Iverson Farm
Restoration Feasibility Study

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Camano Island, Island County

Funded in Part by Washington Department of Ecology State Revolving Fund Loan
and Washington Department of Fish and Wildlife Lead Entity Grant

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1.0 INTRODUCTION

1.1 Feasibility Study Background

Island County Public Works received a loan from Washington State Department of Ecology and a grant from Washington Department of Fish and Wildlife to study the feasibility of restoring inter-tidal marsh to some or all of the old Iverson Farm, located on the western edge of Livingston Bay on Camano Island. The purpose of the feasibility study, as defined in the text of the grant, is to "evaluate the options for passive site development and wetland/shoreline habitat enhancement… consistent with applicable Island County codes".

Island County Public Works contracted with two firms to assist in the preparation of two key elements for the tidal restoration feasibility study. Sheldon & Associates, Inc. was hired to assess the effects from identified Alternatives on the availability of habitat for fish and wildlife inside and outside the existing dike, with special emphasis on juvenile fish habitat. Phil Williams Associates (PWA) was hired to conduct a comparison of flooding and tidal inundation extent for each Alternative.

The Sheldon & Associates, Inc (S&A) study specifically addresses the following issues:

1. Assess existing wetland conditions inside and outside the dike. Using best professional judgment, identify the functions and values those wetland communities provide in existing conditions;
2. Determine the extent of habitat types present in existing conditions for wildlife guilds (groups of wildlife species with similar life history needs), including 'species of local importance' as defined by the County;
3. Predict anticipated changes in habitat types and vegetation community types to be expected based on Alternatives identified by the project team;
4. Provide recommendations on water quality monitoring needs in the project area;
5. Identify habitat conditions in the nearshore and diked reaches that may provide benefit to juvenile and/or adult salmonids in existing and anticipated conditions for each Alternative identified;
6. Provide a summary of recommended actions or considerations for restoration actions within the Iverson Farm site.

This report provides the results of Sheldon & Associates, Inc portions of the feasibility study.

1.2 Goals of the Restoration

Based on conversations with Island County staff, the following goals (not a prioritized list) have been identified for the potential restoration actions within Iverson Farm:

1. Maximize habitat diversity within the Iverson Farm system while minimizing adverse effects to human structures or infrastructure;
2. Increase fish habitat and/or access to habitat;
3. Increase passive recreation opportunities for the public;
4. Assure no increase in flood risk to structures or infrastructure;
5. Assure no risk to groundwater (i.e. no saltwater intrusion into wells).

1.3 Limitations of this Study

Limitations of funding and timing for this study has influenced the data collection stage, effected the extent of analysis of available data, and influenced the reliability of forecasts of future conditions, and hence, accuracy of recommendations. Within the study limits, site-specific information gathered in the field by the consultant team and/or the County staff has been used to form the basis of the analysis of existing and anticipated conditions. Predicting future conditions in such complex ecosystems, subjected to innumerable physical, biological, and chemical variables, is always speculative. Our analysis has been based on the best available historic and existing data for the Iverson Farm site and documented transitions that have occurred (or are occurring) at other estuary restoration sites within Puget Sound.

2.0 EXISTING CONDITIONS

2.1 Landscape Setting

Island County Public Works purchased approximately 300 acres of the old Iverson Farm located on the northeast side of Camano Island, on Livingston Bay. See Appendix A, Figure 1 for the vicinity map. Livingston Bay is located at the northwestern head of Port Susan, the large embayment located between the mainland and Camano Island to the west. Port Susan (an extension of Possession Sound) was formerly a closed embayment at the mouth of the Stillaguamish River. Early in the 20th century, West Pass was dredged at the head of Port Susan, to link it to Skagit Bay to the north. Livingston Bay, and the small estuary at Iverson Farm, is situated due west of the mouth of the Stillaguamish, hence the waters in the Bay have always had a strong freshwater influence, and have always been subject to large sediment loads from the river.

The Stillaguamish River is the fifth largest tributary to Puget Sound and historically was estimated to have contributed approximately 21% of the anadromous fish in the Sound (WRIA 5: Washington Conservation Commission, 2000). From the Habitat Limiting Factors report for the Stillaguamish, we know that nearly 85% of the saltmarsh estuary of the Stillaguamish was converted to agriculture between 1870 and 1968. By 1968 there was only 3 square kilometers of salt marsh left, yet at the same time the size of the delta of the River was *increasing* due to increased sedimentation from land uses upstream (WRIA 5: Washington Conservation Commission, 2000). The WRIA 5 report notes, “The newly accreted areas (mostly sand and mud flats) are of far less value to salmon than the original salt marsh habitat”. Although sediment deposition is increasing the size of the delta, the WRIA report concludes that the estuary of the Stillaguamish is not in bad condition, and as of late summer, 2001, a 4,000+ acre section of the delta has been purchased for permanent protection by the Nature Conservancy. The condition of the Stillaguamish River and its fishery runs are critical to the implication of the restoration feasibility study of Iverson Marsh, as will be discussed further later in this report.

The Iverson Farm site is located at the south-western edge of Livingston Bay, at the head of Port Susan. The County owns 300 acres that includes cropland, upland forest, estuarine wetland, brackish marsh, upland scrub, and approximately 62 acres of tidelands. There is approximately 3,274 linear feet of shoreline. Approximately 120 acres, of the agricultural lands, brackish marsh , salt marsh and tide flats of the site are under consideration for this study.

The site contains a north-westerly tending sand spit which protects the saltmarsh, behind to the west, from winter wave action. Extensive mudflats and vegetated saltmarsh habitats are present behind the sand spit in front of the dike that cuts off the former estuary from tidal flushing. Inside the dike are brackish wetlands, freshwater wetlands and actively cropped fields. Figure 2, in Appendix A, depicts the existing conditions of the site.

The dike was installed in the 1940's to control saltwater intrusion into the saltmarsh so that it could be converted to agricultural uses. Borrow pits were dredged inside the dike to provide the fill material for the body of the dike, and to create open water drainage channels to facilitate water movement through the inside of the dike. The former tidal channels were dredged and straightened, again, to facilitate the movement of water out of the farm fields. In the 1960's consideration for drain tiles was given and tiles may have been installed at that time; however it is documented that drain tiles were installed in the fields in the 1980's.

The ditches and drains inside the dike are connected to a dredged main channel leading to a passive tide gate. The tide gate functions to allow water in the channels to flow out through the dike at low tide, while limiting the amount of saltwater that enters the diked area on a rising tide. Tide gates are limited in their effectiveness for a variety of reasons, not the least of which is often the lack of long-term maintenance to assure that saltwater corrosion does not influence the gate abilities to function over time.

East of Iverson Farm, homes have been built along the beach on the east side of Long Beach Road. An upland forest on the east-facing bluff forms the west side of the Iverson Farm property. A detailed description of key areas is provided below.

2.2 Vegetation Community Types

The vegetation within the existing Iverson Farm site reflects the effects of historic and ongoing human activities. It is safe to say that few of the vegetation community types present reflect unaltered historic conditions, however, the low and high saltmarsh communities outside the dike do reflect relatively healthy saltmarsh communities. Appendix B contains seven composite photographs taken from various locations on the Iverson Farm site. The photographs illustrate all of the community types described below. Community type descriptions are separated between those outside the dike and inside the dike.

Nine vegetation communities were identified on the Iverson Farm property from field work conducted August 15, 2001 and from interpretation of 2001 aerial photographs. The communities include mud flat, low salt marsh, high salt marsh, driftwood areas, scrub shrub, brackish marsh, wetland forest, mesic forest, upland forest, and agricultural fields. The relative location of the communities is illustrated on Figure 2 (Appendix A).

The transition from mudflat to low saltmarsh to high salt marsh to upland vegetation is dictated by the frequency, depth and duration of inundation by salt water. All saltmarsh species of vegetation (low and high marsh) have some tolerance to saline conditions: low saltmarsh species can tolerate deeper inundation for a longer period of time than high saltmarsh species. Where inundation depths exceed the tolerance of saltmarsh species, mudflats will dominate. Some species of vegetation are tolerant to salt conditions but not tolerant to inundation: those species will be found in the 'splash' zone, or the area at the upper fringe of a high saltmarsh that only get saline influence from windblown spray or storm-driven waves. As in many terrestrial and aquatic systems, there are species with broad tolerances that may be found across a wide range of inundation and/or salinity gradients. Vegetation tolerances to the frequency, depth and duration of inundation will dictate vegetation community formation and habitat complexity in future conditions.

2.2.1 Outside the Dike

<u>Mud Flat</u>

The mud flat consists of areas with little to no vegetation present, and subjected to tidal inundation two times per day. Silts are likely transported into Port Susan from the Stillaguamish River, and are re-suspended within the embayment with every tidal cycle. The mudflats are characterized by the presence of sparse, silt-covered *Spartina alterniflora* (assumed) with some saltmarsh sandspurry (*Spergularia marina*) and saltgrass (*Distichlis spicata*) present. Some areas of the mud flats were covered by drying algal mats of both leafy and filamentous green marine algae. Extensive portions of the mudflats are not vegetated. Where there is vegetation on the mudflats it is very sparse and the basal leaves on all plants are thoroughly silt covered. The mudflats are at an elevation of 2 feet to less than 4 feet (NVGD), and based on visual observations, they are the first zones to become inundated and the last zones to become exposed during each tidal cycle. It is assumed that both the depth and duration of inundation, and the quantity of fine silts in this area, limits the successful establishment of vegetation. The influence of the silt is evidenced by the presence of thick accumulations of silt on all leaf surfaces of plants in this zone: we have assumed this may result in adverse impacts on the plants ability to respire and photosynthesize. See photo B, Appendix B.

<u>Low Salt Marsh</u>

Low salt marsh occurred at approximately 4 feet elevation (NVGD), where plants were inundated twice per day. The vegetation in this community was more dense and although some basal leaves showed evidence of sediment deposition, substantial portions of mature plants were located well above the zone of silt-laden water. Predominant species in the low salt marsh include saltgrass (*Distichlis spicata)*, pickleweed (*Salicornia virginica*), seaside arrow grass (*Triglochin maritimum*), fat hen (*Atriplex patula*), and tufted hairgrass (*Deschampsia caespitosa*). Pickle weed and saltgrass are the two most common low salt marsh species in the Puget Sound basin; both have a high tolerance for daily inundation and salinity compared to species common to a high saltmarsh. See photos B & C, Appendix A.

<u>High Salt Marsh and Driftwood Areas</u>

High salt marsh occurred at elevations between 4.5 to 5^{+} feet (NVGD), on the eastern portion of the marsh and northeastward of the sand spit, between the mud flat/low salt marsh zone and the unvegetated beach. Areas covered with driftwood often included high salt marsh plant species amongst the wood debris. The wood debris sitting on the soil physically precludes plants getting established. In severe winter storms, shifting wood can scour vegetated landscapes, resulting in a patchwork of wood, bare soil/gravel, and high saltmarsh vegetation. Dominant species in the high salt marsh/driftwood areas include gumweed (*Grindelia integrifolia*), seaside plantain (*Plantago maritima*), and saltmarsh dodder (*Cuscuta salina*) as well as the same species found in low salt marsh areas. Typical saltmarsh grasses were observed including meadow barley (*Hordeum brachyantherum*), tufted hairgrass, bentgrass (*Agrostis* sp.), and quackgrass (*Elytrigia repens*). In addition, Douglas aster (*Aster subspicatus*), silver burweed (*Ambrosia chamissonis*), dune tansy (*Tanacetum bipinnatum*), Queen Anne's Lace (*Daucus carota*), yarrow (*Achillea millefolium*), and fleshy jaumea (*Jaumea carnosa*) were observed. Some shoots of *Spartina alterniflora* were observed with the native vegetation in the high marsh, although it was by no means a dominant. See photos A & B, Appendix B.

<u>Channel Habitats</u>

The channels outside the dikes consist of natural channels and dredged channels, all linked out to the waters of Livingston Bay, via the primary channel. The pattern of existing channels outside the dike includes a foreshortened pattern of primary and distributary channels across the mud-flats. In addition, it appears from the topographic maps and aerials that the portion of the channel linking the tide gate to the Bay has dredged for the portion closest to the dike. The historical (pre-diking) main channels flowed much further to the west than the existing primary channel, plus the near-dike portion is a straight linear feature: quite unlike a natural estuarine channel.

The channels are the conduits of the estuary: they allow water to move into and through the accessible portions of the estuary. They collect and redistribute sediment, organic particulates, and dissolved nutrients from the estuary into the near-shore environments, and they allow mobile species access into the interior of the estuary habitats. The current dike precludes the unrestricted connectivity between the saltmarshes, mudflats and open water of Livingston Bay with the habitats inside the dike.

Photos D & E, in Appendix B, show the channel habitats outside the dikes. Photo E shows the straight configuration of the dredged channel. Photo D shows how the channels can trap woody debris, providing complex substrate for benthic invertebrates, structural complexity for the channel bottom, and a long-term source of particulates.

2.2.2 Inside the Dike

Vegetation communities inside the dikes have been influenced by the placement of the dike and tide gate, as well as by ongoing agricultural practices. Reducing tidal influence, ditching, and drain-tiling have all significantly effected the hydrologic patterns of the area inside the dike, and the subsequent vegetation communities.

Scrub Shrub

Scrub shrub vegetation encompasses a relatively large area from the dike southward to the agricultural fields. The composition of the community is not consistent across that area, however species diversity is relatively limited. On the dike proper, madrone (*Arbutus menziesii*) are present and vigorous. A recent effort, coordinated by Island County staff, had successfully resulted in volunteers removing the vast majority of Scotch broom *(Cytisus scoparius)* from the berm and inland of the dike. The upland area, between the dike and the eastern most drainage ditch is a diverse mixture of native and non-native shrubs including peafruit rose (*Rosa pisocarpa*), crabapple (*Malus fusca*), red elderberry (*Sambucus racemosa*), some Scotch broom and extensive stands of Himalayan blackberry (*Rubus procerus*). Reed canary grass *(Phalaris arundinacea*) and other non-differentiated grasses were also abundant in this area. Some small Douglas fir (*Psuedotsuega menziessii*) saplings were scattered throughout. None of the vegetation in this zone appeared to be very mature, the mixture of species and the lack of mature specimen illustrate that this area has likely been consistently disturbed since the dike was installed. Invasive species were also found, such as *Spartina*, Scotch broom, Canada thistle (*Cirsium arvense*), and Himalayan blackberry.

Further to the west (of the eastern ditch and south of the main E/W ditch) inside the "U" shaped cropped field, is a shrub community that represents a more 'typical' native community. The dominant species are crabapple and various willows (*Salix spp.*). Other species present included peafruit rose, red elderberry, Douglas fir, Oregon grape (*Mahonia nervosa*), and red alder (*Alnus rubra*) saplings. Along the banks of ditches cow parsnip (*Heracleum lanatum*), trailing blackberry (*Rubus ursinus*), twinberry (*Lonicera involucrata*), snowberry (*Symphoricarpos albus*), and oceanspray (*Holodiscus discolor*) were found. See photo G (background), Appendix B.

Brackish Marsh

Brackish marsh communities are present inside the dikes, near the open water ponds, along the margins of ditches, and in several larger stands north and south of the main E/W ditch. These communities were comprised predominantly of Baltic rush (*Juncus balticus*), Pacific silverweed (*Potentilla pacifica*), Distichlis, fat hen, and Douglas aster. Neither the Baltic rush nor the silverweed were common outside the dike. These communities may become inundated during heavy rain events at a high tide (when the tide gates are closed), however it is assumed that they are generally saturated to the surface during the majority of the growing season, and shallowly inundated only periodically.

Not mapped as a separate vegetation community type are the shallow open water ponds located in the northwest corner, behind the dike. These areas are assumed to be partially formed as borrow pits for the dike fill, however they are also in the location of the original main channels of the undiked estuary, therefore they could also be historic channel remnants. See photos G & F, Appendix B.

Mesic Forest

A mesic forest is located within the diked area, at the base of the east-facing hillside that forms the western boundary of the Iverson Farm site. This forest is dominated by red alder (*Alnus rubra*) and salmonberry (*Rubus spectabilis*) with an herbaceous layer of wood fern (*Dryopteris austriaca),* sword fern (*Polystichum munitum)* and stinging nettle (*Urtica dioica)*. The interior of this woodland was not explored, however traces of the old historic channel appear to be evident in the 2001 aerial photograph.

Wetland Forest

A small forested wetland was found within the mesic forest, north of the footpath leading to the interior of the site. This freshwater forested wetland had a canopy of red alder trees with cattail (*Typha latifolia*) and skunk cabbage (*Lysitichum americacanum*) in the understory. This forested wetland lies in the location of a portion of the historic channel. It should be assumed that the interior of the area mapped as mesic forest may contain additional forested wetland with an overstory of red alder that masks the wetland conditions.

Upland Forest

The upland forest is located on the hillslope on the western edge of the property, above the wetlands and agricultural fields. The forest consists primarily of larger red alder, small Douglas fir, small western red cedar, and madrone with shrub understory including red elderberry, salmonberry, oceanspray (*Holodiscus discolor*), and twinberry. Herb species include stinging nettles and mitrewort (*Mitella* sp.). Ferns observed in the upland forest include sword fern, lady fern (*Athyrium filix-femina*), wood fern, and bracken fern (*Pteridium aquilinum*). See photo F (hillside in the background), Appendix B.

Agricultural Fields

The two fields comprise approximately 60 acres that are currently used for agriculture. They are farmed in grain crops, with a small area paralleling the road along the east side planted in row crops. The agricultural fields have been drain-tiled for decades, as that is usually the only means by which former tidal lands can be effectively used for cropped fields. Records from the Soil Conservation Service (SCS), provided by Island County staff, indicate that in 1987, the previous conservation plan (drain-tiling and tide-gate maintenance) was completed in 1967. The 1967 SCS documents indicate drainage ditches, but no drain tiles. Plan sheets dated in 1986, indicate that three drain tile lines were installed on the east side of the larger field, running NW/SE, draining to a mainline tile ditch that emptied into the main N/S drainage ditch on site. See Appendix C for the plan sheets. Any restoration Alternatives will have to include breaking of the drain tiles (not removal) to assure that the system does not continue to function in a manner that might effect flows in the future.

In existing conditions, the fields are often still too wet to plow early enough in the spring to assure installation of a viable crop (farm lessor to Island County staff, 2001). Maintenance on the existing drainage ditches would require them to be dredged to facilitate drainage off the site to make farming economically viable on the site. See photo G (background, right), Appendix B.

Channel Habitats

The channels inside the dikes consist of ditches dredged to facilitate site drainage, old historical channels, and perhaps, borrow pits/channels. In existing conditions, the dredged channels have a trapezoidal shape: flat sides and flat bottoms, usually filled with accumulated silt. Many of the ditches have overhanging vegetation in the upper 1/3 (non-agricultural) portion of the site. Water movement through the channels is dictated by the tide gates and flat gradients: when the tide gates are closed or closing, water movement within the channels stops. Even when the tide gates are fully opened, movement within the channels is very limited by channel gradient and scouring flows do not occur. See photos G & F, Appendix B.

2.3 Fish

The species of fish of particular interest in this study are the following:

Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*Oncorhynchus kistuch*
Chum salmon	*Oncorhynchus keta*
Pink salmon	*Oncorhynchus gorbuscha*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead trout	*Oncorhynchus mykiss*
Cutthroat trout	*Oncorhynchus clarki*

Anadromous fish are those that spawn and spend juvenile stages in fresh water (duration is species and run dependent), then move into saltwater to mature for 2-6 years (species and run dependent), then return to freshwater to spawn and die. These fish are commercially and culturally significant to this region, and therefore increasing available habitats for salmonids is one of the primary motivating factors for this study.

Although there is no documented use of streams on Camano Island by anadromous fish (WRIA 6: Washington Conservation Commission, 2000), it is the fish from the Stillaguamish River, to the east, that one would expect to be using the near-shore and estuarine habitats of Port Susan, and thus any restored habitats within Iverson Farm. The WRIA 5 report (WRIA 5: Washington Conservation Commission, 2000) notes that the species of anadromous fish listed above, all utilize the Stillaguamish River and its estuary. This would include the upper limits of Port Susan, Livingston Bay, and Iverson Farm.

Use by salmonids and other aquatic species, within all the existing channels and mudflats outside the dike at Iverson is assumed however no documented research identifies quantity or species of utilization. Additional site specific data should be collected, however an EPA Take Permit would be required and would limit the type and amount of collection possible. Given the landscape position of the Iverson site (at the mouth of the Stillaguamish), one has to simply believe that accessible habitat will be used if fish are present.

2.3.1 Estuarine Functions for Fish

It is well documented in the literature that estuaries, their channels, vegetated marshes and mudflats are all critical habitats for anadromous salmonids because those habitats provide a variety of critical functions for anadromous fish in both juvenile and adult life stages. The estuaries and small channels are the location in which smolts, emerging from the freshwater river, become adjusted to salt water; and adults, returning from the ocean to spawn, re-adjust to freshwater conditions. The range of functions that could be provided at Iverson Farm are discussed in more detail in the sections following.

Prey Production
Anadromous fish are dependent upon detrital-based food webs (Simenstad, 1983), because detritivores form a significant portion of estuarine salmonid's diet (Healey, 1982). Detritus, dissolved and/or particulate sized organic matter, is swept downstream from plants and/or other organic sources (animals) located upstream. Detritus that is trapped in the nearshore and/or vegetated marshes is available for detritivores to feed on. Detritivores are the main prey species on which anadromous salmonids feed when they are in estuarine or near-shore habitats. Prey production can occur in vegetated saltmarsh, mudflat and/or some channel habitats. Movement of detritus from behind the dikes through the tide gates does occur, however it is severely limited and materials are likely concentrated within the channels below the tide gate outlet (not dispersed throughout the mud flats or vegetated marshes).

Predator Avoidance
Juvenile salmonids avoid predators by seeking refuge in shallow vegetated areas and channels that remain inundated during low tide (Simenstad, 1982). Channels that de-water on falling tides and/or areas where juvenile fish may be stranded in mudflats do not provide appropriate refuge habitats. The vast majority of the existing channels outside of the dike completely de-water during each tidal cycle.

Osmoregulatory Transition
Anadromous fish have to shift their entire physiology from freshwater to saltwater (as they move from juvenile to adult stages) and from saltwater to freshwater (as they head upstream to spawn as adults) (Levy and Northcote, 1982). The time fish spend in estuaries for this transition is species and run specific. Estuaries and the lower reaches of rivers provide the opportunity for anadromous fish to make those physiological changes. This function may be more limited at Iverson, due to the lack of an upstream channel, however it could still provide that function for fish within the Stillaguamish drainage.

Feeding
Juvenile salmonids feed on a variety of different prey organisms and different species of fish utilize different parts of an estuary at different parts of the tidal cycle and/or the year. This is to say that many portions of intertidal areas (main channels, subsidiary channels, vegetated shallows and mudflats) are all used by salmonids at many times throughout the year. Salmonids feed on what is available: a variety of macro-invertebrates, other fish, and, as noted, detritivores (Healey, 1982).

2.3.2 Channel Functions

The three key habitat types, from a fish perspective are: channels, vegetated shallows (saltmarsh), and mudflats. Channels link littoral and sublittoral areas, they allow aquatic species to physically move through the estuary, to find refuge, to get access to vegetated shallows, and they provide for the transport of detritus, woody debris and sediments throughout the estuary and into the nearshore environments. Simenstad (1983) identified three classes of channel:

Main channel: the primary link into and out-of the estuary, the main source of water flow in and out from the deepwater habitats;
Subsidiary channel: a defined channel in which minor water transport occurs;
Blind channel: channels that drain mud-flats and/or areas inundated by incoming tides. These are not flow-through channels, they 'end' on the mud-flats.

Using Simenstad's channel classes, Iverson Farm in existing conditions, and all of the Alternatives, does have and would have a preponderance of blind channels or what PWA describes as first order channel (PWA 2001). Blind channels fill and empty with each tidal cycle, allowing incoming tidal water and all the associated aquatic organisms present in that tidal prism access into the upper reaches of the estuary and mudflat. As the tides fall, these blind channels allow waters to convey particulates and organisms back into the shallow near shore environments. Blind channels dewater completely between each tidal cycle, while larger channels may maintain a wetted bottom, depending upon the depth of the channel, its gradient and the volume of water to be 'transported' within the tidal cycle.

As noted previously in this report, the channels are the conduits: they allow access into the marsh and mudflats of the estuary by any mobile species or organism. The flows exiting through the channels also transport organic debris, organisms, and particulates out from the estuary back into the near-shore and deeper water environments.

2.4 Wildlife

2.4.1 Wildlife Assemblages

For this study, 12 groups or assemblages of wildlife have been identified that would be assumed to use the various habitat types present in existing conditions at Iverson Farm. The assemblages represent a 'lumping' of individual species that may have similar feeding, breeding or rearing habits that result in the various species using habitats in a similar fashion. This assemblage approach is based on the work conducted by D. Swanson for the Deepwater Slough Restoration Feasibility for the Skagit System Cooperative (Sheldon et. al., 1996). The scope of the Iverson Farm study is such that detailed analysis of verified existing use by wildlife species has not been attempted. The presence of habitat features and landscape setting has informed the assumption that the following 12 assemblages use the existing habitats in some manner in existing conditions (examples of species provided, not all species are listed):

Amphibians	Chorus frogs, NW salamanders, red-legged frog
Reptiles	Painted turtles, garter snakes, bull snakes
Shorebirds	Killdeer, yellow legs, snipe, dowitchers, plovers
Wading Birds	Great blue heron, green heron, bittern
Waterfowl	Mallard, gadwall, wigeon, swans, cormorants, brant
Raptors/Owls	Bald eagle, peregrines, owls, osprey, sharp shin hawk
Marsh and Shrub Nesting Birds	Rails, savannah sparrow, red-wing blkbrd, pheasant
Riparian Forest Birds	Woodpeckers, hummingbirds, crows, ravens, flycatchers
Large to Medium Terrestrial Mammals	Black tailed deer, raccoon, coyote, skunk
Small Terrestrial Mammals	Shrews, voles, moles, rabbits, mice
Aquatic Mammals	Beaver, muskrat, river otter

2.4.2 Island County Species of Local Importance

The following species have been noted by Island County Code to be Species of Local Importance:

Species		For these Activities
Great blue heron	*Ardea herodias*	Nesting
Common loon	*Gavia minor*	Nesting
Osprey	*Pandion haliaetus*	Nesting
Pileated woodpecker	*Dryocupus pileatus*	Nesting
Trumpeter swan	*Cygnus buccinator*	None specified; assumed migration and/or wintering habitat

For Great Blue Heron and Pileated Woodpecker, none of the Alternatives will have an effect on their nesting behaviour, as they both nest in upland forest settings that shall remain unaltered by any Alternative. Common loon could nest along the shoreline of the brackish marsh on the interior of the dikes, but given the proximity of the trail location and the extreme sensitivity of this species to humans and domestic dogs, it seems highly unlikely. Any Alternative that eliminates or reduces the brackish marsh would therefore have some (though very slight) potential to effect loon nesting. Osprey would have a net benefit from those Alternatives that would result in the creation of additional intertidal habitats: channel, mudflat or vegetated marshes where osprey could effectively hunt their aquatic prey. Nesting locations for osprey are usually in a dead topped conifer or snag with unrestricted flight access: it is unlikely that the trees assumed to be killed by any of the proposed Alternatives would provide adequate nest sites. It is unknown what benefit or impact the Alternatives would have on trumpeter swans, as they use both mudflat and saltmarsh habitats, as well as the open ponds ,channels, brackish marsh and agricultural fields in the existing conditions. There may perhaps be no net effect on swan use.

2.5 Ecosystem Function

There is an inherent danger is assessing the relative merits of the restoration Alternatives by looking only at fish and wildlife and agricultural uses as non-related parts of a whole ecosystem. In an estuarine system, the key to maximizing benefit is physical connectivity: water moving into and out of a system transports physical and dissolved nutrients from the estuary out into the near-shore environments where benefits occur to the entire suite of the marine ecosystem. As noted in the Deepwater Slough report (Sheldon et. al., 1996), " Vegetated shallows, marshes and mudflats are the most valuable habitat types for primary productivity (through the uptake of nutrients into the food web through photosynthesis), processing of detritus by detritivores, as nursery areas for juvenile fish, and as waterfowl habitat. The estuarine food web includes the benthic primary producers such as micro algae (diatoms) which are present throughout the estuary in shallow subtidal or intertidal mudflats; these are fed upon by benthic invertebrates which also consume detritus (derived from intertidal marshes and upstream sources). The benthic invertebrates form an extremely important food source for fish, shorebirds, and some waterfowl."

Iverson Farm is located within the shallow waters of Livingston Bay in Port Susan which also includes the 4,000 plus acres of intertidal marsh and mudflat habitats at the mouth of the Stillaguamish River (recently purchased by the Nature Conservancy) and Triangle Cove, immediately to the south. This area provides a myriad of habitat types for a wide range of aquatic species. It is critical to the health and carrying capacity of fish stocks from the Stillaguamish River watershed, and as such, Alternatives for restoration should be evaluated within that greater ecosystem context.

2.6 Existing Habitat Use

Table 1, below, provides a summary matrix of the relative uses of each existing habitat by each wildlife assemblage identified for this study. Each assemblage is identified as to whether it uses each habitat on a scale of low to moderate to high. Given that each assemblage represents multiple species, often with diverse feeding, breeding and/or rearing and refuge needs, this type of qualitative scaling vastly simplifies complex ecological relationships, however it is as specific as this study can accomplish given the scope and timing. Fish are not included on the summary matrix, as it is assumed for this study that all fish species will use all available aquatic habitats: channels, mudflats, and vegetated marshes. In later summary tables, the expected relative change in presence of each habitat type is estimated per each Alternative.

Table 1 Habitat Use By Wildlife Assemblages

	Mud Flat	Low Salt Marsh	High Salt Marsh	Open Water Pools[1]	Scrub Shrub	Brackish Marsh	Mesic Forest	Wetland Forest	Upland Forest	Ag. Fields
Amphibians	None	None	None	Low/None	Low	None	High	High	High	Low
Reptiles	None	None	Low	None	Low	None	Low	Low	Moderate	Moderate
Shorebirds	High	High	Moderate	Low	None	Low	None	None	None	Low
Wading Birds	High	High	High	High	None	High	None	None	Low/ Moderate	Moderate
Waterfowl	High/ Moderate	High/ Moderate	High/ Moderate	High	Low	Moderate	Low	Low	Low	Moderate[2]
Raptors/Owls	Low	Low/Mod	Low/Mod	Low	Low/Mod	Low	Low/Mod	Low/Mod	High	High
Marsh and Shrub Nesting Birds	Low	Low	Moderate	High/ Moderate	High	High/ Moderate	Low	Low	Low	Low/ Moderate
Riparian Forest Birds	Low	Low	Low	Low	Low	Low	High	High	High	Low
Large to Medium Terrestrial Mammals	Low	Moderate	Moderate	None/Low	Moderate	None	Moderate	Moderate	High	High/ Moderate
Small Terrestrial Mammals	Low	Low	Low/Moderate	Low	High	High/ Moderate	High	Moderate	High	High
Aquatic Mammals	Low	Moderate	Moderate	Moderate/ High	Low/High	Moderate/ High	Low/ Moderate	Low	Low	Low

[1] Pools are open water channels behind the dike; most are brackish, although channel/pools at the south end may be less saline
[2] Use of agricultural fields by waterfowl is dependent upon crops: grain crops could be of high benefit to waterfowl.

3.0 ALTERNATIVES

As noted previously, the primary focus of this feasibility study is to analyze the feasibility and consequences of various Alternative approaches to restoring tidal influence at the Iverson Farm site. Four Alternatives are briefly described below.

3.1 No Action

No Action Alternative would mean leaving the Iverson Farm property in its existing conditions, with the assumption that it implies a commitment to maintenance of the tide gate in a functional manner to preclude unplanned dike breaching and/or failure.

3.2 Full Restoration

This Alternative assumes that the entire 100 acre site behind the existing dike would be restored to tidal influence. The western portion of the dike would be removed to match the existing grades of the surrounding salt marsh. The eastern portion of the dike would be left intact to preserve upland shrub habitat on the dike and saltmarsh community outside the existing dike. This Alternative also assumes that the Long Beach community water line would be necessary (PWA, 2001). Material removed from the dike would be used to fill existing unwanted ditches. Tidal inundation would result across the entire Iverson Farm site. The outlet would initially be widened to 95 feet and excavated to a depth of 10 feet below MHHW (depth –4.8 ft. NGVD). It would result in approximately 100 acres of newly inundated area (PWA, 2001) and would require a protective dike to be installed between the estuary and the Long Beach access road. See PWA Figure 13 in Appendix D of this document.

3.3 Dike Setback

This Alternative assumes that roughly ½ of the area currently diked would be restored to inter-tidal influence. A new cross-dike would be placed mid-way to the south of the existing cross-dike to protect the water main. The cross-dike would parallel the road, heading north along the east side of the estuary to assure flood protection for the residences on the north end of the road. It is assumed that the initial opening would be 85 feet wide (invert elevation of –4.3 ft NGVD), and it would shrink to approximately 52 feet wide and 8.5 feet below MHHW (PWA, 2001). The proposed new channel opening for the cross-dike alternative would be centered around the existing opening of the tide gate. See PWA Figure 15 in Appendix D of this document.

3.4 Self-regulating Tide Gate

This Alternative is based on the goal to increase hydrologic connectivity between the habitats inside and outside the dikes, without subjecting the entire interior area to flooding and inundation, and to maintain some of the complexity of interior habitats and dike upland habitat. A self-regulating tide gate would allow approximately 50 acres of the interior of the existing habitat to be inundated, without the need for protective berms for either the residences or the water main (PWA, 2001). See PWA Figure 16 in Appendix D of this document.

4.0 FUTURE CONDITIONS: BY ALTERNATIVE

The discussion below is provided in qualitative terms of an expected shift in availability of habitat type for each wildlife guild and all the fish species, for each proposed Alternative. The discussion is done in a qualitative manner because there is no ability, within the scope of this project to quantify actual habitat gain or loss by Alternative. Part of the challenge, as stated in the beginning of this report, is that the habitats resulting from any restoration action will be subject to a wide range of physical, chemical, and biological variables that will ultimately control the final outcome. Fully informed predictions cannot be generated within this scope.

For all Alternatives, the upland forest along the western margin hillside is not expected to be altered. As noted in Section, 3.4.2, no significant change to species of local importance, as defined by the County, would be anticipated from any Alternative. Fish results are 'lumped' because of many similarities between how the various species use these types of habitats, and because we do not have substantiated data or literature that clearly addresses what species will be using these habitats. Where appropriate a summary matrix is provided which illustrates the relative change in habitat types available for each of the wildlife assemblages and fish, by Alternative

4.1 No Action

The No Action Alternative would assume that no actions would be taken to remove or alter the existing dike and tide gate system, except to assure long-term maintenance and repair to assure that dike failure is precluded (or quickly responded to in case of failure). In this Alternative the extent and distribution of habitat types outside the dike would remain relatively constant in the foreseeable future. Changes might be manifested within the existing mudflat area if accretion allowed for the establishment of colonizing species such as Spartina (a non-native invasive in this setting). Colonization by Spartina may increase the rate of additional sediment deposition, therefore increasing elevation. Although increased substrate elevation would be beneficial for native saltmarsh plants, they have been shown to be poor competitors to established Spartina. Increases in the heights of substrates will result in conditions more advantageous for native saltmarsh species, however competition with aggressive non-natives may preclude the natives from becoming established. However, many variables such as source of sediment, frequency and intensity of storm generated waves can influence the accretion or erosion of the mudflats: elevation relative to tidal inundation determines the extent and composition of plant colonization.

Inside the dike, the No Action Alternative would result in the existing natural vegetation communities proceeding through successional stages to mature systems. The shrub-dominated communities would continue to shift towards a forested community. In upland settings, it would be expected that red alder would succeed to Douglas fir and hemlock (seed source available from the western hillside margin of the site). The very dry, well-drained habitats on the dike proper might continue to be colonized further by madrone and oceanspray, two native species particularly adapted to dry conditions. The moister shrub communities present within the active agricultural zones might succeed to red cedar and/or Sitka spruce (*Picea sitchensis*) dominated woodlands.

The red alder dominated mesic and wet forests, along the western edge of the diked area would likely progress to coniferous dominated forests…species composition would be dictated by ultimate saturation level of the soils. Wetter areas might be expected to establish a red cedar and Sitka spruce canopy, drier conditions would trend towards Douglas fir and hemlock dominance. Both forests would expect to establish a compliment of native sub-canopy and shrub communities beneath the canopy.

The agricultural lands might, at first, be expected to continue to be used for active agriculture. However, feedback from the current lessor, as related to County staff, is that the land is quite marginal for economically viable farming due to the limit of crop choices in the wet conditions and short growing season. Access into the fields in spring for plowing and planting is delayed due to excess moisture. Additional maintenance activities such as channel dredging and/or tighter control of the tide gates might be necessary to make the area truly viable for economically profitable crops.

If commercial agriculture in the traditional sense is not viable on the site, other possibilities have been discussed by County staff with Natural Resource Conservation Service staff (NRCS) including considering agricultural practices for species more tolerant of wetness (blueberry fields). One alternative discussed is whether or not a Tilth organization on Camano would be interested in using the site for small-scale organic farming. Additional consideration might be given to using raised beds throughout the existing fields, to provide for adequate drainage for a broader range of commercially viable crops farmed at a smaller scale than existing conditions.

For the No Action Alternative it should be assumed that the agricultural fields will continue to subside, thereby increasing the extent of their inundation and limiting the viability for crops. If crops and haying practices were eliminated, it is expected that in short order the agricultural fields would first become dominated by pioneering species (usually aggressive non-natives such as Scott's broom and Himalayan blackberry. No other invasive weeds were looked for during our field visits, but additional species would be expected. After the first 5 years (+/-) the weedy invasives would succumb to slower growing, yet still pioneering, species such as red alder, salmonberry, wild rose. Red alder will tolerate the moist soils and it thrives on depleted soils. Once a dense shrub zone is established, then shade tolerant conifers would eventually seed in from the forested hillside up above.

4.2 Full Restoration

Removal of the majority of the outer dike would subject the entire interior of the site to tidal inundation (PWA, 2001). Predicting vegetation establishment in the interior has to be based on the elevations of the existing salt marshes outside the dikes. From the PWA study, the vast majority (estimated at more than 90%) of the area inside of the dike would lie below the elevation of 4.2 feet (NVGD) (see PWA Figure13, in Appendix D). Below elevation 4.2 feet (NVGD) the area would be mudflat and channel habitats. A narrow fringe to the east and in the northeast corner of the area would be between 4.3 to 5.1 feet: this area would establish as low salt marsh. Given that the majority of the area inside the dike has subsided to elevations of 1-3 feet, (NVGD), and the saltmarsh outside the dike begins at roughly elevation 4.5 ft., the depth of inundation by water for high water tides, within the restored zone, would reach depths of up to 2-4 or more feet in the mudflat zone: deeper than the mudflat area outside the dikes in existing conditions. This is too deep for plants to establish, and vegetation restoration would have to be time dependent: until there is sufficient accretion to raise the substrates up to an elevation to support plants. Inside the restored area there would be an increase in channel of various sizes habitats.

The consequence of this alternative would be elimination of all habitats within the diked zone except for channel, mudflat, and some low saltmarsh. Even after 50 years (as projected by PWA based on assumed sedimentation rates, see their Figure13, App. B of this document), the vast majority of the habitat inside the formerly diked area would be un-vegetated mudflat. All the complex upland, fresh and brackish habitat types inside the dike would be eliminated.

The upland habitats on the dike proper would also be lost. This shift in habitat would provide additional habitat for all marine aquatic organisms, fish and shellfish, and wildlife species such as shorebirds and wading birds that utilize such habitats. In addition, removal of the blockage of the tide gates would increase the export of particulate and dissolved organics and nutrients to the near shore and deep-water habits of Livingston Bay. If one assumes that fish are present and using the mudflat, channel and vegetated saltmarsh habitats outside the dike in existing conditions, then this Alternative would provide maximum increase in available habitat for those same species. Given the topography inside the dike, and the presence of the historic channel remnants on the western edge of the site, additional major channels could possibly established along the base of the bluff unless direct action is taken to preclude their re-establishment.

All agricultural uses are assumed to be lost with this Alternative. In their Final report PWA discusses the need for installation of a new dike paralleling the road to assure no flooding of the residential community to the east. The dike, if managed, could be used to established a robust native upland shrub and forest community, however it may be too often used as formal or informal footpath and/or bike path to allow much vegetation regeneration to proceed rapidly.

4.3 Dike Setback

This Alternative is designed to protect the community water main that crossing the interior of the site E/W. Based on the PWA analysis (2001), the majority of the interior space would be mudflat in this Alternative, even after 50 years, with a band of low salt marsh along the eastern boundary. A in the first Alternative, nearly all the interior complex of existing habitat would be lost, with the exception of some of the existing mesic forest and shrub located along the western margin, south of the proposed new cross-dike. The only high marsh identified after 50 years is the remnant high marsh outside the existing dikes, where high marsh is present in existing conditions. See PWA Figure 15, in Appendix D of this report.

In addition this Alternative would result in creation of some upland habitat opportunity on the cross-dike zone. The majority of the agricultural lands to the south would not be converted to intertidal habitat. If the intention is to maintain the use of those lands for agriculture then it may be necessary to make some provisions to regularly maintain the ditches and dikes, and to install a tide gate (or some equivalent) between the field ditches and the newly restored area to assure some movement of water out of the fields is possible. If the agricultural fields are allowed to go fallow in this Alternative then the same relative sequence of pioneering invasives to initial natives to more mature and complex native woodlands should be expected within the agricultural zones.

4.4 Modification of Tide Gates

This Alternative is predicated on using self-regulating tide gates, set to close at a designed maximum based on a calculated volume of water entering the system. Based on the PWA Final study, it appears that in 50 years time this Alternative would establish the most diverse habitat communities per acre of restored marsh of any of the Alternatives. Based on the assumed accretion rates, it is predicted that the interior marsh would have measurable extent of both low marsh and high marsh within 50 years.

The majority of the upland habitats present on the dikes would remain, allowing an upland shrub and eventually forest community to become established. The channels inside the dikes would drastically deepen, in response to the scouring of the tidal flushing twice per day. Channels would broaden and in time, a complex of subsidiary channels would be expected to develop. Filling some of the dredged/straightened channels and allowing or encouraging more convoluted channels would increase the opportunity for more natural channel wandering and dispersal to occur. (It is interesting to note that the future channel pattern compared between the modified tide gate alternative and the cross-dike alternative are nearly identical: if fish habitat is the driver of the Alternatives, there seems to be less reason to consider the large dike opening but cross-dike placement of the cross-dike alternative.

As channels widened and deepened it would be expected that adjacent subsided lands would be subjected to twice daily inundation and flushing. Scour and sediment movement would be influenced by the extent of the tidal prism and subsequent velocities 'controlled' by the armored inlet. Based on extent of tidal inundation, mudflat habitats and channels would be expected within portions of the interior area as well as vegetated marshes. As accretion advanced, low saltmarsh and eventually high saltmarsh would be expected to establish.

Agricultural impacts would parallel the other Alternatives: increased subsidence would result in field getting sequentially more wet and non-productive for many commercially viable crops. As the area within the restoration zone was subjected to twice daily high tides, it could likely affect the ground and surface waters in the fields, causing them to remain saturated longer, and therefore not really viable for farming traditionally.

4.5 Comparative Matrices

The following matrices are provided as summaries of what might occur to wildlife for each proposed Alternative. Table 2, below, provides a summary of how each proposed Alternative may effect the identified habitat types and agricultural uses inside and outside of the dike. Table 3 shows a qualitative assessment of whether or not a particular Alternative is a net benefit or impact (adverse effect) for each wildlife assemblage and for fish. These summaries, by the nature of this study, are broad generalizations and are intended to indicate potential relative trends. Many physical, biological, and chemical processes ultimately would determine ultimate conditions and benefits/impacts from any action.

The assumptions of conditions have to be based on a point in time, therefore, given the speculation by PWA of 50 year conditions, these assessments are based on the assumed community types expected in that time frame (based on PWA models of assumed sediment deposition.)

Values on Table 2, Effects of Alternatives on Habitat Types, are assigned across the following range, which is self-explanatory:

Significant Increase
Increase
Neutral
Decrease
Significant Decrease

Values on Table 3, Effects of Alternatives on Wildlife Assemblages and Fish are assigned as a benefit or impact (adverse effect). The qualifier of 'high' means a significant change, while 'neutral' is self-explanatory.

5.0 DISCUSSION OF ALTERNATIVES

Looking at the estimated results in Table 2 it is clear that the first two modeled Alternatives (full dike removal and cross-dike placement) indicate that channel and mudflat habitat would be gained and all other habitats would be significantly decreased in presence, except for the upland forest, up on the hillside (it remains unchanged from any proposed Alternative in the estuary). Increases in mudflat and channel habitat implies a benefit to fish, wading birds, shorebirds and some aquatic mammals. There would also be some benefit to species that prey upon fish such as gulls, kingfisher, eagle and osprey. Species more dependent upon the marshes and vegetated habitats inside the dike would loose habitat opportunity.

Some wildlife assemblages appear neutral to the Alternatives: this is partially because some assemblages such as waterfowl have members that will utilize freshwater, brackish or saltwater marshes or mudflats (not necessarily the same species, but differing species within the same assemblage). What is beneficial to one species may be adverse to another, but they equalize each other out. The same can be said of the raptors: those that prey on aquatic species may find more prey available in the habitats resulting from the two Alternatives, however those hawks that prey on terrestrial species (red tail hawks and rough-legged hawks for example) may find a decrease in appropriate habitat for preferred prey.

Table 2 Effects of Alternatives on Habitat Types

	No Action	Full Dike Removal	Partial Dike Removal	Modified Tide Gates
Channels	Neutral	Sig Increase	Increase	Sig Increase
Mud Flat	Neutral	Sig Increase	Increase	Increase
Low Salt Marsh	Neutral	Increase/ Sig Increase	Increase	Sig Increase
High Salt Marsh	Neutral	Increase/ Sig Increase	Increase	Sig Increase
Open Water Pools	Neutral	Sig Decrease	Sig Decrease	Sig Decrease
Scrub Shrub	Decrease	Sig Decrease	Sig Decrease	Sig Decrease
Brackish Marsh	Neutral	Sig Decrease	Sig Decrease	Sig Decrease
Mesic Forest	Neutral	Sig Decrease	Decrease	Sig Decrease
Wetland Forest	Neutral	Sig Decrease	Decrease	Sig Decrease
Upland Forest	Neutral	Neutral	Neutral	Neutral
Agricultural Fields	Unknown	Sig Decrease	Decrease	Sig Decrease

Table 3 Effects of Alternatives on Fish and Wildlife Assemblages

	No Action	Full Dike Removal	Partial Dike Removal	Modified Tide Gates
Fish	Neutral	High Benefit	Benefit	High Benefit
Amphibians	Neutral	High Impact	High Impact	High Impact
Reptiles	Neutral	High Impact	High Impact	High Impact
Shorebirds	Neutral	High Benefit	Benefit	High Benefit
Wading Birds	Neutral	Benefit	Benefit	High Benefit
Waterfowl	Neutral	Neutral	Neutral	Benefit
Raptors/Owls	Neutral	Neutral	Neutral	Neutral
Marsh/Shrub Birds	Neutral	Impact	Impact	Impact
Riparian Forest Birds	Neutral	High Impact	Impact	Neutral
Large to Medium Terrestrial Mammals	Neutral	High Impact	Impact	Impact
Small Terrestrial Mammals	Neutral	High Impact	Impact	Impact
Aquatic Mammals	Neutral	Benefit	Benefit/Neutral	Benefit

Some assemblages, such as some wading birds (Great Blue Heron), use a range of habitat types, from marshes to agricultural fields, therefore the Alternatives may benefit or even be neutral, as they will utilize any and all habitat types present.

This comparative analysis is done to compare between the Alternatives, not to compare the restoration of Iverson Farm as a measurable benefit to any particular species or wildlife assemblage or fish population, within the landscape context in which the site lies. In other words, when the assessment is for significant benefit, that means in comparison to the No Action Alternative, not to the resource in question in the context of Port Susan or even all of Livingston Bay…the scale of that landscape is simply too large to allow such a conclusion.

Briefly put, the full removal Alternative would have a significant impact on the freshwater/brackish communities, resulting in a decline in species associated with them. That Alternative results in the largest gain in channel and mudflat habitat, a benefit for fish. Even after 50 years of accretion (based on the PWA modeling), there still would be little increase in vegetated marsh within the estuary, a key goal for fish and other wildlife guilds.

Having said that, it is still sometimes important to look at the proposed actions within a greater watershed/landscape context to determine the relative scale of benefit or impact within the greater vicinity. For this case in point, Livingston Bay and Triangle Cove, are existing intertidal marine systems to which these proposed Alternatives could be compared and contrasted. The primary issue of fish benefit or adverse effects over existing conditions for any one of the Alternatives can be put into a landscape context to gain a different perspective on the relative benefits gained or impacts accrued.

For any of the proposed Alternatives, the majority of the resultant habitat would be mudflat and channel habitats for a minimum of approximately 50-100+ years (PWA,2001). Within Livingston Bay the predominant habitat present is mudflat, it is not a limiting factor to fishery stock survival or recovery. In consideration of any prioritization of Alternatives a serious accounting for delay in vegetated saltmarsh to become established needs to be accepted. Restoration of these habitats is not as easy or as rapid as other wetland or terrestrial habitats. One has to have the long-term vision and patience to allow accretion to slowly develop the substrate elevations that will allow the formation of saltmarsh vegetation. For public projects, conducted with public funds, this can be particularly challenging, as many expect a more instantly quantifiable benefit from such a dramatic action.

Prioritization of goals and functions has to guide the prioritization of choices for these Alternatives. If increased channel and saltmarsh habitat is the 'driver', then the more land-mass exposed to tidal inundation, the more channel, mudflat and eventually, saltmarsh habitats will be created. However, benefit for fish can also be provided by increasing their available prey by increasing export of organics (primary productivity) through the export of dissolved and particulate organics and nutrients with every tidal cycle. Export of organics also strongly influences production in the shallow near-shore zones for macro-invertebrates, eel-grass and herring: all positive influences on fish viability (WCC, 2000). Modifying the tide gates to allow easier and consistent access for fish into the interior habitats, without completely flooding the interior may be a less-than ideal solution, but one that meets more goals than other 'extremes'.

If maintenance of agricultural practices, even modified from the existing cropped fields, is identified as a priority, then serious engineering design and long-term maintenance considerations have to be instigated to assure that adequate drainage is maintained within the soils identified for agricultural uses. If a partial restoration Alternative is considered, the ultimate design will have to incorporate some manner in which to allow groundwater and/or flood waters washed in from over the eastern beach berm (the row of homes) to be removed from the fields.

6.0 REGULATORY IMPLICATIONS

Any proposed action on this site that would influence the wetlands behind the tide gates would require the approval of a Hydraulic Permit Application to the Washington State Department of Fish and Wildlife. Any action that might effect wetlands inside or outside the dikes would be regulated by the Army Corps of Engineers, through Section 404 of the Clean Water Act. Such activity would likely trigger the need for an Individual Permit from the Corps. This would also trigger the need for a Section 401 Water Quality Certification from Ecology.

The requirement for an Individual Permit from the Corps would also trigger the necessity of conducting a Biological Assessment for all listed Federal endangered species and their habitats: Puget Sound Chinook, Bull Trout, Bald eagle, Marbled Murrelet, herring, and eel-grass beds. The Biological Assessment would be required to be reviewed by the National Marine Fisheries Service and U.S. Fish and Wildlife Service.

7.0 REFERENCES

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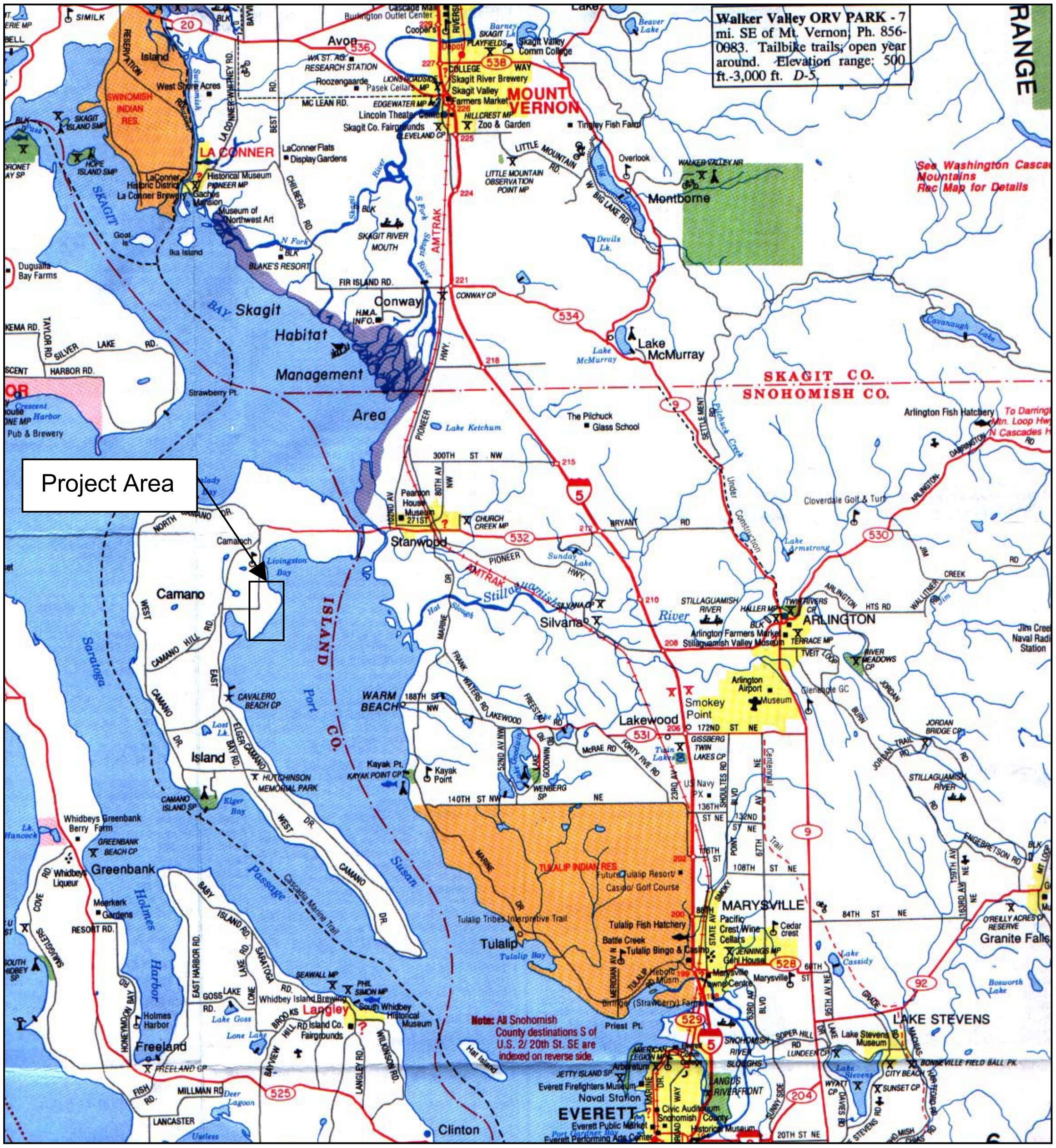
Washington Conservation Commission. Water Resource Inventory Area 6: Habitat Limiting Factors. 2000. Available at: www.conserver.org/salmon/reports/wria06sum.shtml

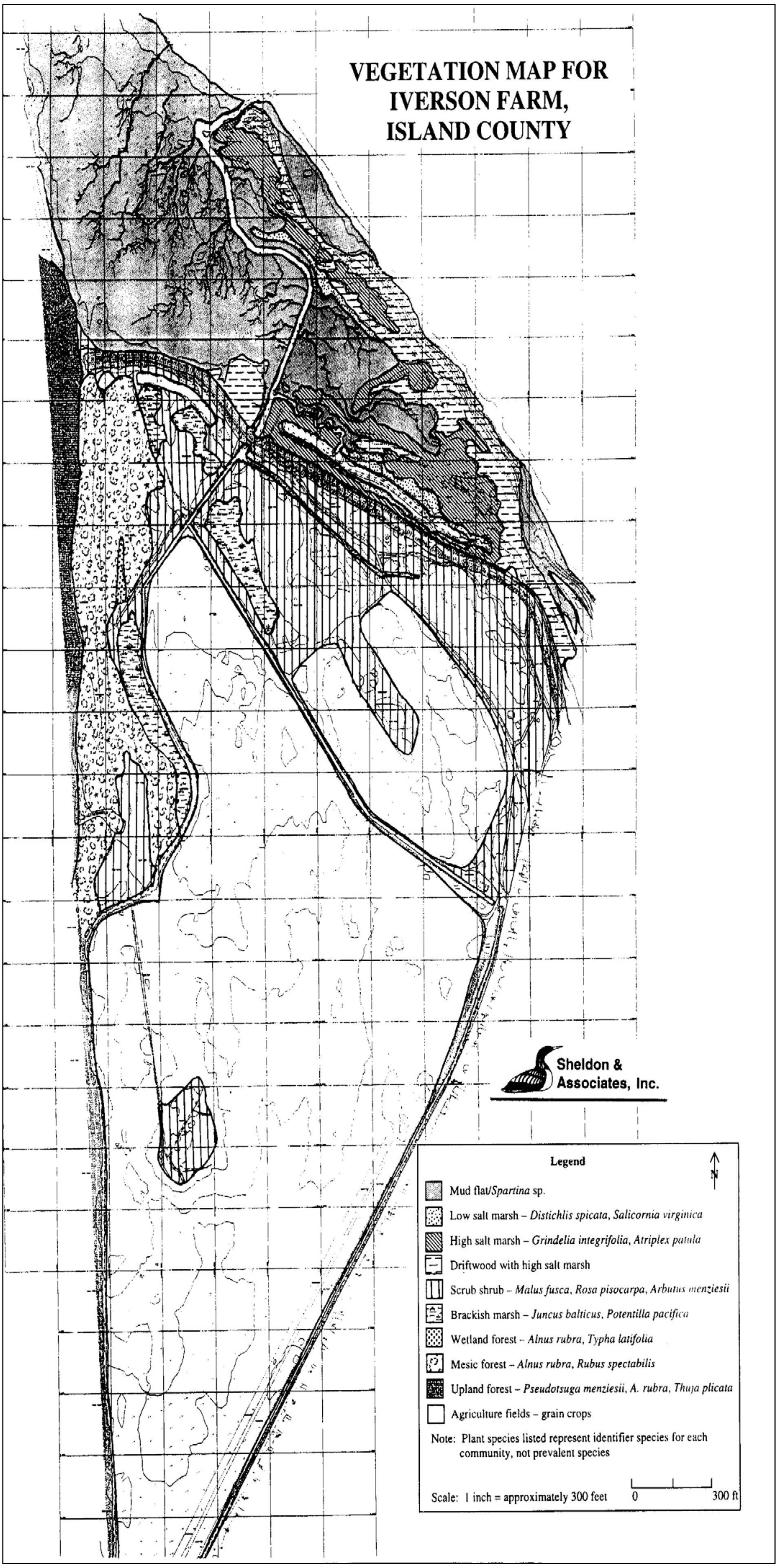
Appendix A

Vicinity map

Existing Vegetation Communities Map

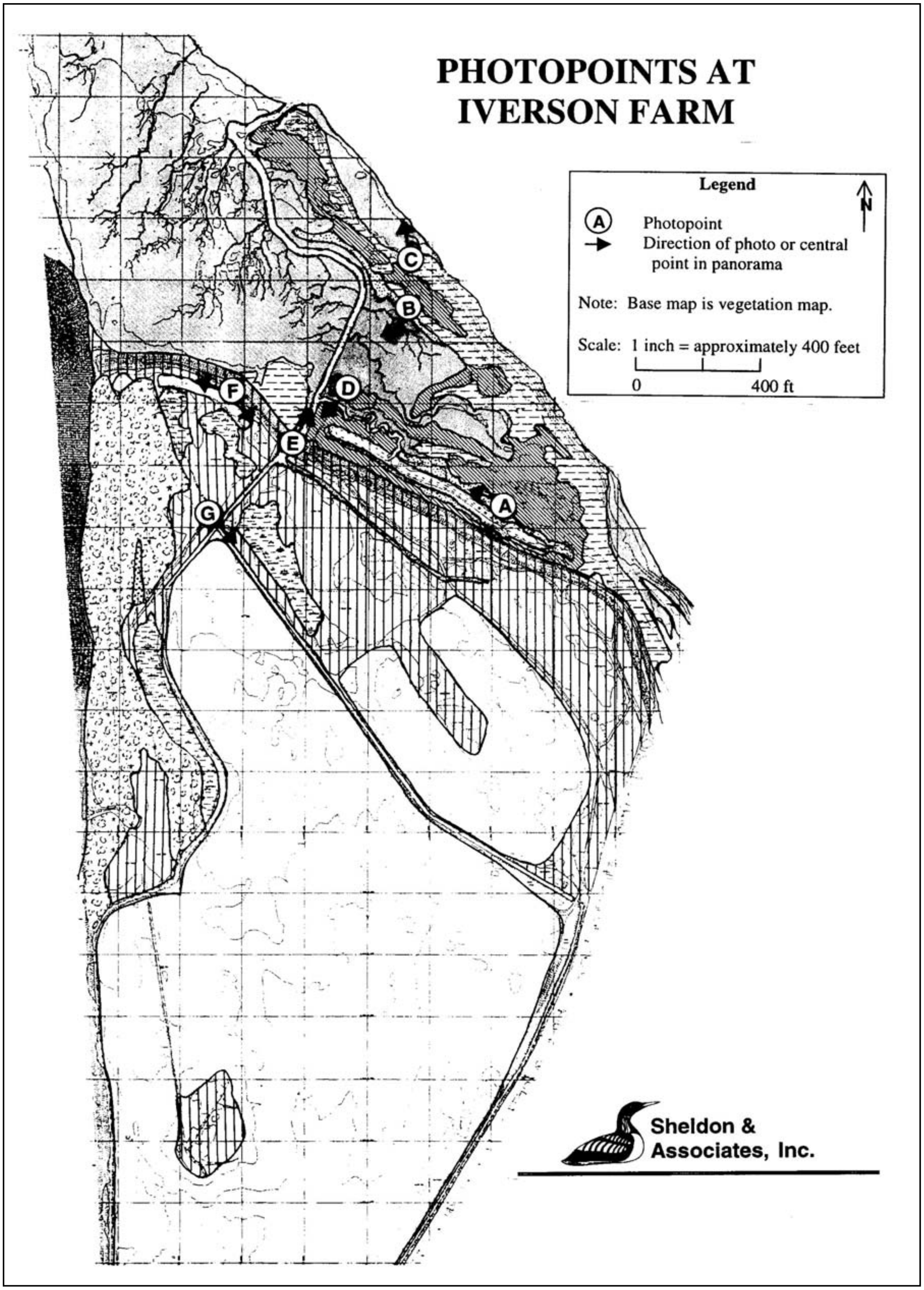


Vicinity Map – Iverson Farm, Island County


VEGETATION MAP FOR
IVERSON FARM,
ISLAND COUNTY
Sheldon &
Associates, Inc.
Legend
N
Mud flat/Spartina sp.
Low salt marsh – Distichlis spicata, Salicornia virginica
High salt marsh – Grindelia integrifolia, Atriplex patula
Driftwood with high salt marsh
Scrub shrub – Malus fusca, Rosa pisocarpa, Arbutus menziesii
Brackish marsh – Juncus balticus, Potentilla pacifica
Wetland forest – Alnus rubra, Typha latifolia
Mesic forest – Alnus rubra, Rubus spectabilis
Upland forest – Pseudotsuga menziesii, A. rubra, Thuja plicata
Agriculture fields – grain crops
Note: Plant species listed represent identifier species for each community, not prevalent species
Scale: 1 inch = approximately 300 feet
0
300 ft

APPENDIX B

Composite Photographs from On-site


PHOTOPOINTS AT
IVERSON FARM
Legend
N
A
Photopoint
Direction of photo or central
point in panorama
Note: Base map is vegetation map.
Scale: 1 inch = approximately 400 feet
0
400 ft
A
B
C
D
E
F
G
Sheldon &
Associates, Inc.

Photopoint A – Salt marsh from eastern end of borrow pits looking west to northwest (from left to right).

Photopoint B – Salt marsh from log debris and berm looking south to northwest (from left to right).

Photopoint C – Salt marsh shoreline edge looking northwest to north (from left to right).

Photopoint D – Salt marsh channel at mid-tide looking southwest towards tide gate.

Photopoint E – Salt marsh area nearing high tide, looking northwest to south east from the tide gate (from left to right).

Photopoint G – Ditches inside dike looking northeast to southwest (from left to right).

Photo taken from Point F looking west along inside borrow pit.

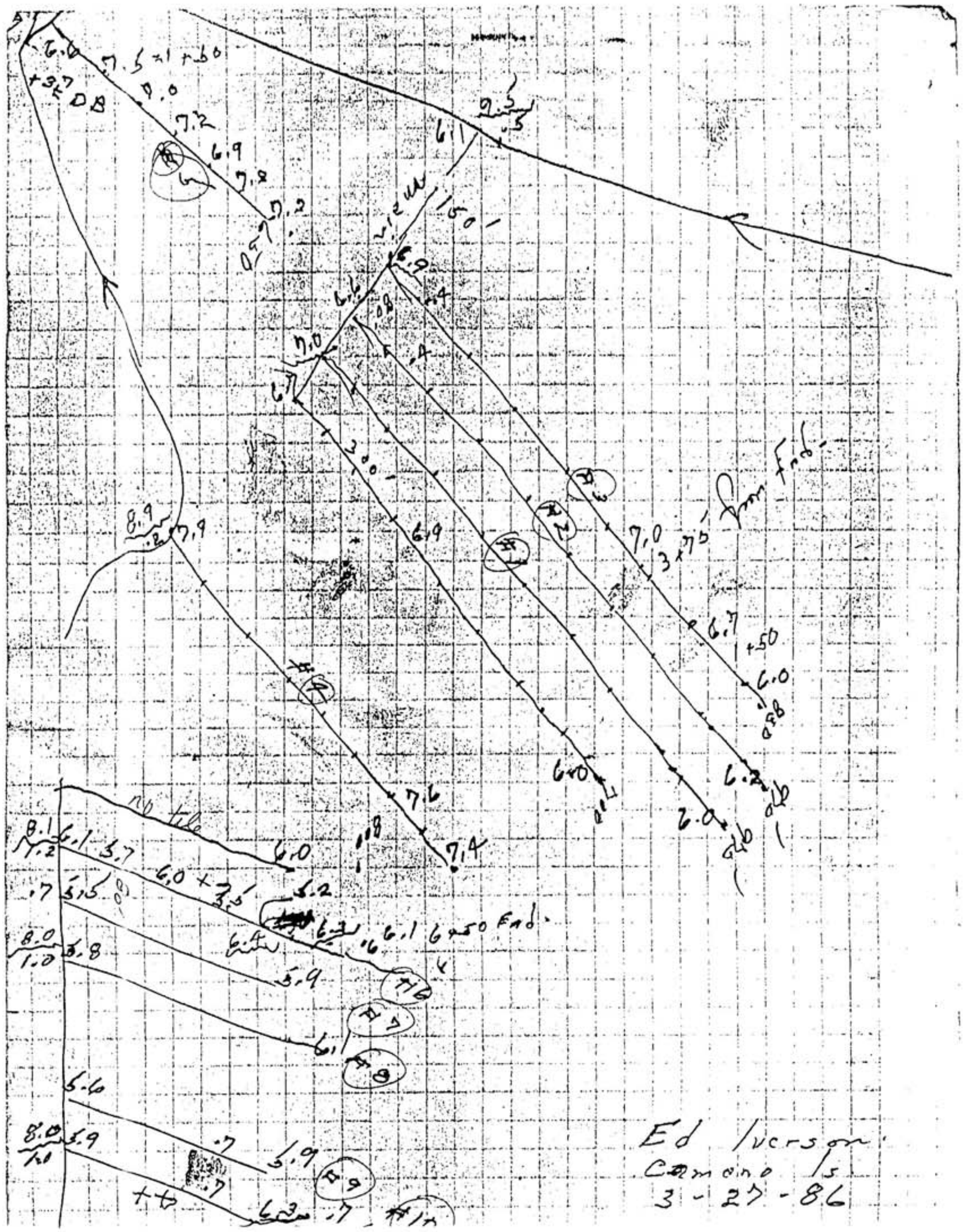
Photo taken from Point F looking southeast along inside borrow pit.

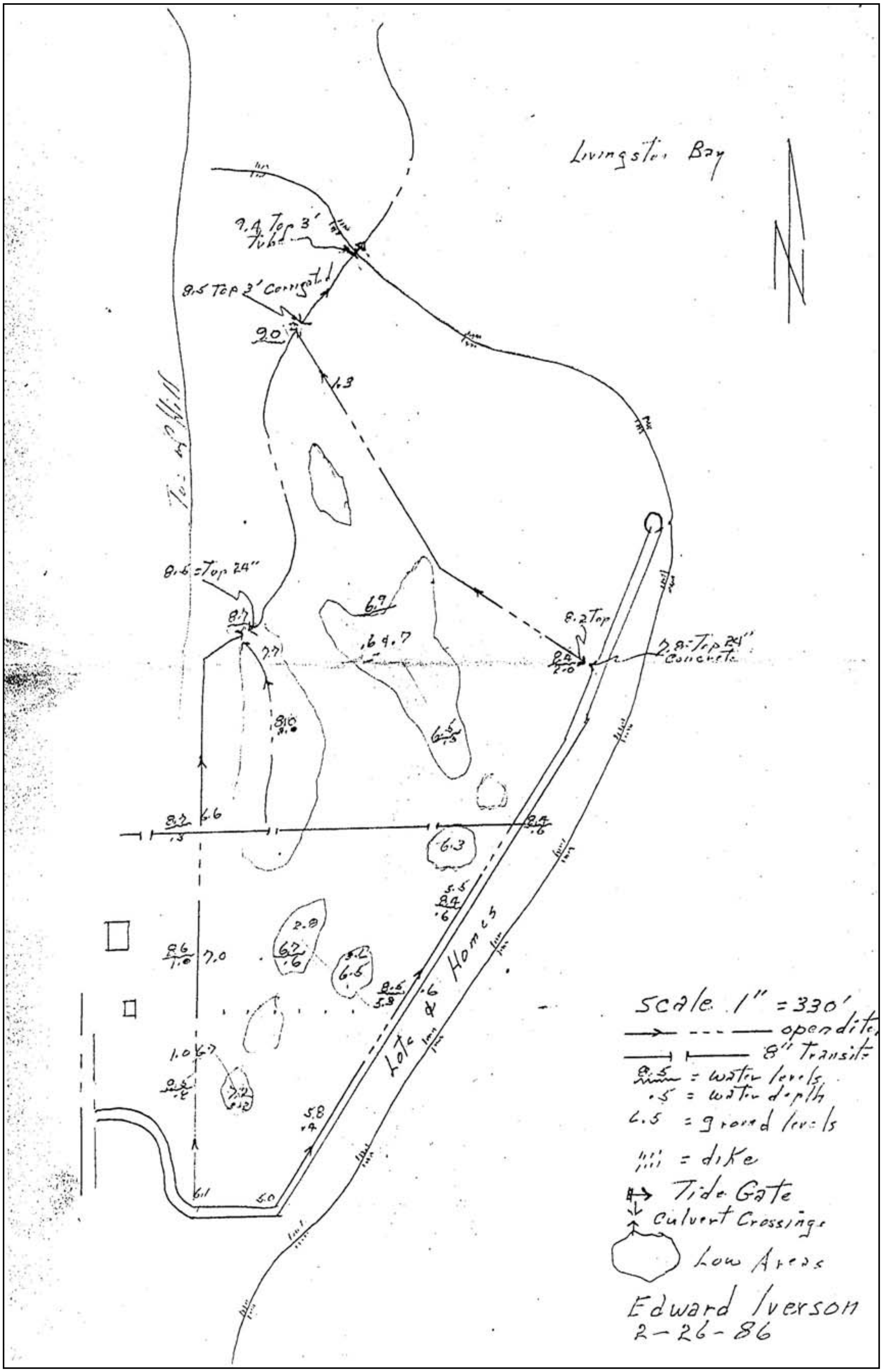
APPENDIX C

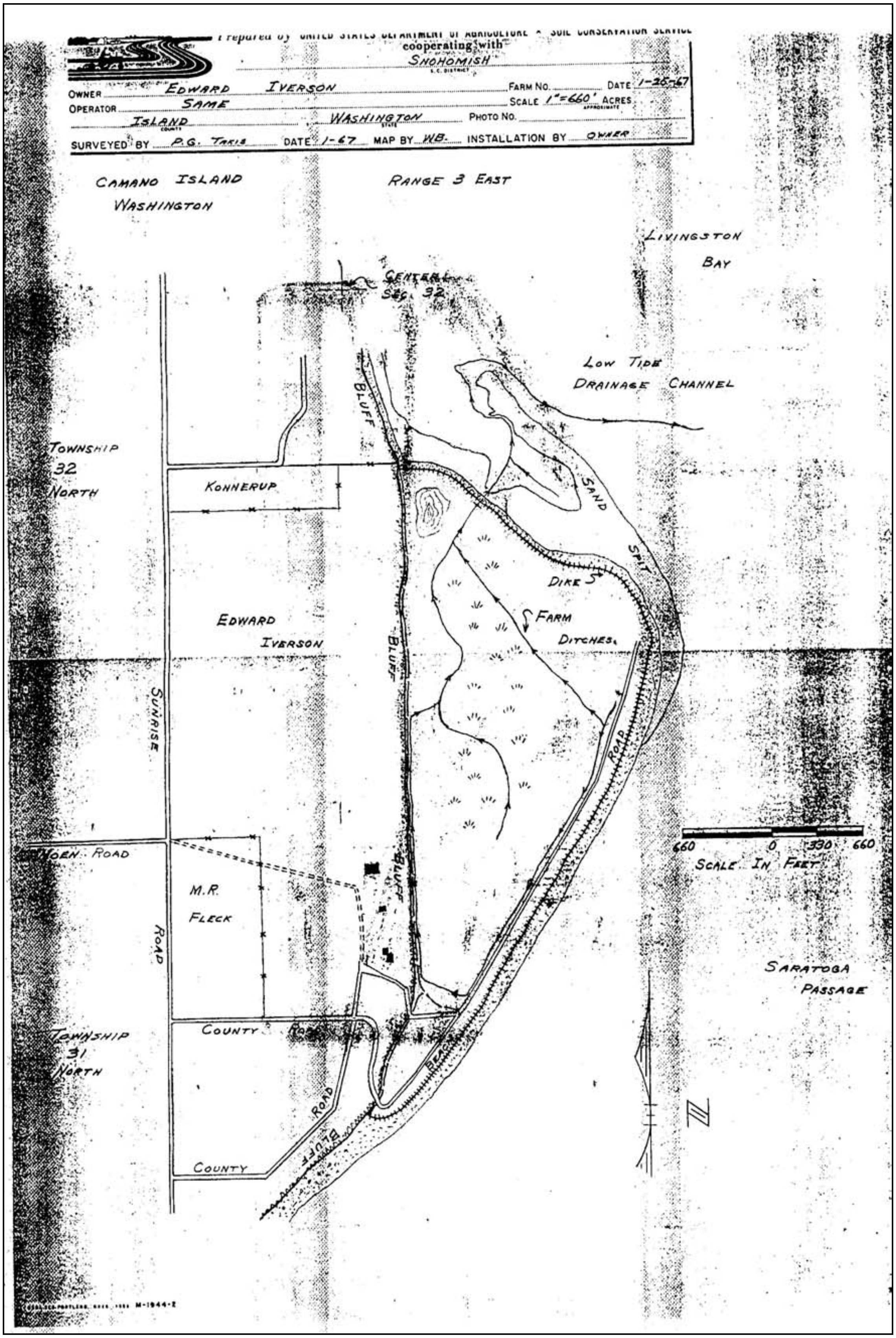
Drain Tiles Map

DRAIN TILES MAP

Stem Island Design – see SCS calculations for revised tile sizes. 7/28/86




Livingston Bay
9.5 Top 3' Corrugated
9.0
8.6 = Top 24"
8.2 Top
7.8 = Top 24" Concrete
Lots & Homes
Scale 1" = 330'
open ditch
8" Transite
= water levels
.5 = water depth
6.5 = ground levels
= dike
Tide Gate
Culvert Crossings
Low Areas
Edward Iverson
2-26-86


Prepared by UNITED STATES DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE
cooperating with
SNOHOMISH
OWNER EDWARD IVERSON
FARM NO.
DATE 1-25-67
OPERATOR SAME
SCALE 1"=660'
ACRES
ISLAND
WASHINGTON
PHOTO NO.
SURVEYED BY P.G. TAKIS
DATE 1-67
MAP BY WB.
INSTALLATION BY OWNER
CAMANO ISLAND
WASHINGTON
RANGE 3 EAST
LIVINGSTON
BAY
CENTER SEC. 32
LOW TIDE
DRAINAGE CHANNEL
TOWNSHIP
32
NORTH
KONNERUP
BLUFF
SAND
SPIT
DIKE
FARM
DITCHES
EDWARD
IVERSON
SUNRISE
ROAD
660
0
330
660
SCALE IN FEET
M.R.
FLECK
ROAD
SARATOGA
PASSAGE
TOWNSHIP
31
NORTH
COUNTY
ROAD
COUNTY
M-1944-Z

Appendix D

Phil Williams & Associates Alternatives

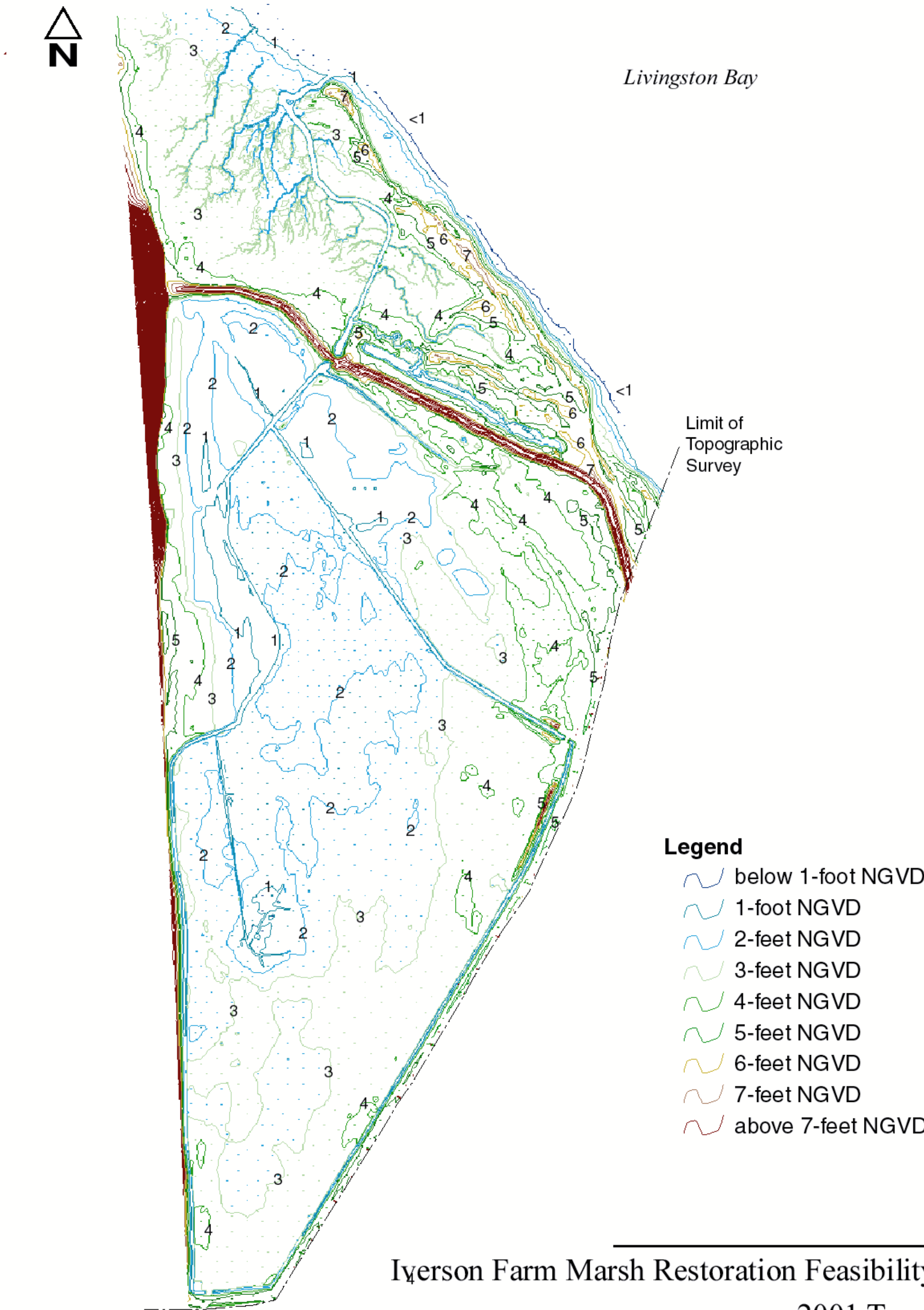
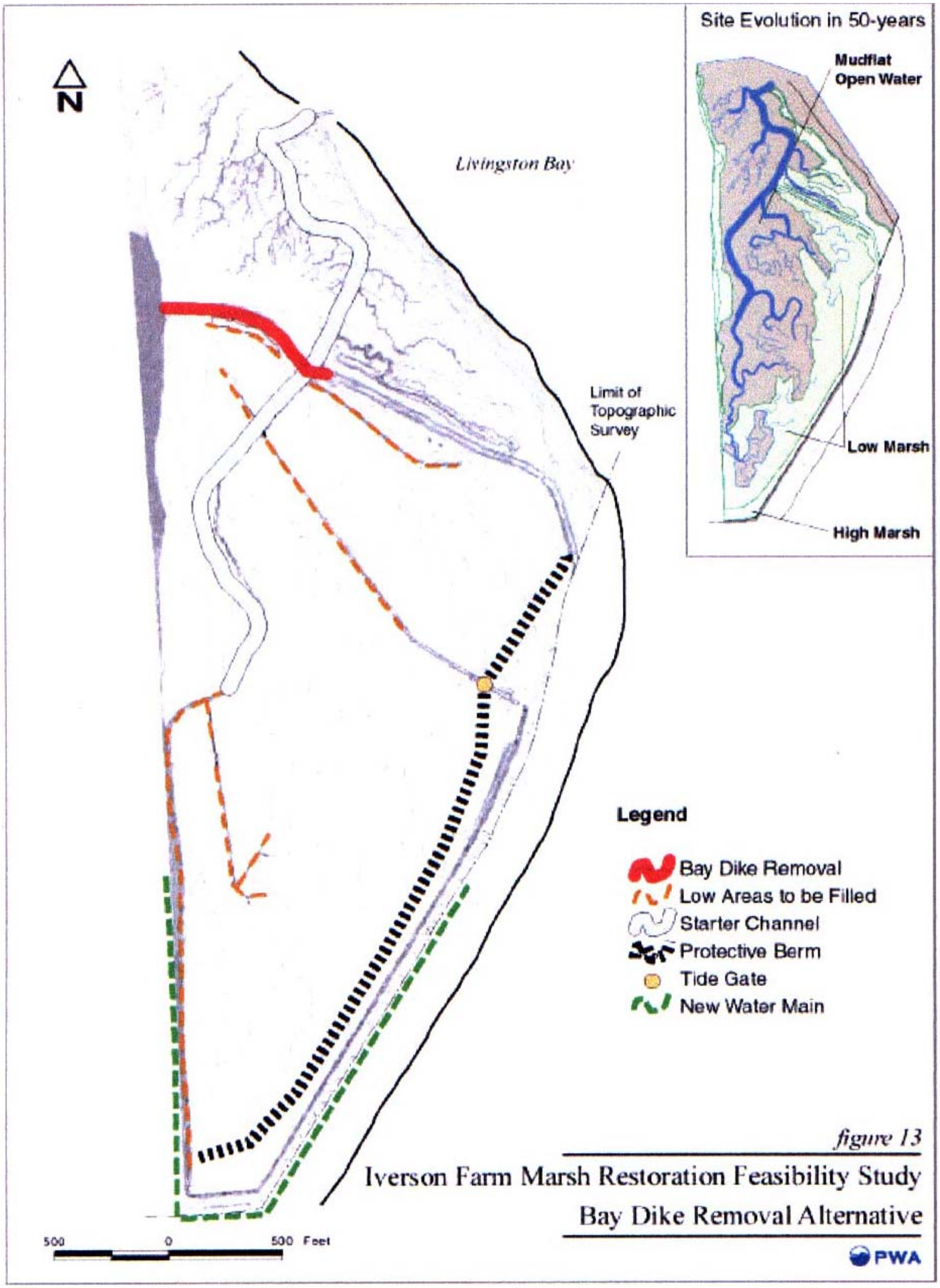


figure 6

Iverson Farm Marsh Restoration Feasibility Study

2001 Topography


Site Evolution in 50-years
Mudflat
Open Water
Low Marsh
High Marsh
N
Livingston Bay
Limit of Topographic Survey
Legend
Bay Dike Removal
Low Areas to be Filled
Starter Channel
Protective Berm
Tide Gate
New Water Main
500
0
500 Feet
figure 13
Iverson Farm Marsh Restoration Feasibility Study
Bay Dike Removal Alternative
PWA

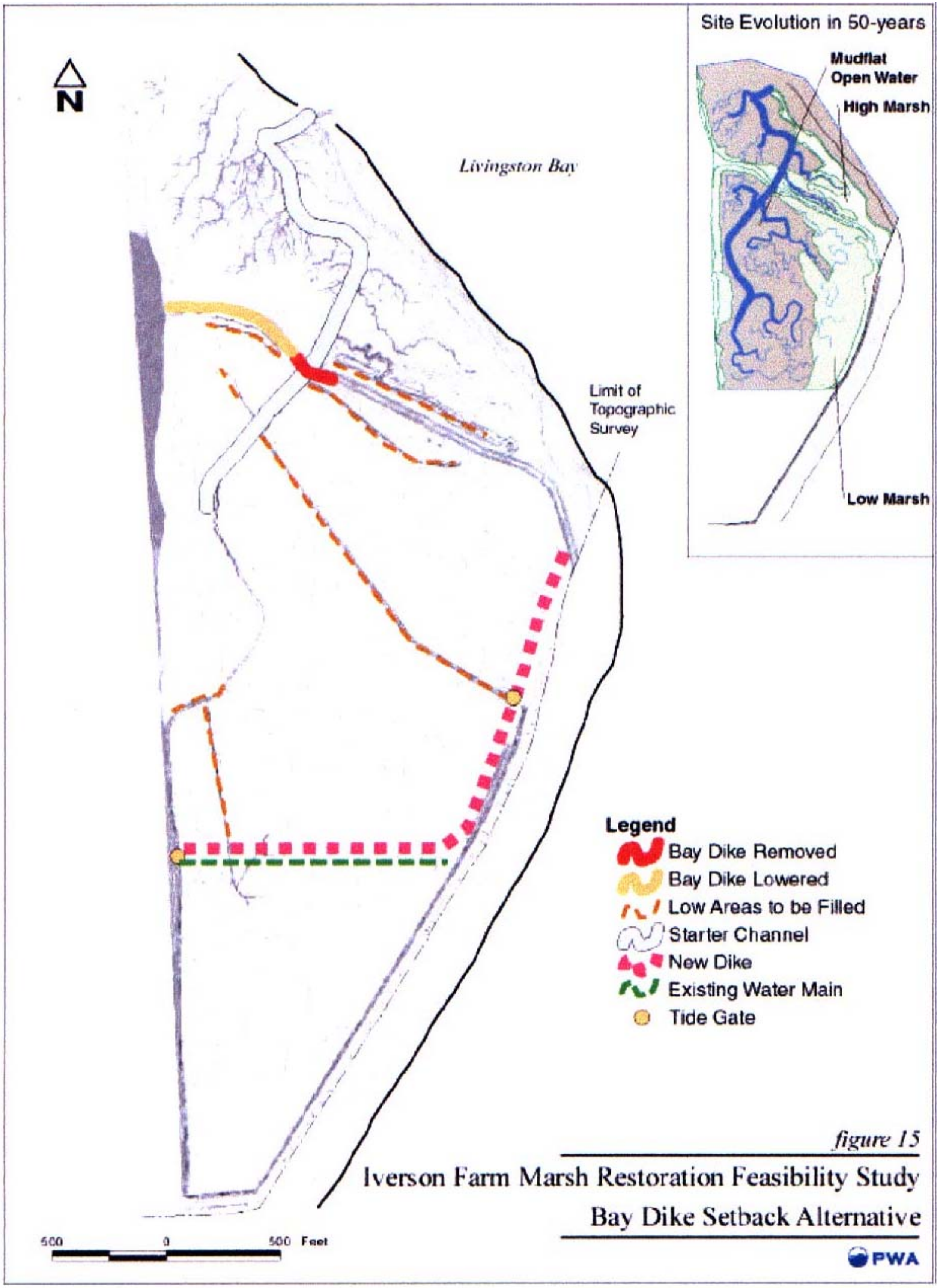


figure 15

Iverson Farm Marsh Restoration Feasibility Study

Bay Dike Setback Alternative

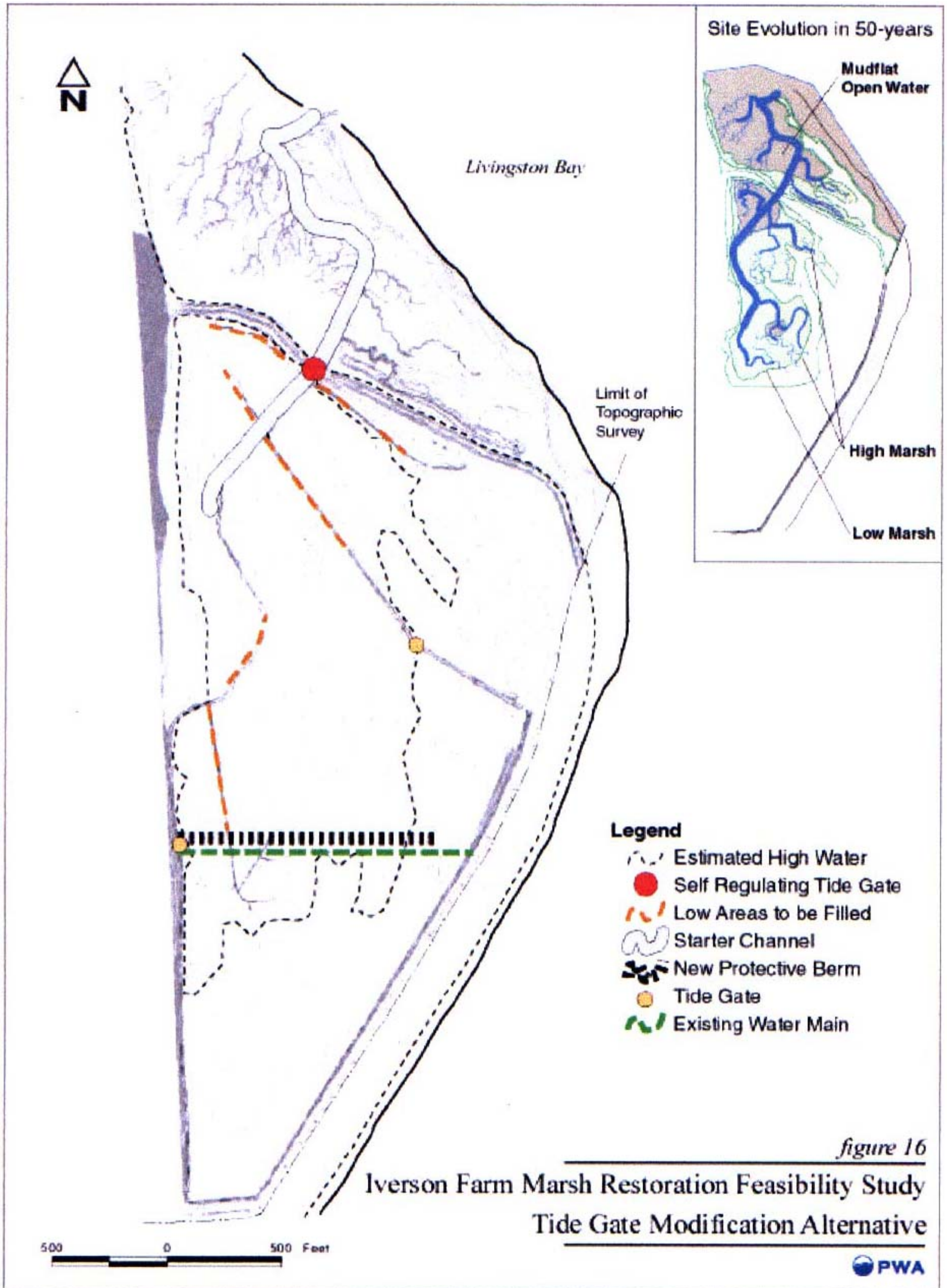


figure 16

Iverson Farm Marsh Restoration Feasibility Study

Tide Gate Modification Alternative