immediately upstream of the outlet will be graded back to form stable slopes and then planted with salt-tolerant native plant species to stabilize the soil. A total of about 325 cubic yards of grading is anticipated.

Several mitigation measures are proposed to reduce the environmental impacts that may result from implementing the proposed alternative. Further mitigation measures may be developed as part of the project permitting process.

## 6.2 Recommendations

The recommended plan, as documented in this study, has been developed to the conceptual design level. As the project progresses from the feasibility study through the final design and permitting stages, there are several engineering and ecological issues that must be considered in more detail. These issues include but are not necessarily limited to the following.

- A detailed geotechnical investigation must be completed in order to develop the design for the foundations of the new Channel Road Bridge.

- A detailed design of the new Channel Road Bridge must be developed based on the architectural conceptual drawings completed as part of this study.

- Detailed sediment flux modeling should be conducted to predict the quantity and distribution patterns of fine sediment that will be mobilized from the lagoon after construction. Based on the results of the modeling, an ecological analysis of the mobilized sediment's impact on shellfish beds and eelgrass in the inner harbor must be completed, including a detailed plan for mitigation, restoration, and/or compensation for damages to these resources.

- A biological assessment (BA) must be completed to determine the project's likely affect on ESA-listed species. Based on the results of the BA, the project proponents will negotiate with state, federal, and tribal biological resource management agencies to develop plans for reducing construction related impacts on listed species, including determination of the construction timing window.

- The project proponent must negotiate with the owner (The Conner Family) and the conservation easement holder (The San Juan County Lank Bank) of the land surrounding the lagoon for approval for installation of the forest buffer and removal of the fish passage barriers.

- The proponent must finalize a plan for providing traffic access to the southwest tip of the island during replacement of the bridge. Tentatively, the plan might need to include acquisition of a temporary right-of-way for public traffic on Lagoon Road and Potlatch Road.

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# Public Comment to Draft Report

## Deer Harbor Estuary Meeting June 21
## Deer Harbor Community Club

1:10 Meeting opened by Joe Gaydos with an overview of the project

1:20 Russell Barsh talked about the archeology of the area, the historical fish trap and evidence that there was a significant fishery using the Deer Harbor estuary. There is evidence that there was a year-round source of food, and that there were shellfish and resident fish. The question he tried to answer was: has the harbor become less productive over the years? He has a program called the Samish Stewards that looked a broad cross section of scientific evidence including the upland hydrology as well as conditions in the estuary. His conclusion was that there is less water in the creek system than previously, and his recommendations include looking at two areas with dams and a roadway that is blocking flow from a wetland into the creek. Another recommendation was to increase vegetative cover to reduce the amount of evaporation taking place in the watershed.

1:45 Jim Johannessen spoke about his results which included work starting in 2003, and touched on topography, historical shoreline change and sedimentation and erosion. Jim looked for older plans, and maps. In the 1880's a map was map that showed the neck of the estuary to be 120" wide, and it is now 50'. Rock was placed under the bridge, and the estuary shows evidence of filling with sediment at a greater rate than would be expected. The vegetation line indicated that the estuary is not growing or shrinking, but generally staying the same shape, but it is filling. There is some erosion immediately upstream from the bridge, there is 20 ft. of recession in that area which is a significant erosion area. The rock under the bridge is essentially creating a pond, and cores show that sedimentation has increased. If the bridge span were widened and the rock removed, the resulting flushing of sediment is unlikely to extend out to the eelgrass beds in the outer estuary.

2:00 Tom Maul started his intro by talking about the scope of the project and that included in that was the citizen input to the design. He asked questions of the audience, and introduced the questions they had formed in their process of coming up with the design.

2:05 Rob Hutchison talked about the 4 qualities that they (Hutchinson and Maul) looked at, the site, education, community and building. They focused on the opportunities to emphasis the site.

2:10 Tom Maul talked about the design they had come up with, and the qualities and the materials. He showed design drawings.

2:30 John Van Lund talked about the specifics of bridge design per the County, and some of the history of the bridge itself. Notably, in 1956, the county proposed filling the channel with road fill, leaving only a culvert to connect the lagoon with the Inner Harbor. He talked about his application for a Federal "BRAC" Grant to pay for the bridge replacement, and the timeline for that process which is within 6 years. He also stated that the bridge could be narrower and shorter, and that is could include steel, but SJCDPW strongly prefers concrete for ease of maintenance. (85% of bridges in WA are concrete). The bridge width must be in 4-foot increments (e.g. 28' or 32') since that is the available deck panel size. Safety on the bridge would naturally be a priority for the County; he strongly recommends a "T" intersection at the west end so that east-bound traffic must completely stop before entering onto the bridge. The WSDOT bridge inspection that was done in January 2005 showed that the bridge is currently structurally sound and should be serviceable for another 5 to 10 years if necessary.

## Questions and Comments from the Community

1. Question: (Karen Hutchins) What is the reason for widening the bridge? Are plans for future community development and growth dictating it? Response: (John Van Lund) No, the width of the bridge is dictated by the width of standard deck panels which come in 4 ft. widths, so it can be 20', 24', 28, or 32' wide. He recommends a minimum width of 28 feet to allow for a wide shoulder.

2. Question: (Craig Wier) Parking is a problem in Deer Harbor. Will the proposed interpretive center and/or information displays at the bridge require additional parking facilities? Response: (John Van Lund) There is no plan for parking facilities near the bridge.

3. Question (Michael Durland): What exactly is the status of "REED"? Is it a registered non-profit organization? Response (Ken Brown). No. It's simply an informal organization of people interested in restoring the ecology of Deer Harbor.

4. Question (Michael Durland): Does the San Juan Land Bank's conservation easement on the Connor property have a cancellation clause that is triggered if "species of concern" are impacted or lost? If so, what are the species of concern? The feasibility study did not address this issue. Response: (Tom Slocum) The project team is unaware of this issue and will look into it.

5. Question (Michael Durland): What will be the impacts from release of sediment due to widening and deepening the channel, particularly to oyster beds in the vicinity of the bridge? Response: (Jim Johannessen) We will not know until we receive the results of the sediment transport evaluation, however, the impacts are expected to be relatively low, and re-deposition of sediment will likely occur well downstream of the bridge area where the tidal flow velocity will be lower.

6. Question (Michael Durland): Why was the Deer Harbor Marina not included in the study area? Response: (Jim Johannessen) Because it was beyond the anticipated effect of the bridge replacement project. Also, the team does not think that water quality problems that may or may not be associated with the operation of the marina are relevant in terms of estuary geomorphology.
7. Comment (Michael Durland): Requests to review the final draft before it is released to the public. Response (Tom Slocum and Robin Clark): The project team will consider this request.

8. Comment (John Riberg): The draft report could not be downloaded from the website. Response (Robin Clark) We believe that it is available, and that it will also be put up on the REED website.

9. Question (Mike Douglas): How large was the native population? Response: (Russell Barsh) it wasn't possible to make any kind of estimates because the SRFB grant did not fund an archaeology survey that was proposed. Anecdotally, a similar pre-historic fish trap that has been identified in Dugwalla Bay on Whidbey Island supported several families.

10. Question (Mike Douglas): What is the process for making a decision about the bridge? Will there be communication with citizens to review the planst before the final decision is made? Response: (John Van Lund) The county will run the decision-making process, probably with the assistance of a consultant. Typically this includes formation of a citizen steering committee and public notice and comment opportunities..

11. Question (Ann Shanks):How will the information from the meeting be synthesized? Will there be an EIS? Response: (Ken Brown)We will publish meeting notes, and there will be a newsletter sent out. (John Van Lund) The county will also be doing an EIS, and they will be doing public outreach and take further comments on the EIS. The draft feasibility study already provides much of the material that would be included in an EIS. (Tom Slocum). Reminded the audience that the feasibility study deals primarily with the lagoon habitat restoration alternatives, and that a separate review process will be done for the county's replacement of the bridge.

12. Question (Ken Wood): Has the possibility of a foot bridge been investigated, with an alternative of having the road go around the estuary? Response (John Van Lund): No, this wasn't part of this study, but could be included in future alternatives. SJ County would be interested in hearing any suggestions that the public may have.

13. Comment (John Riberg): Doesn't like the "screen" design of H&M's proposal. The bridge should be kept as small as possible to reduce its visual impact; a foot bridge or very small structure would be preferable.

14. Question (speaker identified himself as being from the Cayou Valley Homeowners Assn., but did not give his name): Will the sediment increase, and the amount of water in the estuary decrease? Response: (Jim Johannessen) To some degree the "ponding" of water will decrease resulting in less water in the lagoon at low tide, however, ultimately sediment deposition in the lagoon is expected to decrease after normal tidal flux is restored.
15. Question: Will the water supply wells in the area be impacted by salt water or lower yields? Answer (Jim Johannessen): since the hydraulic head in the lagoon will not significantly change, we do not expect that local wells will be impacted.

16. Question: Will the new bridge design allow for boats to pass under it? Response: (Tom Maul) The Coast Guard's classification for the channel does not require that navigability be maintained, so at high tide, only boats that could go under the bridge would be kayaks.

These also could be portaged over the road. This issue could be re-considered in future designs.

17. Comment: (Dwight ?): Pedestrian traffic on the bridge is dangerous and so the interpretive center, which would attract people, should not be located on or near the bridge.

18. Question (Tracy Betcher): How long will the sediments take to flush out of the estuary? Response: (Jim Johannessen) The channel development is expected to take one to two years. During this time there would be some increase in turbidity.

19. Question (name not given): Are there toxics in the sediments above the estuary, and are they going to be addressed? Response: (Russell Barsh) The Samish research lab did some monitoring of pH, dissolved oxygen, coliform bacteria and salinity and the only elevated parameters that they noticed were coliform in the northeast end of the lagoon. Samish but did not test for heavy metals or pesticides but would be interested in doing so if funding were available. (Jim Johannessen): a few sediment cores were tested for lead isotopes but did not detect any significant concentrations of these.

20. Comment: Land owners want more info on the fecal coliform issue. Response: (Russell Barsh) the reports have not been completed, and the landowners involved will be notified first.

21. Comment (Cat Fennel): Some of the watershed issues were included in the bridge removal project, but many were not addressed. In particular, a lot of sediment enters the lagoon from shoreline erosion and if the full tidal prism is restored, this bank erosion will increase. The rocks under the bridge act like a weir and cause an eddy upstream. This causes a lot of the erosion and turbidity. Response (Jim Johannessen). The project team has found that much of the turbidity in the lagoon water is due to re-entrainment of fines from the bottom due to waves and currents. Fine sediment tends to fall out in the upper estuary, and heavier gravels and sand are found near the bridge. Making the channel larger will reduce the velocity of the tidal flux, which should decrease bank scour upstream of the bridge. Also, the restoration plan includes planting and stabilization of shorelines to reduced shoreline erosion.

22. Comment (Sharon Parsons): People in the estuary don't know about the project. Aren't there requirements for notifying adjacent landowners? Response: (Ken Brown): There is a reader board near the marina, newsletters were sent out, and there will be a website. Another newsletter will be produced, and other ways to get the word out will be investigated. (Jim Johannessen) Since there is no formal proposal to do anything yet, there is no requirement for notifying adjacent landowners at this time.

23. Comment (Sharon Parsons): Would like the bridge design to include pedestrian walkways on both sides, minimal wooden railings and a rustic design. People should be able to see through the railings.

24. Question: Are there two separate projects: the bridge and the estuary? Response: (Joe Gaydoes) the funding for this study had to do with the bridge, other studies could look at other aspects of the estuary.

25. Question (Bob Connor): Is there PSP in Deer Harbor year round? Will sediment impact the eelgrass? Response (Tina Wyllie-Echeverria): If turbidity is elevated for more than a few weeks, it will damage eelgrass, but since the eelgrass beds are quite far south of the bridge, it is unlikely that sediment released from the lagoon channel restoration will impact them. (Dave Lloyd, representing the SJ Co. MRC): SJ Co. Health Dept. says PSP is very rare in Deer Harbor, but fecal coliform is present and is the main health risk.

26. Comment (Mike Stansbury): The Deer Harbor watershed is the groundwater recharge area for all wells in the community, so releasing more water from wetlands and ponds into Fish Trap Creek may impact water supply wells.

27. Comment: (Mike Stansbury): There is a distinct seepage face on the west side of the lagoon, about 3 feet below the ground surface elevation, where the overlying silt and clay meets underlying granular soil. This seepage is a source of a plume of fine sediment/turbidity during wet winter conditions. Does the study's analysis of sediment dynamics account for this? Response: (Jim Johannessen) there could be some sediments coming in from the surrounding land, and greater vegetative cover will help ease this situation.

28. Question (Cat Fennel): If the rock sill under the bridge is the main problem, why not just remove the rocks? Response (Jim Johannessen): If the rock armoring is removed, the tidal flow would scour around the bridge piers. He has seen scour holes 30-feet deep. (John Van Lund): Since we don't know what the subsurface conditions are or how deep the piers are, it's possible that they could collapse, so don't remove the rocks!

**Letter from Mike Stansbury 8/15/05**

**MEMORANDUM**

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| **TO:** | Tom Slocum |
| Cc | Terry Neill<br>Anthony Richardson<br>Bob Foulks<br>Bob Conner<br>Kim McClees<br>Sarah Williams<br>Michael Durland<br>John Van Lund<br>Robin Clark |

**FROM:** Mike Stansbury

**DATE:** August 15, 2005

**SUBJECT:** **Deer Harbor Estuary Study**

Tom:

As you and the team finalize the report in the next month or so, I wanted to provide a few comments about the study and report and provide some perspective of a homeowner in the vicinity of the project.

Scientific Data

As I read the report, it became very obvious that most of the data that substantiates the results of the study is to be included in an appendix which of course was not available during our review of the report. I think it is imperative for this data to be available right away, not after the report is finalized and submitted. As I will describe in the following paragraphs, very little scientific data has been produced to date that shows that it is feasible to return the estuary to its full natural condition.

Bridge Replacement

The report assumes that the baseline condition for the project is the replacement of the bridge and the removal of the existing rock sill. I respectfully disagree as the baseline condition for this action should be the replacement of the bridge alone and removal of the rock sill should be one of the alternatives to be evaluated. Once that is done, then the report can analyze the impacts of different sizes of bridges. It is interesting that the fact that the estuary will go dry during virtually every tidal cycle is hardly mentioned and not mentioned at all in the visual impacts section of the report. There certainly needs to be more emphasis placed on identifying the impacts to removing the rock sill.

The team needs to recognize that unless there is better scientific data produced, most of Deer Harbor and probably all of those of us who overlook the estuary will oppose the project and probably take legal action to make sure it doesn't happen.

The report needs more information on the construction aspects of the bridge replacement and road relocation, i.e. how long will it take, better describe the required detour, a better evaluation of the possibility of not utilizing a detour, etc. I was not even aware of the fact that there is an existing road that can be used for the detour. The report needs to show the cost of simply replacing the bridge without extending its length or removing the sill.

Fisheries

The Deer Harbor community was under the impression that the project was designed to restore the fisheries to the estuary. However, there is virtually no information or data to support the thesis that it can be restored or even improved. Simply improving habitat will do little if there are little or no fishery resources available. This part of the report needs significant improvement; maybe it is in the missing appendices.

The fish passage projects seem to be a significant waste of effort since the report documents that there is little water in the tributaries due to upstream diversions and storage. It seems to me that before you propose fish passage upstream, we need to make sure there is water there at times other than following a heavy rain. The whole analysis of passage benefits seems a little strange to me without more streamflow.

I did some quick trigonometry calculations on the proposed tree buffers that are suggested for the west shore. When you combine the height of the trees, the number of years before they will mature, the distance from the shoreline to the variable waters edge, and the existing temperature of the estuary, it seems like the probability of a significant improvement in temperature is very low. I recognize that the cost is also relatively low but let's not oversell the true habitat benefit.

<u>Erosion and Sedimentation</u>

It seems to me that the existing erosion of the west bank just upstream of the bridge is one of the only real problems that can be solved by the bridge replacement project. However, a little regrading and bank stabilization would also solve the problem, probably at a significantly lower cost. It would be nice, however, if the report could show where the sediment that results from this erosion actually ends up.

The idea of removing the rock sill and its subsequent release of sediments needs further attention, as does the concept of allowing channels to form in the estuary. The report needs to use scientific data and models to tell us where it will go. Simply letting it move down into Deer Harbor is not particularly appealing to many people, particularly those who work or reside in that area. It would not take much sedimentation between the bridge and the harbor, for instance, to eliminate the Boatworks as a viable business since it would be impossible to get boats to and from their dock.

<u>Conclusions</u>

As currently written, the report seems to have a Field of Dreams mentality, build it and the fish will return. I agree that improving habitat is a worthwhile endeavor. However, the report need to quantify the potential benefits in real world terms and to recognize that there are negative sides to the proposal.

**Letter from Michael Durland 5/4/05**
Tom Slocum:

I have read your revision of the "Toxic Substance and Hazardous Waste Assessment." Please explain the change of the title to "Hazardous and Toxic Site Assessment? As I understand it, this assessment pertains to the water quality of Deer Harbor and Deer Harbor Lagoon for the purposes of evaluating the region for a restoration project. Please review and respond to these other issues regarding this and the draft report on this section.

1. Why wasn't the Appendix written before the report was written? It seems to me that the Appendix would include the "Assessment plan and implementation" and
the data collected from that executed plan. Shouldn't the Appendix have been written before the section?

2. I reported the misconduct of a leasee to the DOE and my concerns about a possible spill at the 155 Channel Rd. property in the 1990's. Michael Spencer of the DOE expressed verbally to me an opinion that my issue was "not a priority" and that possible improper sampling or analysis of samples indicated that we needed to resample and reanalyze the soil. This was completed and the property at 155 Channel Road referred to in your draft as Deer Harbor BoatWorks was removed as a possible contaminated site from the DOE List. Please contact Michael Spencer at the DOE to get information.

3. I have submitted samples to the DOE in the past from the curtain drains at the bank where the run off reaches Deer Harbor. There was no indication of petroleum or copper discharged at the point. To my knowledge and that of the DOE no copper reaches the Deer Harbor waters from Deer Harbor BoatWorks. I could have provided you with that information.

4. Deer Harbor BoatWorks allows no dry-dock work within 50 ft of the water front. Outside work is only allowed on the impermeable work area. The storm water run off from that work area is collected into a catchment sump and treated by bioremediation for petroleum byproducts. We consistently test clean of petroleum byproducts. The storm water samples I submit to the DOE are from that sump overflow. We do not submit samples that have used the soil as a filter before the curtain drain as allowedby DOE regulations. This is because we are trying very hard to stop the production of bottom paint dust before it enters the environment. This is the best way for us to see how we are doing versus simply trying to submit "good" samples to the DOE. If you visit other boatyards you will see people working on gravel right next to the waterfront. If you investigate further, you will learn that they only sample the area where they pressure wash boats not the entire work areas. The difference at Deer Harbor BoatWorks is that we are trying to work within the intent of the law not the letter of the law.

5. There are four industrial sites in the Deer Harbor Watershed: Deer Harbor Marina, Cayou Cay Marina, Deer Harbor BoatWorks and Mr. Cookston's property on the northwest side of the water shed. I am puzzled that Deer Harbor Marina, which has an extreme effect on the Lagoon and Deer Harbor both in hydrologic flow and water quality is excluded from the study area. The marina used mostly for transient moorage, the presences of a fuel dock, and a pumpout station are bound to have effects on the water quality and the potential exposure to pollutants. Locally, "Inner Deer Harbor" includes both marinas where it is considered a "no wake zone." Why was the Deer Harbor Marina excluded from the "study area"?

6. I find it interesting that two marinas with boats that have bottom paint on them, and engines and oils in the bilges are not mentioned at all in this section. The abandoned cars and trucks in the watershed area, the construction sites in the watershed, nor the other industrial properties

were not even mentioned in this section. Just the other day, I walked by a property in the watershed where someone had removed the bottom paint off their boat no more than 10 feet from a drainage that flows into a wetland that then flows in to Deer Harbor. You state "No other field observations were made..." how were field observations executed?

7. Deer Harbor BoatWorks initiated the "pilot program" for native oysters in Deer Harbor which is done on my oyster track in front of the BoatWorks.

I found your "Assessment" to be unprofessional and incomplete. There is no indication that copper, other heavy metals, or petroleum byproducts are being introduced to Deer Harbor or Deer Harbor Lagoon from my property. Boat owners scrub copper bottom paint off their boats or have divers scrub the copper off at the marinas. Derelict vehicles and heavy equipment are abandoned in the watershed. A dust inhibitor was spread on the road next to the lagoon. Why, out of the four industrial sites and the untold number of commercial sites in the Deer Harbor Watershed, did you chose to only mention Deer Harbor BoatWorks in your report?

Deer Harbor BoatWorks is a local boatyard that is supported by the local community. We allow people to work on their own boats, and it is a constant educational process to impress upon customers the importance of being a responsible boat owner and the effects of bottompaint on the environment. We encourage our clientele to use products that are more environmentally friendly. We do not allow dry-dock work within 50-feet of the waterfront; we only allow outside work on impermeable surfaces and collect the stormwater from that surface; we test at our sump so that we may determine how we can limit the production of copper dust, and we bioremediate for petroleum byproducts. I reported a possible transgression of a leasee to the DOE--personally. I encouraged the use of my property for restoration of the native oyster. I also sponsor the annual cleanup effort in Deer Harbor.

Mr. Slocum, I understand that you may have been under a deadline to complete this report. I do find that the selectivity and inaccuracy of information provided thoughout is very disconcerting. I also found the disregard for how such a biased presentation may effect a small and local business rather appalling. My suggestion is that either do a full and complete assessment of all the industrial and commercial sites in the Deer Harbor Watershed (including the Deer Harbor Marina), or you leave that section out of the report entirely.

Sincerely, Michael Durland _