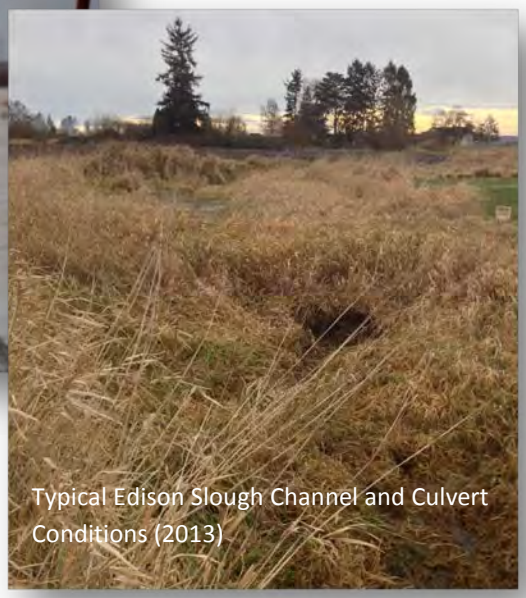
EDISON SLOUGH
DRAINAGE IMPROVEMENT PLAN

Prepared for: Skagit County Public Works
1800 Continental Place
Mt Vernon, WA 98273

March 5, 2015

Edison Slough - 2009 Flooding Event


Typical Edison Slough Channel and Culvert Conditions (2013)

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EXECUTIVE SUMMARY

Edison Slough is a complex, low gradient watercourse that drains the western slopes of Bow Hill and shares a common floodplain with the Samish River, Skagit River and Samish Bay. The watercourse abuts the historic towns of Bow and Edison and has a long history of flooding and anthropomorphic modification. The watershed today includes rural residential, public, and agricultural lands and various flood control infrastructure to manage intra-basin drainage and the influences from Samish Bay, the Samish River, and the Skagit River.

The purpose of this Drainage Improvement Plan is to address the problems of small scale frequent flooding and inundation, poor water quality, and slow conveyance rates in the lower Edison Slough floodplain, which impacts commercial agriculture/aquiculture viability, private property, land use, and community well-being. Agriculture is of high value in Skagit County, as is aquaculture and the sensitive Samish Bay ecosystem, and there is a documented need for continued monitoring and intervention to maintain the quality of these valued resources. The viability of local agricultural land, the efficacy of public infrastructure, the preservation of sensitive habitat areas, and reasonable management costs are recognized as priorities in the impacted Skagit County communities.

This plan focused on the low gradient floodplain portion of the Edison Slough watershed, although conditions in the upper watershed contribute to some of the issues faced by the Edison Slough floodplain community. The floodplain receives surface and groundwater flow from the western slopes of Bow Hill and Samish River watercourses and is tidally influenced by Samish Bay, resulting in a complicated interaction of hydrology. The current channel conditions and drainage infrastructure, as well as groundwater and climate conditions, were found to exacerbate flooding issues and degrade water quality. While some of the flooding and water quality issues are related to land use and drainage management within the watershed and are therefore “controllable” variables, other factors are natural and more difficult to manage for.

Based on current information gathered during the preparation of this report as well as the extensive evaluation of previous studies conducted in the Edison Slough watershed, we have identified the following near-term recommended management alternatives to improve drainage and water quality conditions in the watershed:

1) Maintain existing culverts, including inspection, cleaning, and sediment removal to increase low flow and storm water conveyance, including smaller floods from Samish River overflow
2) Continue replacement of undersized public culverts and private culverts at areas of constriction
3) Monitor the West Bow Hill Road tide gate and implement adaptive management strategies; consider replacement of the structure with a more appropriate design
4) Manage channel banks; restore creek-side geometry, livestock fencing and windrow/riparian planting where appropriate and in areas with willing landowner participation
5) Continue outreach and education efforts emphasizing the implementation of Best Management Practices to improve water quality

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6) Consider the reconfiguration of the storm drainage system near the intersection of Cains Court and McTaggert Avenue in Edison to enable gravitational conveyance to the existing drainage system infrastructure if maintenance efforts alone are ineffective and managing flooding.

It is our conclusion that implementation of the alternatives above will result in cost-effective drainage management actions that will help alleviate existing and near-term drainage and water quality problems within the Edison Slough watershed.

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1 INTRODUCTION: EDISON SLOUGH DRAINAGE IMPROVEMENT PLAN

The floodplain communities along the banks of Edison Slough and within the upper watershed have reported routine flooding and drainage issues that appear to have increased in both frequency and duration of inundation in the past few decades (Appendix A). The inundation impacts agricultural production, personal property, and community wellbeing. In addition, the poor drainage conditions and watershed management practices in Edison Slough have adversely impacted water quality, resulting in occasional shellfish harvest closures in Samish Bay and impacting sensitive marine ecosystem habitats. Unlike many of the other watercourses in the lower Skagit and Samish floodplains, the Edison Slough watershed is not presently managed by a Drainage Improvement District, so no comprehensive drainage management plan or implementation of routine, system-wide maintenance activities outside of County road right-of-ways has occurred.

1.1 Location and Physiography

Edison Slough is located within the Samish River and Skagit River floodplains in the northwest corner of rural Skagit County immediately east of the town of Edison and south of the town of Bow (Figure 1). Edison Slough flows from Bow Hill through agricultural farmland, rural residences, and past two small townships. Edison Slough drains into the southeast end of Samish Bay, north of the mouth of the Samish River, and is influenced by hydrologic inputs from multiple watersheds as well as tidal processes (Figure 2).

1.2 Project Goals

The community goals of this project are to decrease the frequency and severity of flooding, improve drainage conditions, and reduce negative water quality impacts, thereby protecting local agricultural production and water quality in Edison Slough and Samish Bay. In meeting these project goals, the following objectives will be achieved:

1) Decreased flooding impacts during “typical” (seasonally recurring) flood events.
2) Increased agriculture and aquiculture viability.
3) Development of cost-effective projects that improve conveyance and minimize frequent and/or extensive maintenance needs.
4) Implementation of multi-beneficial measures that simultaneously improve water quality and promote agriculture.
5) Development of an implementation schedule and procurement of 5-year permits.

1.3 Work Program

Element Solutions was retained by Skagit County Public Works to assess existing conditions and provide management recommendations and conceptual designs to address the problems

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associated with flooding of the Edison Slough floodplain within the Edison Slough watershed. In addition to the new analysis performed for this effort, previous studies were reviewed and integrated into the analysis where appropriate. These analyses include:

1) Montgomery Watson, 1993.
2) Graham-Bunting & Associates, 1998.
3) Wheeler Consulting Group, 2002.
4) Anchor QEA, LLC, 2010.

Development of the multi-faceted work program included the following general tasks related to site assessment, planning, and concept design:

TASK 1: Problem Identification and Community Outreach

Public meetings were held on September 11, 2013 and January 21, 2014 to collect information about the issues, educate stakeholders, and obtain permission for property access from affected landowners. In addition, letters were sent to property owners to inform them of the project goals, solicit information, and to request their cooperation with property access (Appendix A). Historical studies and information were also reviewed.

TASK 2: Watershed Analysis

Analysis of the channel conditions on participating landowner properties was conducted during the fall and winter of 2013-2014. Analyses included a profile and cross section survey, culvert inventory and assessment, habitat assessment, OHWM delineation in upcoming project areas, reconnaissance-level wetland investigations, and photo point surveys. To the extent possible, every effort was made to integrate findings and recommendations from previous studies.

TASK 3: Plan Development

A comprehensive drainage improvement plan for the Edison Slough floodplain was prepared to implement the drainage improvement measures and obtain environmental permits.

1.4 Methods

1.4.1 Desktop Assessment Methods

A desktop analysis included review of existing studies and maps, and use of GIS software to analysis spatial and physical conditions. The following datasets in Table 1 were used in the GIS desktop analyses:

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Table 1: Desktop Watershed Analysis Data Set References

Data	Format	Date	Source
Aerial photography	Mr Sid (.sid)	1934, 2010, 2011	NAIP, Skagit County/Pictometry
LiDAR	Bare earth grid	2006	USGS
Historic Mapping (GLO Survey)	grid	~1880's	Skagit County
Jurisdictional/Property Data	.jpg/.pdf	2014	Skagit County

1.4.2 Field Assessment Methods

Right of access was provided by less than half of the property owners along the creek, making it impossible to obtain the preferred degree of comprehensive field observations (Figure 3). Field assessments were made where access was granted. Where field access was not granted, analysis relied upon desktop assessment, previous assessments, and professional judgment. Photo points were established at public right-of-way crossings, and captured conditions upstream and downstream of the selected locations (Appendix B).

Ordinary High Water Mark Assessment

A survey of the Ordinary High Water Mark (OHWM) in the areas where projects were selected was surveyed by a trained and qualified OHWM delineator. The OHWM was mapped with GPS mapping grade hand-held receivers and is accurate to +/- 3 feet.

Cross-Section Profile Channel Survey

Where private access was granted Element surveyed the channel cross-section at culvert crossings (upstream, at the crossing, and downstream) for hydraulic modeling purposes and to evaluate obstructions and culvert conditions; channel profiles were also surveyed to compare to historic survey information and evaluate areas of sedimentation. The survey was completed with Real-Time Kinetic (RTK) GPS with centimeter scale accuracy.

Fish Habitat Assessment

A qualified fisheries biologist performed desktop and field assessments to evaluate habitat conditions and to develop Best Management Practices and restoration strategies. The method utilized WDFW recommended methods.

1.5 Project Team

The project team included numerous members from Skagit County Public Works and was managed by Dianne Crane. The consultant team from Element Solutions (Paul Pittman, David Galbraith, Ryan Vasak, Jeff Ninnemann, Tami DuBow, Micah Gregory, and survey team),

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represented a diverse range of expertise in the disciplines in geology, geomorphology, engineering, fisheries biology, habitat ecology, and watershed/drainage management. The team worked collaboratively with Skagit County and the local community to develop and assess the drainage improvement plan.

2 WATERSHED CONDITIONS

The upland headwaters of the Edison Slough watershed include contributing slopes on west facing aspects of Bow Hill. Located within the greater Samish River and Skagit River floodplains and at the margin of a managed tidal floodplain (Figure 2), the lowland Edison Slough floodplain encompasses roughly 1,350 acres and is the primary focus of this study. However, upland drainage is inextricably linked to the Edison Slough lowland floodplain, as are the hydrological effects of the Self-Regulating Tide Gate (SRTG) at Bow Hill Road, the low drainage divide and Samish River levee on the south watershed boundary, and the surface modifications of the Burlington Northern Railway fill.

2.1 Geology and Soils

The Bow Hill uplands consist of surficial, unconsolidated Pleistocene glacial deposits composed largely of glacial till and glaciomarine drift diamicton (Figure 4). These glacial deposits have low porosity and uptake, and store very little water once the forest canopy is removed. The Edison Slough lowland floodplain consists of Holocene alluvial deposits overlying marine deposits, which formed when the Skagit/Samish River deltas prograded into marine tidelands. While the alluvial deposits have relatively high infiltration rates, the presence of a high groundwater table limits the up-take ability of the soils during the wet season. The floodplain soils are susceptible to compaction from dewatering, which can exacerbate subsidence and relative sea-level rise conditions. Although outside of the scope of this assessment, the probability of soil liquefaction occurring in floodplain soils during seismic shaking is high.

Soils in the Edison Slough floodplain are silt loams and sandy silt loams derived from alluvium and volcanic ash, which occur in floodplains and/or relict deltas. In the absence of flooding, they are generally poorly to moderately well drained, and are typically deep (more than 80 inches to restrictive layer), with a high available water storage capacity. Much of the land area within the Edison Slough floodplain includes *Mt. Vernon very fine sandy loam, Skagit silt loam, or Field silt loam* soils, according to the 2013 NRCS Soil Survey (Figure 5). These soils function as prime farmland if adequately drained and protected from flooding. Other soil types are present in reduced abundance, and occur in localized areas. In the Bow Hill uplands, the subsurface is composed of relatively impermeable glacial sediment rather than alluvium, and dominant upland soils such as *Bow gravelly loam* contain abundant glacially-derived clays. In this region, the glaciomarine drift and glaciolacustrine deposit substrate functions as a shallow restrictive layer.

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2.2 Geomorphology and Topography

In the lowland floodplain, Edison Slough flows within a relict Samish River/Skagit River distributary channel network which is part of the greater Skagit and Samish River delta. The modern day Edison Slough channel is under-fit to this relict channel. The low gradient of Edison Slough lends itself to slow flow velocities for intra-watershed flow regimes, resulting in little to no lateral migration, erosion, or scour of bankside landforms. Within the floodplain, the bed material and substrate is predominately fine-grained sediment and organics. During overflow from the Samish River watershed, velocities can increase significantly, transporting finer-grained sediment from the upper floodplain reaches.

The Edison Slough floodplain channel area was organized into six separate reaches to coordinate the following detailed reach assessments (Figure 6); the reach categorization format developed below is utilized throughout the Drainage Improvement Plan to facilitate discussion of management alternatives by providing a physiographic reference for channel reaches that share common geomorphic characteristics.

Reach 1

Reach 1 begins immediately east of the Drainage District 16 tidegate paralleling Farm to Market Road, and extends around the township of Edison to the self-regulating tidegate (SRTG) at the West Bow Hill Road bridge. Reach 1 is defined by tidal processes. During low tide, Edison Slough is under-fit to the main channel and the West Bow Hill Road tidegate system drains as positive head pressure opens the gate. During high tide the entire channel reach is inundated with water from Samish Bay, and the tidegate systems close to restrict flow into Reach 2 and beyond. The channel morphology in Reach 1 is straight, with one large meander. The township of Edison was built into the depositional bend of this meander, and development extends nearly to the point bar. The under-fit low tide channel has begun to wander and incise within the confines of the larger high tide channel throughout Reach 1, a process which is ongoing during low-flow and reverse-flow conditions. The riparian habitat in Reach 1 is comprised of salt tolerant species and is sparse and irregularly distributed on both north and south banks. Agricultural, commercial, and residential development has resulted in significant modifications to natural bank conditions. The substrate is predominantly fine grained silt and sand. Infilling and dredging for construction and drainage management applications has historically had a significant effect on drainage conditions in Reach 1. Similarly, the absence of LWD and lack of channel sinuosity in the reach is indicative of anthropogenic modification.

Reach 2

Reach 2 begins at the self-regulating tidegate system located at the West Bow Hill Road bridge and extends upstream 1.2 river miles upstream, ending 0.1 river miles beyond the intersection of West Bow Hill Road and Chuckanut Drive (SR 11). This reach is highly

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influenced by tidal conditions and the tide gate. The reach experiences tidally induced water surface elevation fluctuations and some minor salt water intrusion that affects the vegetative communities nearly all the way to SR 11.

The channel in Reach 2 has been modified and simplified by both documented channel realignments and potentially undocumented historic dredging and levee activities. The channel in Reach 2 generally meanders parallel to the south side of West Bow Hill Road. The right bank (north) of the channel alternates between abutting West Bow Hill Road and private rural residences and farms, whereas the left bank (south) of the channel is predominately farmland. Large woody debris (LWD) is absent in this reach. Additionally, a portion of the historically active channel has been isolated from Edison Slough due to realignment of West Bow Hill Road, creating a relict, disconnected oxbow. The channel is broad, deep, and wetted throughout the year. The substrate is predominantly organics, sand and silt.

Tree and shrub canopy cover is largely absent in the riparian zone. Where vegetation exists, it largely consists of isolated deciduous trees and shrubs. The riparian cover is limited to approximately 3% of the south bank. Reed canary grass is the dominant shoreline vegetation.

Reach 3

Reach 3 begins 0.1 river miles upstream of the intersection of West Bow Hill Rd and Chuckanut Drive (SR 11) and extends upstream to a point 0.1 river miles beyond the confluence of the main stem and a side channel that parallels the BNSF railroad tracks. Reach 3 extends 3.8 river miles upstream of the self-regulating tide gate at West Bow Hill Road.

The channel in Reach 3 may have been modified and simplified via historic dredging, but much of its historic meandering course remains. The channel in Reach 3 generally meanders parallel to the south side of Bow Hill Road. The right bank (north side) of the channel alternates between abutting Bow Hill Road and private rural residences and farms, whereas the left bank (south side) of the channel is predominately farmland. LWD is generally absent in this reach. Three small tributaries enter Edison Slough along this reach; the first tributary is a small ditch that drains farmland to the south through a culvert under Bow Cemetery Road, the second drains the upper watershed of Bow Hill and along Bow Hill Road through a BNSF bridge, and the third tributary drains the upper watershed along Ershig Road and the BNSF rail line. Fine sediment and organics dominate the channel substrate; however, gravel and sand substrate is present in the channel draining the Bow Hill uplands at the BNSF railway crossing.

Reach 3 receives perennial flows from the upper Edison Slough watershed and approximately 52% of the upper watershed area on Bow Hill is directed to the tributary in this reach. Despite this freshwater input from Bow Hill, elevated water temperatures in Reach 3 may exist due to the limited riparian cover in the upper reaches of Edison Slough.

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The average riparian zone width along Reach 3 is approximately 70 feet. The right bank (north side) of Reach 3 constitutes the shoulder of Bow Hill Road/private residences/farmland and is dominated by patches of deciduous trees and shrubs (65%) and reed canary grass patches (35%). The left bank (south side) of Reach 3 has a similar mix of tree/shrub patches and reed canary grass patches, but the tree cover is slightly less dominant on this bank. The tree and shrub canopy cover in the riparian zone in Reach 3 is significantly greater than Reach 2, consisting of patches or clusters of deciduous trees and shrubs. In the areas that do not have a tree or shrub canopy, reed canary grass dominates the shoreline vegetation.

Reach 4

Reach 4 begins 0.1 river miles beyond the confluence of the main stem and a side channel that parallels BNSF railroad tracks and extends upstream to the intersection between Skagit County tax parcel #P34060 and P34083, 545 feet north of Worline Road along the property boundary. The reach extends 5.9 river miles upstream of the self-regulating tide gate.

The channel in Reach 4 has been modified and simplified via historic dredging and ditching activities. The channel in Reach 4 generally meanders through farm land, occasionally passing rural residences while generally paralleling the east and north side of Worline Road. Portions of Reach 4 have been straightened and channelized.

Riparian vegetation is generally lacking, except at a selected property where a mature, intact riparian forest exists. Partial riparian cover exists locally in some areas, typically vegetated with scrub-shrub type vegetation.

The substrate is primarily organics, silt and sand, although locally gravel substrate can be found. In some areas the gravel substrate is likely lag from when the Samish River occupied this stream course, but some of the gravel is transported during higher flow events. However, predominant flows in this reach can only transport sand and silt.

Portions of the channel in this reach go dry during summer months and isolated pools are common.

Reach 5

Reach 5 begins at the intersection between Skagit County tax parcel #P34060 and P34083, located 545 feet north of Worline Road along the property boundary. It extends to just downstream of the confluence of the main stem and an east-connecting side channel. The side channel has a large railroad bridge associated with it and the reach break is located at a private culvert owned by parcel #P34145. The channel in this reach is often dry in summer months. The reach extends 6.4 river miles upstream of the self-regulating tide gate.

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Reach 6

Reach 6 begins just downstream of the confluence of the main stem and a side channel that connects from the east (associated with BNSF bridge) and extends upstream until the stream channel becomes diffused into farm fields on Skagit County tax parcel #P34307. The reach extends approximately at 7.3 river miles upstream of the self-regulating tide gate. This reach is not recharged by the Bow Hill drainages and is dry during long portions of the year. During the winter, water is ponded in the channel areas, but the channel often does not convey flow unless precipitation events are extreme or overtopping of the Samish levee occurs.

2.3 Land Use and Anthropogenic Influence

Edison Slough is a tidal arm of Samish Bay and is part of the Skagit-Samish River Basin. Historic diking is reported to have cut off the old North Fork Samish River, creating Edison Slough. The entrance to Edison Slough is across the expansive tide flats of Samish Bay, which are exposed at low water. Historically, vessels could enter the slough and reach the town of Edison at high water, though navigation was challenging. In the early 1900s, logs were towed up the channel to supply a small shingle mill in Edison (Willis 1975). In 1915, the Army Corps of Engineers determined that the slough was "worthy of improvement" for debris and projecting points removal, as well as deepening and widening of the channel at bends to improve water flow for irrigation to local agricultural sites (USCOE 1915).

Levees were reported to have been installed in the relatively recent past to reduce the inundation of Edison Slough from the Samish River. Additionally, the tide gate was installed to increase agricultural productivity.

The Edison Slough watershed currently has mixed land use. The Bow Hill uplands are primarily rural residential or utilized for private forestry, with some limited agricultural activities. The lowland floodplain is primarily agricultural, with some limited rural residential land use. The two exceptions are the townships of Bow and Edison, which have semi-urban commercial and residential development densities.

The public drainage and transportation infrastructure of the Edison Slough watershed includes drainage ditches, culverts, bridges, tide gates, stormwater facilities, county roads, state roads, a fire station, and school. Many private infrastructure elements, including drainage ditches and private culvert-road crossings, link to and interact with the public infrastructure.

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3 WATERSHED HYDROLOGY

The lowland Edison Slough floodplain receives hydrologic inputs from the Edison Slough uplands (Bow Hill), the Samish River, the Skagit River, and Samish Bay (Figure 2). The effects of these contributing drainages on hydrologic processes within the floodplain are compounded by the high groundwater table and tides; historically, much of the Edison Slough floodplain would have been inundated by seawater during high tides. Of particular focus for this study are the hydrological influences from the Edison Slough uplands on Bow Hill and occasional floodplain inundation by the Samish River during peak flow events. While these sources of hydrology are the focus, the influence of the Skagit River, the potential for coastal flooding, and the high water table cannot be ignored; these variables contribute to the complexity and challenges of managing the watershed.

3.1 Intra-Basin Drainage and Flooding

Flooding commonly recurs at numerous sites within the watershed on both public and private property, as reported by the community (Figure 7). Anecdotal accounts claim that the most frequent source of flooding is from general ponding in the low areas and from surface water flows from the upper watershed. The occurrence, flashiness, and magnitude of flooding from upland watershed sources are reported to have increased in recent years. It is plausible that forest clearing, improved capture and routing of stormwater, and insufficient stormwater storage from impervious developments are contributing causes behind the recent change in hydrology, likely resulting in small-scale flooding in the Edison Slough lowland floodplain and associated impacts to water quality. While this type of flooding is most frequent, it is also the most localized, primarily impacting agricultural production and private properties in the vicinity of Edison Slough rather than affecting public safety. However, this type of flooding can decrease the general wellbeing of the community and adversely impacts local agribusiness. The primary effects of this type of flooding are a high ground water table and poor drainage conditions, which leads to persistent soil saturation and diminishes the ability of the watershed to drain effectively.

The following engineering controls modify hydrology and influence drainage and flooding within the Edison Slough floodplain (Figure 8):

1) A sea dike and tide gate that control sea level inundation, located at the downstream end at West Bow Hill Road (SR 527).
2) A levee along the northern bank of the Samish River.
3) Road culverts and drainage networks.
4) The Burlington Northern Railway alignment.
5) The Skagit River levees.

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3.2 Inter-Basin Freshwater Hydrologic Inputs and Drainage

The Edison Slough floodplain is low gradient and during the winter months has a very high water table, which is often present at the surface. Prior to draining and diking, the area was likely a vast tidal/floodplain wetland. Today, wetland hydrologic conditions still exist, but at to a reduced degree (Figure 9). Many areas that have wetland hydrology conditions are not regulated as wetlands because of prior converted status. Flooding that occurs when the Samish River overtops its right bank levee and enters the Edison Slough watershed compounds the issues associated with the high seasonal water table. While this occurrence is somewhat infrequent, it is of greater consequence than the intra-basin hydrology. During these less frequent but larger flood events, the Edison Slough lowland floodplain can become almost completely inundated by floodwater. It is estimated that this occurs on roughly a decadal scale, most recently in 2009. Undersized culverts within the drainage improvement area have been shown to exacerbate flooding conditions (Anchor 2010). Most of these culverts are privately owned and maintained.

The Edison Slough headwaters on the uplands of Bow Hill flow into established drainage networks on both private property and the publicly managed right-of-way maintained by Skagit County Public Works. Excepting a brief discussion of the existing drainage management concern of Hobson Road, specific assessment of the upland infrastructure is beyond the scope of this plan and is only addressed in broad terms. Future development in the upland area will be subject to stormwater regulations, which should help to reduce the worsening of potential hydrologic impacts if designed and implemented correctly.

3.3 External Seawater Hydrologic Inputs and Tidal Influence

Both the intra-basin and inter-basin flooding problems in the Edison Slough drainage improvement area are compounded by seasonal and atmospherically enhanced high tides (king tides). In addition, the seasonally high ground water table prolongs periods of ponded surface water during the wet season and after flooding, and is likely influenced by tide gate capacity.

The self-regulating tide gate (SRTG) has been reported by several of the residents within the community as a contributor to flooding events. It is reported to occasionally malfunction or not be effective at keeping seawater out of the slough, or to not drain fast enough when floodwaters back up against it. During periods of high tide or in the event the tide gate malfunctions, flooding could be exacerbated by negative drainage conditions and ponding.

3.4 Potential for Catastrophic Flood Events

Flooding due to a major Skagit River flood or overtopping of the sea dike would be a very rare event, but could potentially result in significant impacts to the Edison Slough floodplain. The existing tide gate and drainage infrastructure is not designed to manage events of this magnitude. Damage from this type of catastrophic flood event would be widespread, and may pose considerable risk to public health and safety. Management for these types of events is beyond the scope of this plan but should be considered in broader emergency response planning.

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3.5 Low Flow Conditions

Edison Slough is recharged by the seasonally active perennial headwater streams and groundwater recharge on Bow Hill during low flow conditions. Therefore, large sections of Edison Slough are dry during the summer and early fall seasons, when precipitation rates are low and the groundwater table drops. During these periods, only localized, isolated pools remain wetted. The dry, disconnected channel conditions present during low flow conditions impact habitat availability and function.

3.6 Climate Change

Edison Slough is particularly vulnerable to certain changes in climate and sea level. When developing and selecting management alternatives for the Edison Slough system, the inherent variability of weather, climate and sea level should be taken into account for longer-term planning decisions.

3.6.1 Weather and Climatic Influences

Recently, the Pacific Northwest has experienced a Pacific Decadal Oscillation (PDO) shift that began in the spring of 2009. The PDO is a weather pattern that shifts every 20-30 years, determining which months have the most precipitation and spring-time temperatures. In the previous "warm" cycle that ended in early 2009, the fall months of November, December and January statistically had the most rain, and therefore the most flooding events. The "cool" cycle we have entered will likely result in higher rainfall events occurring most often in the months of February, March and April, along with cooler spring temperatures. In addition, shallow ground water will remain at high levels during this period. The cool, wet spring coincides with a critical agricultural period for pasture and planting, resulting in increased conflict between field conditions and economic demands.

3.6.2 Sea Level Rise

In addition to the short-term PDO weather cycle, long-term climate change should be considered. Predicted and observed climate-induced sea level increases have the potential to significantly impact drainage conditions in Edison Slough. A range of sea-level rise predictions have been made, from several inches to many feet (IPCC); approximately 6 inches of sea level rise have been measured in the past half century. Sea level rise rates vary because of local tectonic deformation, particularly in deltaic and seismically active areas such as Edison Slough. A conservative estimate for sea level rise in the Puget Sound Basin is about 13 inches by 2100, although much higher levels of se-level rise are possible in low-lying basins such as Edison Slough (USGCRP, 2009).

The Edison Slough floodplain and channel is at or below the upper reaches of inundation from high tides; without sea-level management infrastructure, frequent inundation of much of the lowland floodplain would occur. It is likely that the Skagit/Samish delta has been undergoing

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some subsidence due to soil compaction, dewatering, and localized sediment loading, which is exacerbated by a truncation of the floodplain depositional rate created by levee and dike infrastructure. The subsidence will compound predicted sea level rise conditions, and the rate of sea level rise may by higher locally in these areas than the rates of sea level rise that are projected to occur regionally.

Even a conservative predicted rise in sea level is very significant for Edison Slough, which is located below or just above the influences of the current sea level. The eventual rise in sea level will increase the frequency, duration and magnitude of negative drainage conditions in Edison Slough by increasing groundwater elevations and exacerbating the effects of weather and climate change in already flood-prone areas. The long-term viability of vulnerable agribusiness and communities like Edison should be evaluated and integrated into decision making, either proactively or reactively, at some point in the near future. At a minimum, the participants in this plan must be willing to consider formulating new strategies for coping with changing environmental conditions.

4 WATER QUALITY

Edison Slough is on the Department of Ecology 303(d) list of polluted waters for fecal coliform, dissolved oxygen, and pH. In addition to adversely impacting fish habitat, poor water quality due to upland sources of pollutants has been linked to water quality issues affecting the aquaculture in Samish Bay, as well the overall health of the Puget Sound ecosystem.

4.1 Clean Samish Initiative

While there is no adopted Total Maximum Daily Load (TMDL) or pollution control plan for Edison Slough specifically, Skagit County along with local and state partners has been actively trying to identify and improve water quality conditions through the Clean Samish Initiative. The program seeks to comprehensively address pollution in the Samish Bay Watershed, including in Edison Slough. Edison Slough water quality was investigated as part of the Samish Bay Watershed Water Quality Monitoring Program, which began in 2000.

4.2 Skagit County Critical Areas Ordinance

Skagit County continues to collect water quality data to help determine if the Skagit County Critical Areas Ordinance for ongoing agriculture (SCC 14.24.120) has adequately protected water quality in areas where land use was historically, and continues to be, predominantly agricultural. Recently, Edison Slough was noted as a “very high priority” in the Clean Skagit Initiative March 2013 updates, and staff recommended working with a particular landowner to develop a farm plan that excludes livestock from the channel.

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5 HABITAT BIOLOGY AND ECOSYSTEM CONDITIONS

5.1 Wildlife Habitat

While much of the historically abundant wildlife in the region has been displaced or otherwise reduced by development and land-use changes within the Edison Slough watershed, there is still an active wildlife community present there. In particular, song birds and migratory waterfowl utilize the Edison Slough watershed and can be seasonally plentiful. The WDFW has identified one Bald Eagle (*Haliaeetus leucocephalus*) nest within a 1-mile radius of the drainage improvement area. Small mammals in nearby cultivated fields and fish in the watercourses are the source of food for predatory birds. Beavers and recently made beaver dams are also present in the watershed. Priority Habitat Species are summarized in Appendix C – Biological Assessment & Information for Permitting.

5.2 Fish Habitat

For the purpose of this document, the term "fish" includes all species of native cold-water fishes. However, particular emphasis is placed on the salmonid species, which are regulated by the WDFW as commercially and recreationally important species and co-managed by tribes as culturally important species. These species include Pink salmon, Chum salmon, Sockeye salmon, Coho salmon, Chinook salmon, Rainbow trout (including Steelhead), Cutthroat trout, and native char. Pink salmon, Chum salmon, Sockeye salmon, Coho salmon, Steelhead and Chinook salmon are anadromous, meaning that they return to freshwater habitats to spawn after spending the majority of their lives in saltwater. Rainbow trout, Cutthroat trout, and native char can either be freshwater residents or anadromous.

A classification of "Watercourse Type" was developed using the WDFW methodologies and input from WDFW staff (Appendix D). In summary, the channels of Edison Slough are primarily "Managed Watercourses with Headwaters" with some "Natural" and "Artificial" watercourses. The classification system can be utilized to develop permits and BMPs for project implementation.

5.2.1 Edison Slough Fish Habitat Description

For the purposes of this Drainage Improvement Plan, the fish habitat evaluated was in the lowland floodplain reaches of Edison Slough, where land use is predominantly agricultural and drainage issues and flooding are most problematic. The habitat description builds on the previous study area defined by Warinner and McGowan (2004) that included the lowland reaches of Edison Slough. The upland drainage networks were not assessed.

The Edison Slough watershed offers "significant yet impacted habitat resources for salmonid fish." (Warinner and McGowan, 2004). The lower reaches of Edison Slough exhibit characteristics typical of managed drainages in the Skagit River valley; dredged and deepened channels, monotypic riparian vegetation, straightened channel courses, and homogenous streambed substrate. Some areas of the Slough function as stream, while other areas could be

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classified as palustrine, flowing wetlands. In general, the channel banks are dominated by reed canary grass (*Phalaris arundinacea).* In some stretches where water flow is low or has been artificially constricted (e.g. upstream of Ershig Rd.), reed canary grass extends to the middle of the channel, further restricting flow and promoting the accumulation of organic debris. Exceptions to this vegetation pattern can be observed in the portion of channel east of the railroad grade, as well as the portion of channel that is immediately downstream from the Ershig Road crossing. The riparian canopy in both of these sections is dominated by willow (*Salix spp.)* interspersed with both cottonwood (*Populus balsamifera)* and red alder (*Alnus rubra)*.

In the lowland area, channel morphology is typical of a dug and relocated watercourse. Sinuosity is lacking, and habitat complexity is low. Habitat forming structures, such as large wood debris (LWD) and boulders as well as channel shaping flows, are absent in this reach, resulting in homogenous habitat types. While the upper reaches of the Edison watershed contain riffles, pools and cascades (Warinner and McGowan, 2004), the lower channel is almost without exception one long glide. Channel substrate in the lowland portion of Edison Slough is dominated by a mix of silt/fines and decaying organic debris. Stream sediments associated with wetlands have a higher composition of organic material, while flowing portions generally exhibit substrate bed material composed of both soft and firm mud. Persistent low flows and low water depths (> 0.6m) have allowed the establishment of in-channel aquatic macrophytes, which have promoted epiphytic growth.

5.2.2 Habitat Verification and Assessment

Field observations by Vasak and Pittman (2013) confirmed that stream habitat conditions are similar to those assessed by Warinner and McGowan in 2004. Little has been done to improve conditions in Edison Slough in the intervening 10 years, and it is reasonable to assume that habitat function is also similar. Warinner and McGowan (2004) indicated that the Edison watershed provided suitable habitat for Chinook, Coho, and Chum salmon, as well as Cutthroat trout. The upland reaches of the Edison watershed were identified as areas of potential spawning, while the lowland reaches were classified as rearing habitat.

The tidally influenced reach of Edison Slough (~ 1 mile upstream of the SRTG) could provide rearing and foraging habitat for estuarine-dependent salmonids, e.g. Chinook salmon, and is used by non-game fish species such as the three-spined stickleback (*Gasterosteus aculeatus).* However, despite the occasional saltwater input, elevated water temperatures in Reach 3 would be expected due to the limited riparian cover. Elevated water temperatures and reduced dissolved oxygen levels, especially during the summer and early fall, limit the suitability of the channel habitat for juvenile fish rearing. Until quality and accessibility of stream habitat are addressed, fish use will likely remain limited.

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5.2.3 Fish Passage

Fish that enter Edison Slough do so through the self-regulating tide gate (SRTG) at West Bow Hill Road. The SRTG protects the project area from flood and tidal flows, and while fish passage is possible, the SRTG can restrict and temporarily limit the passage of adult and juvenile fish. Upstream passage is restricted to very narrow windows of the tide cycles, during which the tide gate is open and the discharge velocity does not exceed the upstream swimming capabilities of the individual fish. The window for upstream passage is greater for adult fish than for juvenile fish because of their stronger swimming capabilities. The tide gate does not completely block the downstream passage of adult and juvenile fish, though downstream passage is limited to low tide cycles when the water surface elevation upstream of the tide gate is sufficiently greater than the water surface elevation downstream of the tide gate, creating the head differential required to open the tide gate.

5.3 Fish Distribution

Fish use surveys conducted by Warinner and Barkdull (2003) show that Edison Slough is used by Chinook salmon, Coho salmon, and Chum salmon (WDFW 2005). Methods used to capture fish included: seine netting, electrofishing, and minnow trapping. The first two methods are sufficient to assess presence/absence, though none of the methods as employed could result in population estimates. All seine efforts were conducted downstream of the SR 11 crossing. Minnow traps were set in the slough at the Edison School bus barn crossing, the SR11 crossing, the Bow Cemetery Road crossing, and at the Ershig Road crossing. Electrofishing was conducted along the railroad grade and along Ershig Road. Electrofishing data from the entire watercourse would have been useful, but collection permit restrictions precluded assessing the entire length of the watercourse (Warriner 2005). Results of the fish capture efforts are summarized below in Table 2.

Table 2: Salmonids captured in Edison Slough watershed, adapted from Warinner (2005).

Location	Coho	Chinook	Chum
Ershig Road	2	0	0
SR 11 Crossing	1	1	0
Edison School Xing	0	0	1
Tidegate area	0	1	0
Total	**3**	**2**	**1**

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5.3.1 Potential Fish Use Periodicity – Skagit Region (excerpt from WDFW)

Anadromous adult Coho and Cutthroat typically enter the lower reaches of the watercourse to begin their upstream migration to the spawning habitats in late fall. Spawning occurs in the upper reaches of the watercourse where suitable spawning substrate is present and accessible. Coho spawn in the late fall and Cutthroat spawn in early spring. Coho adults die after spawning whereas Cutthroat can survive to spawn in successive years. Anadromous adult Cutthroat that survive spawning out migrate the watercourse from mid to late spring. After hatching from gravel nests (redds), emerging juvenile Coho and Cutthroat will distribute themselves to suitable rearing habitats in the watercourse. Anadromous juvenile Coho and Cutthroat generally spend 22 to 18 months rearing in freshwater before migrating to the marine environment. Juvenile anadromous Coho and Cutthroat are present in the accessible reaches of the watercourse throughout the year. Resident adult and juvenile Cutthroat are typically present in the upper reaches of the watercourses throughout the year. It is generally assumed that between February and July, fish from other watercourses may migrate from the estuary into the lower reaches of the watercourse via the culvert/tide gates to forage on available prey. The upstream distribution and duration of residence for these migrating fish is limited by water quality, prey availability, and their physiological affinity for salt water. In addition to salmonid species, forage fish species such as surf smelt and sand lance also use the estuary habitats for rearing, and could potentially migrate into the lower reaches of the watercourse. Adult native char and Cutthroat could also be expected to migrate into the lower reaches of the watercourse in pursuit of juvenile salmon and forage fish species. The elevated water temperatures found in these lowland systems may also lead to colonization by exotic species of fish that prefer warm water habitats.

5.4 Wetland Ecology and Regulation

Wetland conditions providing hydrologic and ecologic functions are present in the Edison Slough watershed, particularly along the margins of the watercourse and at the base of Bow Hill (Figure 9). Many of the wetland areas are exempt to regulatory requirements because of prior converted status and continued agricultural uses. Fallow areas and non-agricultural uses may not qualify under the prior converted status exemption and wetland regulations may apply under certain conditions. Specific wetland mapping was not performed for this analysis.

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6 CHANNEL PROFILE AND CULVERT CONDITIONS

6.1 Channel Profile and Cross Section Survey

A channel profile and cross section survey was performed at culvert crossings on properties where right-of-access was granted (Figure 3). The survey data is presented in Figure 10, Sheets 1 through 12. The survey datum is in NAD 83 (horizontal) and NAVD 88 (vertical) and was performed using Real Time Kinetic (RTK) GPS with centimeter level accuracy. The profile survey noted top of soft-bottom and top of firm bottom. A comparison of the 2013 profile to the circa-1998 channel profile with surveyed culverts is also shown in Figure 10, Sheets 1 through 12. In summary, the survey showed that no significant accumulation of firm-bottom deposition has occurred in the channel between 1998 and 2013; however, there is a significant accumulation of "soft bottom" sediment (organic mud/muck, root mass, and silt). The survey data revealed that cross sectional areas at some locations are greatly reduced by road crossings and culverts. During the survey, a "king tide" high water mark was surveyed and is shown in the cross section profile. The elevation of the king tide (~9.5 feet NAVD 88) intersected the channel bed profile upstream of Worline Road, indicating that at high tides or when the tide gates are closed, ponding can be expected to extend upstream several miles.

6.2 Culvert Inventory

Culverts were identified and mapped using:

- Publicly available imaging tools, such as Google Earth, Pictometry, and GIS.
- Culverts on ROE parcels that were encountered in the channel profile and cross sectional survey.
- Visual observations from roadside or publically accessed locations.

It is probable that not every culvert was mapped or described accurately. Mapped culverts are shown in Figure 8. A description of prominent significant culverts is presented in the Edison Slough Floodplain Culvert Inventory in Table 3.

Table 3: Edison Slough Floodplain Significant Culverts

Reach	Identifier	Location	Description
Reach 1	SRTG*	West Bow Hill Road	Tide Gates Multiple Types
	TG*	Edison - Longhorn	Tide Gate - Single gravity flap-gate culvert
Reach 2	1	W. Bow Hill / School Access	12' x 7' RCB
	2	W. Bow Hill 720' U/S 2	4' x 48" HDPE Pipes
	3	W. Bow Hill 1,700' U/S 3	18' x 5' RCB
	4	W. Bow Hill /Chuckanut	12' x 6' RCB

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Reach	Identifier	Location	Description
Reach 3	5	W Bow Hill 15544	3 x 48" CPE
	6	Bow Cemetery Rd	Replaced in 2014 - 15'x 8' RCB
	7	Worline Rd	Replaced in 2014 - 15'x 8' RCB
Reach 4	8	Private (Muktiar Farms Ag Xing)	15’ x 15' wooden plank bridge
	9	Private (6695 Worline)	30” CMP
	10	Private (Wallace Ag Xing)	24” CMP
	11	Private (7071 Worline)	36" CPP; 1 abandoned 12"
	12	Private (7177 Worline)	18” CPP, 18” CPP, 30” CPP
	13	Private (P34110 Field access)	12” Concrete, 18” Concrete
	14	Private (7565 Worline)	36” Concrete
Reach 5	15	Private (P34060 Ag Xing)	48” CMP
	16	7574 Ershig Road (private dirt road, south of BNSF Xing)	12” CPP, 24” Concrete
	17	Ershig Crossing North of Worline	56” CMP, 56” CMP
	18	Private or Skagit County? 17045 Llama Ln	24” Concrete, 24” Concrete
	19	7720 Ershig Road (Private)	12” Concrete
Reach 6	20	Ershig Crossing South of Worline (between 7764 & 7800 Ershig Road)	36” Concrete, 36” Concrete

*Note: Tidegates are exclusive to Reach 1. Not all culverts in system are shown. Some culverts were not directly observed or surveyed, as right of entry (ROE) was not granted by the property owner.

6.3.1 Edison Slough Culverts Assessments

Anchor QEA performed hydraulic modeling on the Edison Slough floodplain reach and identified a number of culverts that were undersized, causing backwatering conditions that exacerbated upstream flooding and decreased the rate of floodwater discharge. The Anchor replacement prioritization was updated and used as the basis to develop alternatives to address the most acute undersized culvert conditions.

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6.3.2 Edison Township – "Longhorn" Tide Gate Assessment

Element investigated a specific drainage area of concern in the township of Edison, where stormwater runoff accumulates in the southeast quadrant of the McTaggart Avenue and Cains Court intersection. The current stormwater drainage system includes a series of catch basins that collect and convey stormwater west through a tide gate (noted here as the "Longhorn" tide gate) prior to discharging into Edison Slough behind the existing Longhorn Tavern. The combination of large rainfall events and high tides tend to cause stormwater accumulation at the corner, potentially impacting adjacent buildings and properties. Figure 11 (Sheets 1 & 2) shows the vicinity of the drainage area of concern. To further evaluate the identified alternatives, relevant catch basins, rim elevations, pipe diameters and inverts, and a high water mark were surveyed.

7 ALTERNATIVES IDENTIFICATION

The following alternatives were identified from input in public meetings, from Skagit County staff, from previous studies, and from desktop and field analysis. While the following alternatives were generally developed based on current and existing conditions, it should be noted that the Edison Slough watershed, as well as the Samish River, Skagit River, and coastal systems that influence Edison Slough, are dynamic rather than static systems. Alternatives identified for present conditions may need to be reevaluated as conditions change. In particular, predicted changes in climate and sea level conditions may have a dramatic effect on vulnerable areas such as Edison Slough.

7.1 Proposed Alternatives Limitations

The alternatives proposed in this report are designed to manage intra-basin Edison Slough flooding or episodic inter-basin overflow from the Samish River. The alternatives and recommendations identified in this assessment are not expected or intended to eliminate flooding or reduce impacts from catastrophic flood events associated with flooding of the Skagit River or coastal dike breaches. No engineering or site specific design was performed for this assessment; rather, the alternatives and analysis are based on planning-level conceptual designs.

7.2 Regulatory Requirements

Whether or not the current or anticipated regulatory environment will allow a proposed alternative action to occur is an important consideration and practical concern when addressing drainage management and improvement plan feasibility. Alternatives that are likely to encounter significant regulatory challenges are identified and briefly discussed in the alternatives identification section; however, these alternatives were ultimately dismissed because they were not believed to be "permittable," or because they required extensive environmental review well beyond the scope of this assessment.

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7.3 Alternatives Identification and Description

The following section provides an inventory and description of alternatives to address the following management concerns previously identified. The alternatives were divided by their function to address the following management issue objectives:

- Increase Conveyance
- Address Hydrologic Inputs from the Upper Watershed and Samish River
- Improve Water Quality
- Improve Edison Township Flooding.

All "regular" maintenance activities, such as culvert cleaning, are assumed to be activities already being implemented and were not included as alternatives for this analysis unless otherwise noted. It is assumed that regular maintenance activities will continue into the future.

Alternatives Identified for Increasing Conveyance

The following alternatives are proposed to improve channel conveyance, thereby decreasing the severity and frequency of flooding:

MAINTENANCE ACTIVITIES

ALTERNATIVE C-1: Dredging

Dredging to open channel conveyance is a traditional management alternative. Dredging typically utilizes a hydraulically operated boom-type excavator. The excavator has a wide flat bottomed bucket that is used to scrape down one side, round the bottom, and come up on the opposite side of the channel in one continuous motion. The excavation leaves the watercourse with a deeper channel profile, inclined sides and a rounded bottom. Dredged material is either removed or deposited landward of the watercourse. Dredging is often associated with having environmental impacts, particularly to instream habitat conditions. Edison Slough has ESA listed species, therefore dredging as a management tool will have challenges from a regulatory perspective.

ALTERNATIVE C-2: Channel Bank Mowing

Reducing channel bank roughness during bankfull flows can help to increase conveyance. Channel out-of-water mowing is the routine removal of vegetative material above the water line to the bank top. It is completed using various types of mechanical mowers (rotary or flail designs), and reduces the abundance of vegetative material during the growing cycle. Channel bank mowing creates fewer environmental impacts than dredging, but still may have environmental regulatory challenges in some circumstances.

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ALTERNATIVE C-3: Channel Bank Spraying

Reducing channel bank roughness during bankfull flows can help to increase conveyance. The use of herbicide can be an effective tool for suppressing reed canary grass growing along stream banks (or in the bottom of dry channels). Care and appropriate licensure and permitting are needed to spray in or near aquatic environments. De-vegetating the banks will require additional follow up actions to stabilize the exposed soils and reduce erosion potential. Often, spraying is done as part of a maintenance program associated with additional management strategies, such as replanting channel banks with native shrubs.

CONSTRUCTION ACTIVITIES

ALTERNATIVE C-4: Culvert Replacement

Improving the conveyance of the drainage system can be accomplished by reducing the constriction created by undersized culverts. Many of the culverts within the project area are under sized and contribute to the localized flooding and potentially fish passage issues. Hydraulic modeling has shown where these constrictions affect conveyance and water surface elevations the greatest. Bridges are often more effective at conveying larger flows than culverts and also aid in improving fish passage conditions.

ALTERNATIVE C-5: Channel Widening

Increasing the channel width can increase the conveyance capacity and storage potential in a drainage system. Channel widening can include the mechanical removal (back/track hoe) of vegetation or re-sloping channel banks. The widening of channel banks is often associated with restoration efforts, which include riparian planting to replace canary grass and non-native vegetation. Channel widening can either occur above or below the OHWM, depending upon conveyance needs and regulatory conditions. Permitting channel widening above the OHWM is substantially easier to permit than below OHWM actions.

ALTERNATIVE C-6: Channel Realignment

Realigning channels to connect topography and shorten, lengthen, or straighten them can be employed to manage a range of conveyance scenarios, and historically was a common tool for agricultural irrigation and drainage management. Channel realignment includes constructing new channels and redirecting watercourses. No feasible realignment alternatives were identified within the Edison Slough floodplain area to significantly improve conveyance, however channel realignments could be done to promote habitat and water quality. A potential realingment alternative was identified and evaluated along the BNSF railway, but was determined to not be feasible based on profile conditions.

ALTERNATIVE C-7: Tide Gate Modifications, Maintenance, or Replacement

Tide gates affect conveyance, as do the tides that they manage. Tide gates are notorious for needing regular adjustments and maintenance and typically work better under a narrow range of

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flows than a large range of flows. Edison Slough has two distinct flow regimes; intra-watershed flows, which are prevailing, and the less frequent Samish River overflows, which are predominantly associated with major flooding events. Currently, it appears that the Edison Slough self-regulating tide gate (SRTG) is adjusted to the lower flow, intra-watershed flow conditions, thus it is anticipated to function poorly during a large inter-basin flood. Tide gate maintenance is required frequently, and a regular inspection program is typically needed. All tide gates will require frequent and on-going maintenance, including removal of any lodged debris and sediment that may prevent the gate from closing or operating properly. It is possible that alternative tide gate systems could better address the broader range of flow conditions characteristic in Edison Slough.

ALTERNATIVE C-8: Pump(s)

Edison Slough drainage management is challenged by low gradient topography, high ground water table, and at or below sea level conditions. The drainage infrastructure for Edison Slough does not currently include a pump site; however, adjacent drainage areas and watersheds do employ the use of pumps to manage surface and shallow groundwater. A pump for Edison Slough would have to accommodate a range of volumes, from normal intra-watershed flows to overflow from the Samish River. Use of a pump could create positive drainage conditions and help to reduce the period of inundation following flooding. Pumps require maintenance and an energy source and can be expensive infrastructure to install and maintain.

ALTERNATIVE C-9: Floodgate

A floodgate utilized in conjunction with other drainage infrastructure, including but not limited to tide gates, pumps, or levee systems, can offer relief from flooding by evacuating stored water behind levees. A floodgate can either be manual or head-pressure activated. A floodgate can act much like a tide gate by allowing one-way flow. In the case of Edison Slough, a floodgate would likely be positioned at the same location as the existing SRTG or integrated into a tide-gate design. A floodgate generally remains closed during most conditions, but may be opened when floodwater needs to be drained from the system.

Alternatives Identified for Managing Hydrologic Inputs

The following construction alternatives are proposed to address deficiencies in the management of upper watershed hydrology and flood prevention:

ALTERNATIVE H-1: Upper Watershed Storage Areas

Temporary storage of flow from upper water shed areas can attenuate flood peaks from high intensity rainfall events. Larger detention or storage areas in the Bow Hill uplands or at the margin between the uplands and the floodplain could be used to store surface water during storm events, reducing or attenuating the impacts from intra-watershed flooding, in addition to potentially offering some water treatment to improve water quality conditions.

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ALTERNATIVE H-2: Samish River Levee Modifications

Levee modifications can be used to alter the "level of protection" and flood inundation frequency. A taller and longer right bank levee on the Samish River could reduce the frequency and/or magnitude of floods in the Edison Slough floodplain due to flooding of the Samish River. Conversely, lowering the levee could alleviate drainage issues in other drainage areas on the Samish River floodplain, while increasing the flow into Edison Slough. Infrastructure is not currently in place to accommodate regular or sustained flows from the Samish River. Any activities to modify the Samish River levee would need to be coordinated with the other impacted drainage areas.

Alternatives Identified for Improving Water Quality

The following alternatives are proposed to address the problem of degraded water quality within the Edison Slough watershed:

ALTERNATIVE WQ-1: Install Riparian "Filter-Strip" or "Hedge Row" Buffer

Improving vegetation along the banks of Edison Slough and the upper headwater areas of Bow Hill would reduce water temperatures, provide a means for biofiltration, and increase the uptake of certain pollutants, as well as stabilize banks by reducing erosion and increasing biodiversity and water-dependent habitat (Appendix D).

ALTERNATIVE WQ-2: Fencing Livestock

Installation of fencing to exclude livestock from ditch/stream access would provide increased separation from livestock waste and sedimentation, and allow for vegetative buffer strips to establish themselves along watercourses.

ALTERNATIVE WQ-3: On-Site Stormwater Treatment Modifications

Providing areas for stormwater retention would allow for particulates and sediment to settle, improving downstream water quality. Stormwater can be managed with engineering as well as environmental solutions; stormwater retention facilities combined with enhancement of vegetative communities would increase biofiltration and pollutant uptake.

ALTERNATIVE WQ-4: Agricultural Practices BMPs

Agricultural BMPs governing environmentally sensitive activities such as manure application, fertilizer use, waste management, sediment and erosion management, and stormwater management can decrease the point sources of pollutants. Many local, state, and federal programs are already in place to educate landowners about BMPs, and ordinances have been created to enforce them.

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ALTERNATIVE WQ-5: Education

Providing information to landowners and stakeholders regarding ways to help maintain a clean watershed and addressing issues such as stormwater treatment, agricultural waste, septic systems, animal feces, and vehicle maintenance, can be an effective management tool and may be utilized to supplement the aforementioned alternative actions.

Alternatives Identified for Improved Drainage in Edison Township

Four potential alternatives were proposed to alleviate the issue of stormwater accumulation within the Edison township. The alternatives include improving, modifying, and/or maintaining existing infrastructure:

ALTERNATIVE D-1: Stormwater Vault

Installing a holding tank/vault that would provide storage for stormwater runoff during high tides could alleviate occasional flooding from the occurrence of high precipitation during periods of high tide or high ground water. The vault would be sized to detain stormwater runoff until the high tide subsided and the stormwater runoff could be released through the tide gate and into Edison Slough. If vault sizing calculations indicated a need for a cost prohibitive sized vault, a smaller vault with a pump could be installed to save on the initial construction costs. This alternative relies on the tide gate to function properly, if the tide gate fails this alternative does not provide relief from the stormwater accumulation.

ALTERNATIVE D-2: Stormwater Pumping System

Installing a stormwater pumping system and forcemain connected to the stormwater system located near the intersection of Cains Court and the alley south of and parallel to McTaggart Avenue could provide positive drainage during all conditions. This alternative requires reconfiguration of the stormwater system near the intersection of Cain Street and McTaggart Avenue to isolate the catch basins on the south side of McTaggart Avenue so they would not be tidally influenced. Once the two catch basins were isolated, a pump would be installed to pump stormwater flows south down Cains Court to the southern conveyance system. Flows entering the southern conveyance system are conveyed to a detention pond where they are released into the slough through a tide gate or through a pump.

ALTERNATIVE D-3: Gravitational Drainage System

Reconfiguring the storm drainage system near the intersection of Cains Court and McTaggart Avenue to allow the two catch basins on the south side of McTaggart Avenue to gravity drain to the southern drainage system could provide positive drainage without the use of pumps. The southern drainage system, as described in Alternative D-2 above, would be conveyed to a detention pond and released to Edison Slough via existing pump.

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ALTERNATIVE D-4: Maintaining Existing Tidegate and Infrastructure

The existing drainage system works more often than not and under most conditions. Fairly routine maintenance of the existing infrastructure is already underway, but has had periods of time in which maintenance has lapsed. Maintaining the infrastructure seems to help in most, but not all, conditions and maintenance needs appear to be frequent. At times, the tide level, regional groundwater, and precipitation levels overwhelm the infrastructures ability to drain effectively and ponded water and some localized flooding of structures occurs. This alternative would be to increase the frequency of maintenance and manage the occasional flooding with alternative temporary measures, such as sand bags or pumping.

Dismissed Alternatives

The following alternatives were determined to be unfeasible within the scope of the project, were likely not "permittable" from a regulatory perspective, and/or did not adequately address project goals, and were therefore omitted from further analysis:

ALTERNATIVE X-1: Dredging Seaward of the Tide Gate

Obtaining a permit for dredging seaward of the tide gate is highly unlikely; therefore this alternative was rejected as not feasible.

ALTERNATIVE X-2: Skagit River Levee Modifications

Modification of the Skagit River levee system and overflow corridors are not within the scope of this project. Modification of the levee would have resounding impacts on the infrastructure of the Edison Slough system and the Samish River system and the communities that reside there. While there may be some value to exploring this alternative in the future, clear objectives and rationale would need to be developed and a significant amount of analysis performed to quantify the changes.

ALTERNATIVE X-3: Seawall Modification

It is possible that seawall modifications may be sought in the future, especially if they are overtopped, but at the present time these alternatives are not within the scope of the project.

ALTERNATIVE X-4: No Action

If no action is taken, flooding and poor water quality can be expected to continue and will likely increase in severity and duration. Channel conveyance will decrease due to sedimentation and reed canary grass build-up, while rising sea levels will increase the already high water table and will increase the effects of tidal influences on the floodplain. Furthermore, the aforementioned climate change characteristics related to the current cool PDO makes increased flooding in the future highly likely. The failure to identify and act upon a viable alternative would result in an increase in the frequency and magnitude of flood events over time.

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Water quality in Samish Bay is highly influenced by contributing waters and upstream processes. Water quality could potentially worsen in the future as land use in the Edison Slough watershed adapts to changing climatic, build-out and out of compliance agricultural practices. In the event that no action is taken and water quality continues to deteriorate, the effects will be felt not only within the local fish population, but within Samish Bay and Puget Sound as well. In recognition of these potential consequences, the "No Action" alternative was omitted from further analysis and consideration.

8 BENEFIT-COST ANALYSIS OF ALTERNATIVES

Unless otherwise noted, all of the identified alternatives were preliminarily determined to have a high probability of being technically feasible based on elevations and survey information and engineering review. The regulatory feasibility will need to be assessed on a case-by-case basis, but every effort was made to select feasible alternatives from a regulatory perspective. Table 4 depicts a quantitative analysis of the feasibility of the identified alternative strategies by comparing relative to cost (planning-level implementation estimates) and the relative potential benefits to improve conveyance and improve water quality. In summary, projects that had multiple benefits (improving both conveyance and water quality) and were of a lower cost fair better than single benefit projects or projects with a higher cost. In summary, the projects that were identified as having the highest benefit to cost ratio are:

- Alternative C-7: Tide Gate Modifications
- Alternative WQ-1: Riparian Buffers (windrows)
- Alternative WQ-2: Fencing Livestock
- Alternative WQ-4: Agricultural BMPs.

Additional management strategies with a medium benefit to cost ratio are:

- Alternative H-1: Stormwater Mitigation (both on-site storage and treatment and base of Bow Hill storage/treatment concepts)
- Alternative C-4: Culvert improvements
- Alternative WQ-5" Education
- Alternatives C-2/C-3 and C-5: Bank management (mow/spray, geometry improvements).

Table 4 provides a first cut at determining which projects provide greater overall "value" for the community and environment. The second effort to refine alternatives was to integrate Skagit County's "ability" to take on selected projects from an available resource perspective, in addition to working within the specific funding authorities and general "viability". The findings from the collected alternatives assessment are provided in Section 9.

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Table 4: Cost-Benefit Calculations for Edison Slough Drainage Improvement Plan Alternatives

Alternative	Conveyance Effect	Water Quality Effect	Combined Benefits Score	Planning Level Cost (Implementation)	Planning Level Cost (Maintenance 25-Yr)	Combined Benefits Score	Benefit / Cost
No Action	-2	-2	-4	0	1	1	-4.0
Flood and Stormwater Storage	3	2	5	5	2	7	0.7
Tide Gate Modifications	3	2	5	0	2	2	2.5
Riparian Buffer	1	3	4	3	1	4	1.0
Fencing Livestock	1	3	4	1	0	1	4.0
Stormwater Treatment	1	3	4	4	3	7	0.6
Agricultural BMPs	0	3	3	2	1	3	1.0
Education	0	3	3	1	3	4	0.8
Mowing	2	0	2	0	3	3	0.7
Culvert Upsizing	3	1	4	6	3	9	0.4
Channel Widening	3	-1	2	3	2	5	0.4
Channel Realignment	3	-1	2	4	3	7	0.3
Levee Modifications	2	0	2	4	3	7	0.3
Pump(s)	2	0	2	4	4	8	0.3
Dredging	2	-1	1	3	2	5	0.2
Spraying	2	-2	0	1	2	3	0.0
Flood Gate	2	0	2	4	2	6	0.3

RELATIVE BENEFITS	PLANNING-LEVEL COSTS	SCORE	RELATIVE BENEFIT TO COST
3 highly beneficial	$0 - $10,000	1	Hi
2 beneficial	$10,000 - $50,000	2	Medium
1 somewhat beneficial	$50,000 - $100,000	3	Low
0 no impact	$100,000 - $250,000	4	
"-1 slightly detrimental	$250,000 - $500,000	5	
"-2 detrimental	> $500,000	6	
"-3 highly detrimental			

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9 RECOMMENDED PLAN ACTIONS

The goals of decreasing flooding and improving water quality can be met with a combination of methods, management strategies, and project actions. This section outlines and describes the alternatives selected that will best meet the project goals. For a description of the stream reach identified below each recommended alternative, refer to Section 2.2.1 (Edison Slough Watershed Geomorphic Assessment). It is recommended that more extensive engagement of stakeholders be part of vetting these recommended alternatives prior to formal adoption as a management strategy.

9.1 Recommended Project Elements

Our recommended plan elements include the following:

1) Culvert Maintenance

To improve conveyance, existing culverts should be inspected and cleaned; a number of existing culverts are currently obstructed by sediment, reducing conveyance potential. Maintenance may include localized dredging adjacent to culvert openings and occasional cleaning out of the culvert interior. Cleaning is usually performed through the use of high-pressure water, mechanical dredging, or by hand. Repair or replacement is necessary when incidental damage occurs to the culvert that would prevent optimum water flow or an unsafe crossing situation. While Skagit County manages public crossings, landowners would need to engage in their own management activities to ensure adequate conveyance is achieved.

Suggested Area for Alternative Implementation:

- REACH WIDE - Reach 1, Reach 2, Reach 3, Reach 4, Reach 5
- Highest Priority Areas: Ershig Road and Llama Lane

2) Culvert Replacement Strategy

Skagit County has been implementing a culvert replacement program that began nearly a decade ago. Culverts at public crossings, as well as at a private crossing, have been replaced, beginning at the tide gate and continuing upstream. In 2014, Skagit County replaced the undersized culverts at Bow Cemetery Road and Worline with 15' diameter reinforced concrete bridge (RCB) crossings. The hydraulic analysis by Anchor QEA (2010) recommended additional culvert replacements; our analysis of hydrologic conditions within the watershed generally supports their conclusion and continuing the replacement of undersized culverts. The following culvert replacement prioritization strategy is proposed based upon the degree of hydraulic constriction and conveyance improvement potential of the culvert, integrated with reported drainage impacts and potential public benefit:

1) P34060 Private Agricultural Crossing (Culvert #15)

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2) Ershig Road (Culvert #17)
3) Llama Lane - Skagit County (Culvert #18)
4) 7720 Ershig Road Private Agricultural Crossing (Culvert #19)
5) 7565 Worline Road Private Crossing (Culvert #14)
6) 7177 Worline Road Private Crossing (Culvert #12)
7) 7071 Worline Road Private Crossing (Culvert #11)
8) Culverts #10 and 11 (Private)

Figure 12 shows the spatial distribution of these culverts and Table 3 provides a description of existing culvert type.

We recommend that crossings at County roads and at access points to private residences utilize the 15-foot RCB crossings as designed for the recent Bow Cemetery Road and Worline Road culvert replacement projects (Appendix E). Agricultural crossings may utilize less expensive structures, such as railcar crossings, that meet the intended equipment loading specifications (Appendix F). We recommend that all crossings utilize low profile-type designs and minimize the placement of fill in the conveyance in order to convey larger flow events from Samish River overflow and to minimize backwatering potential.

Suggested Area for Alternative Implementation:

- Reach 4, Reach 5

3) Bow Hill Road Self-Regulating Tide Gate (SRTG) Monitoring with Potential Modification(s) and Ultimate Replacement

To increase conveyance and address flooding impacts, we recommend, at a minimum, developing a rigorous Bow Hill Road tide gate monitoring program and the collection of water surface elevation data and flows to assess the functionality of the tide gate under a range of flow conditions. It is possible that continued adjustments will be necessary, and that adjustments for one range of flows will not be beneficial for the full range of flows encountered by the SRTG. It is also possible that alternative tide gate designs may be more effective at accommodating a larger range of flows; replacement of the existing SRTG with a tide gate that enables fish passage while accommodating intra-basin to inter-basin flooding could significantly improve drainage conditions in the reach. At a minimum, it is anticipated that the Bow Hill Road tide gate will need to be replaced within the next 25 years as it will be nearing the end of its design life. At such time that the existing tide gate is being considered for replacement, we strongly encourage the design team to consider future sea level and climate conditions and the full range of design flow and function considerations.

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Suggested Area for Alternative Implementation:

- Reach 1

4) Localized Channel Bank Widening and Restoration (potentially with limited dredging)

Reach 5 was identified as potentially benefiting from localized restorative channel bank "cleaning" and potentially some very limited dredging based on the stream profile survey and topographic information (Figure 13). In most places, the surveyed profile shows that down-valley gradient exists, albeit at a very low slope. Dredging the entire channel will not provide a conveyance benefit as the most significant conveyance controls are the extremely low gradient, tide gates, and the tidal elevation, rather than localized variability in channel slope or channel depth. The exception may be to remove profile "humps" adjacent to culverts or in areas where fish stranding or passage are concerns. A more preferred solution is to restore channel bank geometry in areas where fill, sedimentation and reed canary grass vegetation has encroached. We recommend that ongoing monitoring of stream bed profiles and channel banks be conducted; if channel infilling is demonstrated in the future, dredging may need to be reevaluated as a potential management option.

Suggested Area for Alternative Implementation:

- Reach 5

5) Riparian Vegetation Strips – "Wind Rows"

We recommend encouraging voluntary collaboration between private property owners and local or state agencies an arrangement that could potentially benefit from cost-sharing solutions. The cost-share approach could help to offset the initial costs of reed canary grass replacement with native shrub creek-side riparian buffers (wind rows). The wind rows could help to improve water quality by facilitating biofiltration, sediment/erosion stabilization, and temperature regulation, as well as and providing increased conveyance potential for low to moderate flows. It is anticipated that maintenance needs would diminish substantially over time, and that within five years the riparian zone would become self-sustaining. Implementing hedge row planting projects on publicly owned properties would also serve as demonstration areas for private individuals. Figure 14 shows areas where hedge row planting would have the greatest effect at improving water quality. Appendix E presents an example of hedgerow planting and sequencing in Whatcom County as an example.

Suggested Area for Alternative Implementation:

- Reach 2, Reach 3, Reach 4, Reach 5

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6) Livestock Fencing

It is recommended that efforts be made to reduce bankside access in areas where livestock have access to surface water. Installing fencing at some distance from the OHWM would allow vegetative buffers to become established, reducing the potential for contaminants to be introduced directly into the watercourse and discharged into Samish Bay. The Clean Samish Initiative program and commitment by Skagit County is already established, and efforts are underway to implement livestock exclusion from surface waters that drain into Samish Bay.

Suggested Area for Alternative Implementation:

- Reach 2, Reach 3, Reach 4, Reach 5

7) BMP Education and Outreach

Education provides a low cost, effective management tool that fosters ground-up changes in personal behavior, which may help to reverse trends in environmental degradation. Education programs that reach community members, especially children, can help provide lasting, long-term changes in how we interact with and manage our natural environment. We recommend that existing educational programs and partnerships continue and that new opportunities for education and outreach be sought after and implemented as they become available. The Clean Samish Initiative Education and Outreach efforts conducted by Skagit County are summarized in the March 2013 CSI progress report as follows:

> *"SCPW is running a TV ad during the critical period to remind Samish residents to follow appropriate measures to eliminate sources of fecal coliform pollution on their property. The cable spot runs in the WAVE Broadband Zone which includes La Conner, West Mount Vernon and the Alger, BayView, Bow, Edison area for a total of 4,795 households starting on April 1st 2013. The ad will run for 4 weeks on 17 different networks and during each of the Mariners Baseball Games.*
>
> *SCPW sent out mailers to livestock owners in the Samish Basin as part of our spring strategy to reduce Bay closures.*
>
> *SCPW has a weekly ad in the Skagit Valley Herald about good stewardship practices during the critical period. The ad will run for 6 weeks and is currently in its fourth week of running."*

8) Channel Bank Vegetation Management – Reed Canary Grass

Channel bank vegetation maintenance can be a component of a wide range of drainage management strategies, from restoration to conveyance-increasing designs. Specific to Edison Slough, we did not identify a significant need for reshaping the banks along the entire watercourse. A more effective long term management strategy suggests prioritizing the

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restoration of natural riparian conditions by replacing canary grass monocultures with diverse native plants. In some instances, creating native plant wind rows may not be desirable or practical. In those instances, developing a mowing program to reduce the density and height of the reed canary grass occurring along the channel banks during low flow conditions will improve moderate flow conveyance and decrease sedimentation. The mowing can be accomplished using a range of methods, from hand mowing/weed eating to mechanical cutting. Mowing methods may include the use of a hydraulically operated sickle bar mower or other cutting head mounted on the front edge of a dredging bucket to get grass or root mass below water, if the appropriate permits and BMPs are obtained. The cut material should be deposited away from the watercourse. It is probable that the action of routine vegetation management will be undertaken by private property owners except where Edison Slough fronts a county road. We do not recommend spraying without implementation of a restoration plan in order to avoid further destabilization of sparsely vegetated areas adjacent to the creek which could be susceptible to erosion.

Suggested Area for Alternative Implementation:

- Reach 2, Reach 3, Reach 4, Reach 5

9) Edison Township Drainage Maintenance and Potential Modification

Upon review of the four alternatives presented in Section 7.2 to address the stormwater accumulation issue across from the Longhorn Tavern, it was determined that Alternative 4 – Maintenance should continue and be more frequent. If this action does not solve the flooding project, then we recommend that Alternative 3 (gravitational drainage) be implemented based on construction costs, projected long-term maintenance costs, reliability, efficiency, and performance. Alternative 1 (Stormwater Vault) is not preferred based on the need for a detention vault and the potential for localized failure should the tide gate fail. The detention vault would also be costly to install; space for installation is at a premium in this location, and constructing this proposed alternative would likely require the County to purchase private property or be granted an easement. Alternative 2 (Stormwater Pumping System) is not preferred based on the need for a pump system. This alternative would utilize the same general conveyance route as Alternative 3 but would require a pump, adding maintenance costs and presenting a potential risk for failure.

Gravitational drainage is preferred because a gravity conveyance system doesn't require a detention system or pump system, providing a long service life with minimal future maintenance requirements. Alternative 3 would eliminate the low lying catch basins within the area of concern (Figure 11, Sheet 2), thus greatly reducing the ability for high tides to cause ponding water at the intersections of McTaggart Avenue and Cains Court. The low lying catch basins would be connected to the southern drainage system, which is served by a detention pond and pump system.

The general construction activities required to construct Alternative 3 include saw cutting, removing and replacing existing asphalt along McTaggart and Cains Court, installation of a new

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storm drain line, abandonment of existing storm drains lines, and the addition of two to four Type-1 catch basins. There are no major utility conflicts anticipated with this option based upon the utility maps provided. The resulting system would add approximately 230 feet of storm drain.

Based on our preliminary analysis of the storm drainage systems in the vicinity, we recommend proceeding with further analysis and design for Alternative 3 to alleviate existing drainage problems in the area of concern. Alternative 3 would add additional stormwater runoff to the southern system, but based on our preliminary analysis, this additional stormwater load is insignificant relative to the load already being managed by the southern system. Should Alternative 3 move forward into the stages of planning and design, we recommend further analysis of the southern system to verify that the additional load will not have an adverse impact on the system.

Suggested Area for Alternative Implementation:

- Reach 1

9.2 Adaptive Management Planning Recommendations

Edison Slough and the Edison and Bow townships are very vulnerable to climate and sea-level changes and as such, there will likely need to be adaptations to changing conditions, particularly in regard to climate change and sea level rise. It is likely that at some point in the future, management actions that are not prioritized today will become the priorities of tomorrow. Examples include pump and levee construction/modification. While pumps and levees were not selected as a high priority management action given today's current conditions, it is probable that a pump will be needed to manage drainage at some point in the near future, and levees or alternative flood management strategies may become increasingly important.

9.3 Recommended Management Plan Implementation Schedule

Four priority areas were identified and recommend for focused implementation (Figure 15). Each of the identified areas contain conditions that limit water quality or conveyance. Implementation for near-term (5-year outlook) should begin as soon as possible to alleviate the most acute drainage and water quality issues. The recommended implementation schedule is:

1-Year Target Goals

Edison Slough Watershed

1) Engage broader stakeholders for vetting and refinement of recommended management actions
2) Priority Areas 1 and 2

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- Contact landowners for culvert replacements starting with highest priority culverts
- Contact landowners for channel work in high priority areas to determine willingness for channel bank management actions
- Coordinate with agencies and tribes

3) Priority Areas 3 and 4
   - Make contacts with Priority Areas 3 and 4 landowners following Priority Areas 1 and 2 and determine the potential willingness for voluntary participation in project actions
4) Initiate permitting process for 5-year target goals for Priority Areas 1 through 4.
5) Fence livestock from surface water areas in areas where necessary and where willingness exists
6) Maintain culverts with emphasis at Ershig crossings
7) Develop plans and specifications for recommend Edison drainage improvement actions needing engineering design
8) Establish a monitoring program for the SRTG and evaluate function.

5-Year Target Goals:

Priority Areas 1 through 4

1) Implement permitted projects as determined by budget, schedule and willing landowners (with acquired easements).

Edison Township

2) Maintain culverts and the Longhorn tide gate. Monitor effectiveness of maintenance. Develop plans to modify if maintenance alone is not an effective strategy.

Edison Slough Reach 1 and 2

3) Continue SRTG monitoring and adaptive management plan – evaluate functionality and consider if existing design is capable of meeting the condition needs; if not, consider a new SRTG design
4) Maintain and modify SRTG and culverts as needed
5) Perform hedge row planting on publicly owned properties or where willing landowners exist
6) Continue to implement the recommended drainage improvement action and monitor

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Edison Slough Reach 3, 4, and 5

7) Improve conveyance and water quality by means of:
    - Acquiring easements as necessary for project implementation on private properties
    - Continued replacement of under-sized culverts – one or two per year
    - Removal of canary grass from riparian areas, replace with native riparian hedge row vegetation as opportunities allow or maintain with mowing
    - Removal of profile "humps" near Ershig/Worline Roads
    - Maintaining culvert conveyance
    - Exploring feasibility of stormwater storage and treatment areas at the base of Bow Hill east of railway
    - Implementing recommended actions on Hobson Road drainage network
8) Monitor water quality conditions
9) Seek funding and partnership opportunities to implement and maintain projects
10) Perform outreach and educational activities to promote watershed stewardship.

25-Year Target Goals

Edison Slough Watershed

1) Develop and implement a monitoring plan to track sea-level change and ground water conditions
2) Resurvey channel profile
3) Evaluate function of channel conveyance measures
4) Monitor water quality conditions
5) Implement adaptive management corrective actions and consider SRTG replacement or modification for realized or predicted future conditions
6) Manage and maintain existing and implemented projects.

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10 CLOSURE

This report was submitted by:

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12 FIGURES

LIST OF FIGURES

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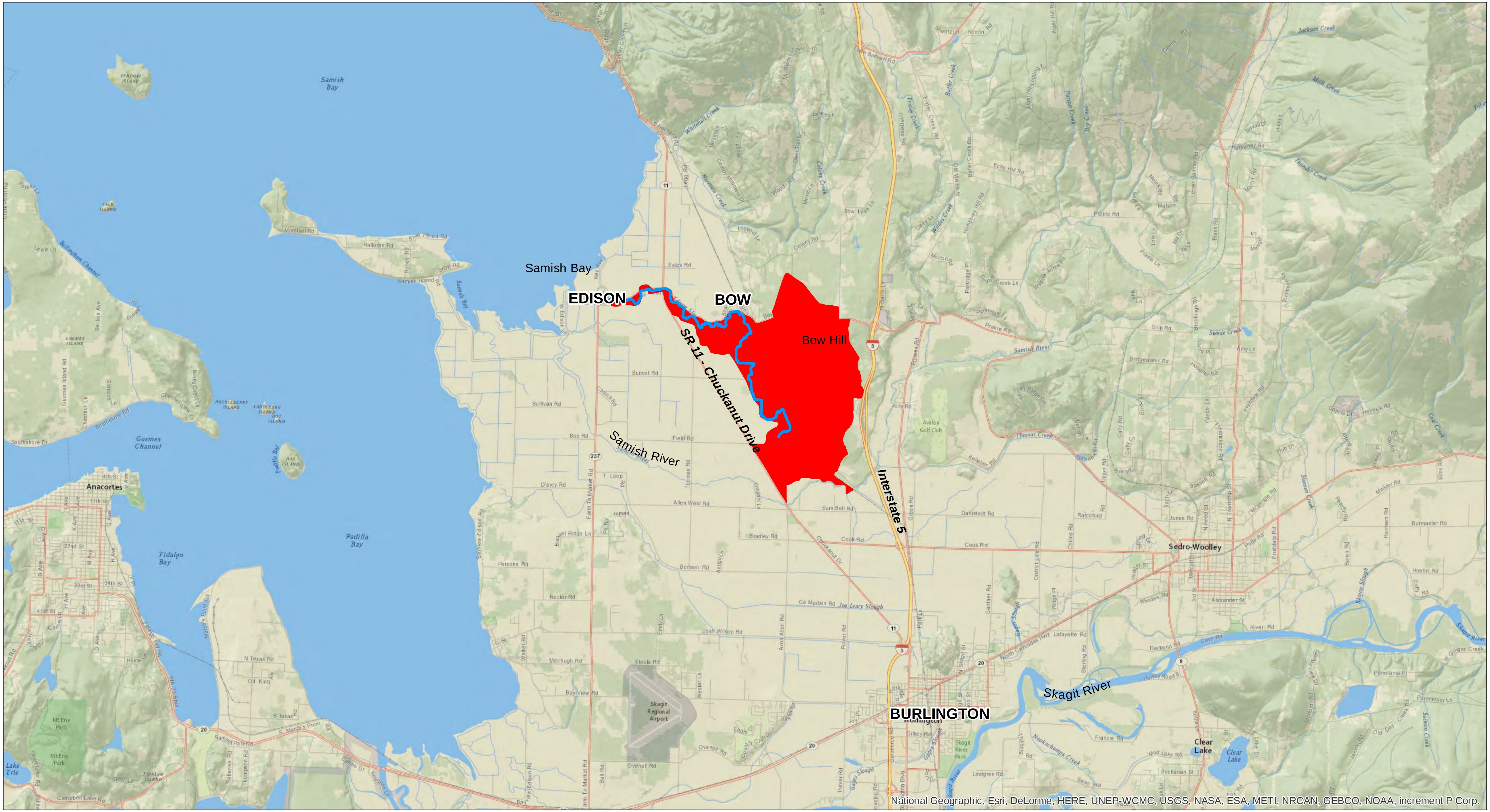

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EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

Edison Watershed

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FIGURE 1
Vicinity Map

Date: 3/5/2015

Samish Bay
EDISON
Edison
Edison Station
BOW
Bow
Bow Hill
SR 11 - Chuckanut Drive
Interstate 5
Samish River
Belfast
Thomas
Butler
Flat
Jarman
UPPER SKAGIT INDIAN RESERVATION
State Salmon Hatchery
Fish Hatchery
Campground
Gravel Pit
Well
Spring
Creek
River
Slough
Mile 0
Mile 5
Mile 6
SUNSET ROAD
SULLIVAN ROAD
FIELD ROAD
BENSON ROAD
ALLEN ROAD
WEST ROAD
BOW HILL ROAD
HOBSON ROAD
BUTLER HILL ROAD
OLD 99 NORTH ROAD
LEVEE
EAST EDISON ROAD

Edison Slough Watercourse

Edison Slough Watercourse

Edison Slough Floodplain Area

Edison Watershed

0 2,000 4,000 6,000 8,000

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EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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FIGURE 2
Edison Slough Watershed

Date: 3/5/2015

Samish Bay

EDISON

BOW

SR 11 - Chuckanut Drive

Bow Hill

Samish River

Interstate 5

Edison Slough Watercourse

- Edison Slough Watercourse
- **ROE as of December 2013**
- **Edison Slough Floodplain Area**
- **Drainage District 16**
- **Drainage District 18**
- **Edison Watershed**

N

0 2,000 4,000 6,000 8,000

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EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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FIGURE 3
Right of Entry (ROE) Parcels Granted for Analysis

Date: 3/5/2015

Samish Bay

EDISON

BOW

SR 11 - Chuckanut Drive

Bow Hill

Samish River

Interstate 5

Edison Slough Watercourse

- Edison Slough Watercourse
- Edison Watershed

Mapped Geologic Units

Unconsolidated Sediments

- Quaternary alluvium, dune sand, loess, and artificial fill
- Quaternary alluvial fans, beach deposits, undifferentiated sedimentary deposits, and lacustrine deposits
- Pleistocene continental glacial, glaciolacustrine, and outburst flood deposits, Fraser-age

Metamorphic Rocks (Amphibolite Faces and Higher)

- Jurassic-Permian metamorphic rocks

Other Features

- Water

N

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EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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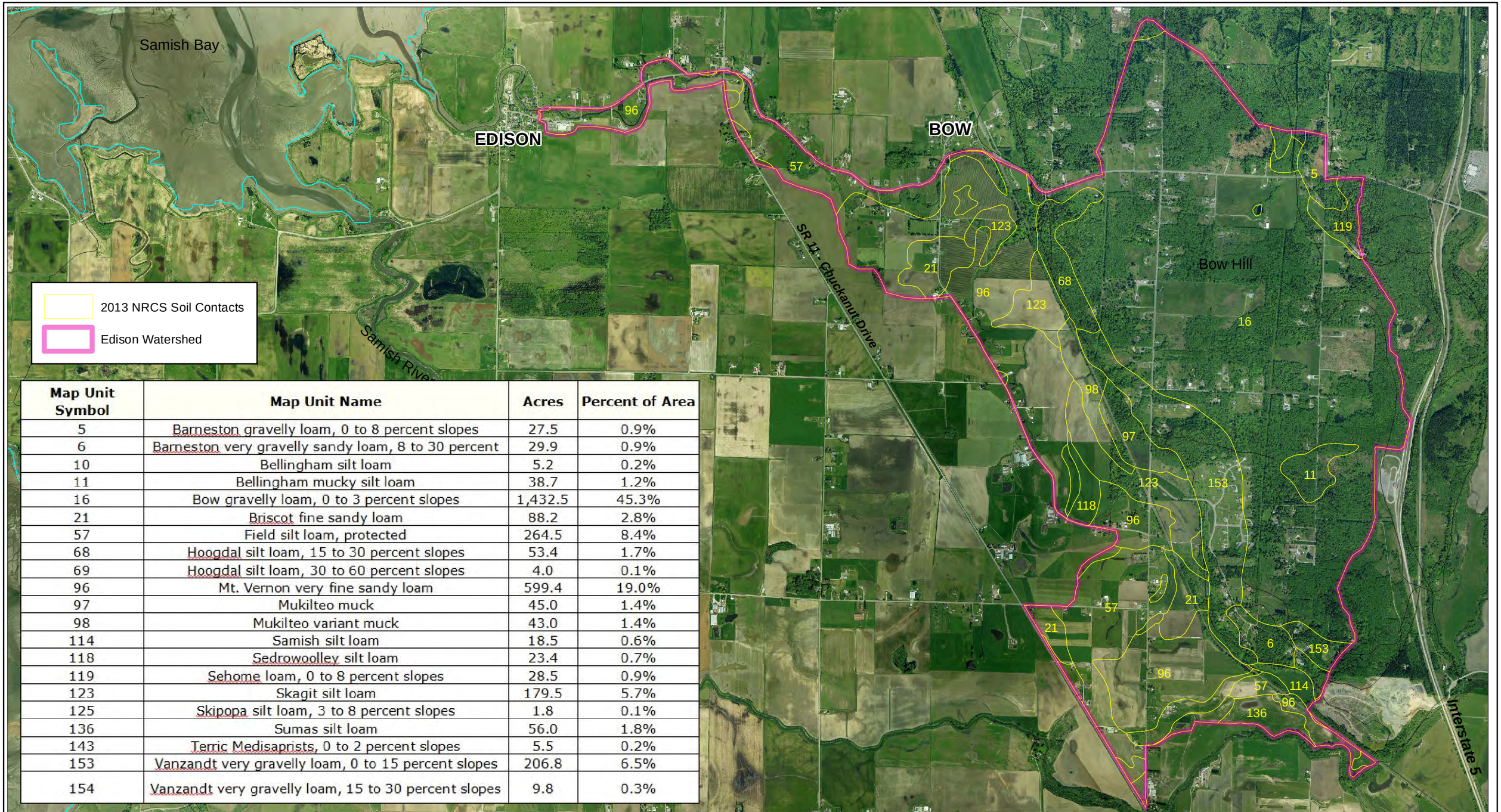
FIGURE 4
Mapped Geology

Date: 3/5/2015



Map Unit Symbol	Map Unit Name	Acres	Percent of Area
5	Barneston gravelly loam, 0 to 8 percent slopes	27.5	0.9%
6	Barneston very gravelly sandy loam, 8 to 30 percent	29.9	0.9%
10	Bellingham silt loam	5.2	0.2%
11	Bellingham mucky silt loam	38.7	1.2%
16	Bow gravelly loam, 0 to 3 percent slopes	1,432.5	45.3%
21	Briscot fine sandy loam	88.2	2.8%
57	Field silt loam, protected	264.5	8.4%
68	Hoogdal silt loam, 15 to 30 percent slopes	53.4	1.7%
69	Hoogdal silt loam, 30 to 60 percent slopes	4.0	0.1%
96	Mt. Vernon very fine sandy loam	599.4	19.0%
97	Mukilteo muck	45.0	1.4%
98	Mukilteo variant muck	43.0	1.4%
114	Samish silt loam	18.5	0.6%
118	Sedrowoolley silt loam	23.4	0.7%
119	Sehome loam, 0 to 8 percent slopes	28.5	0.9%
123	Skagit silt loam	179.5	5.7%
125	Skipopa silt loam, 3 to 8 percent slopes	1.8	0.1%
136	Sumas silt loam	56.0	1.8%
143	Terric Medisaprists, 0 to 2 percent slopes	5.5	0.2%
153	Vanzandt very gravelly loam, 0 to 15 percent slopes	206.8	6.5%
154	Vanzandt very gravelly loam, 15 to 30 percent slopes	9.8	0.3%

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EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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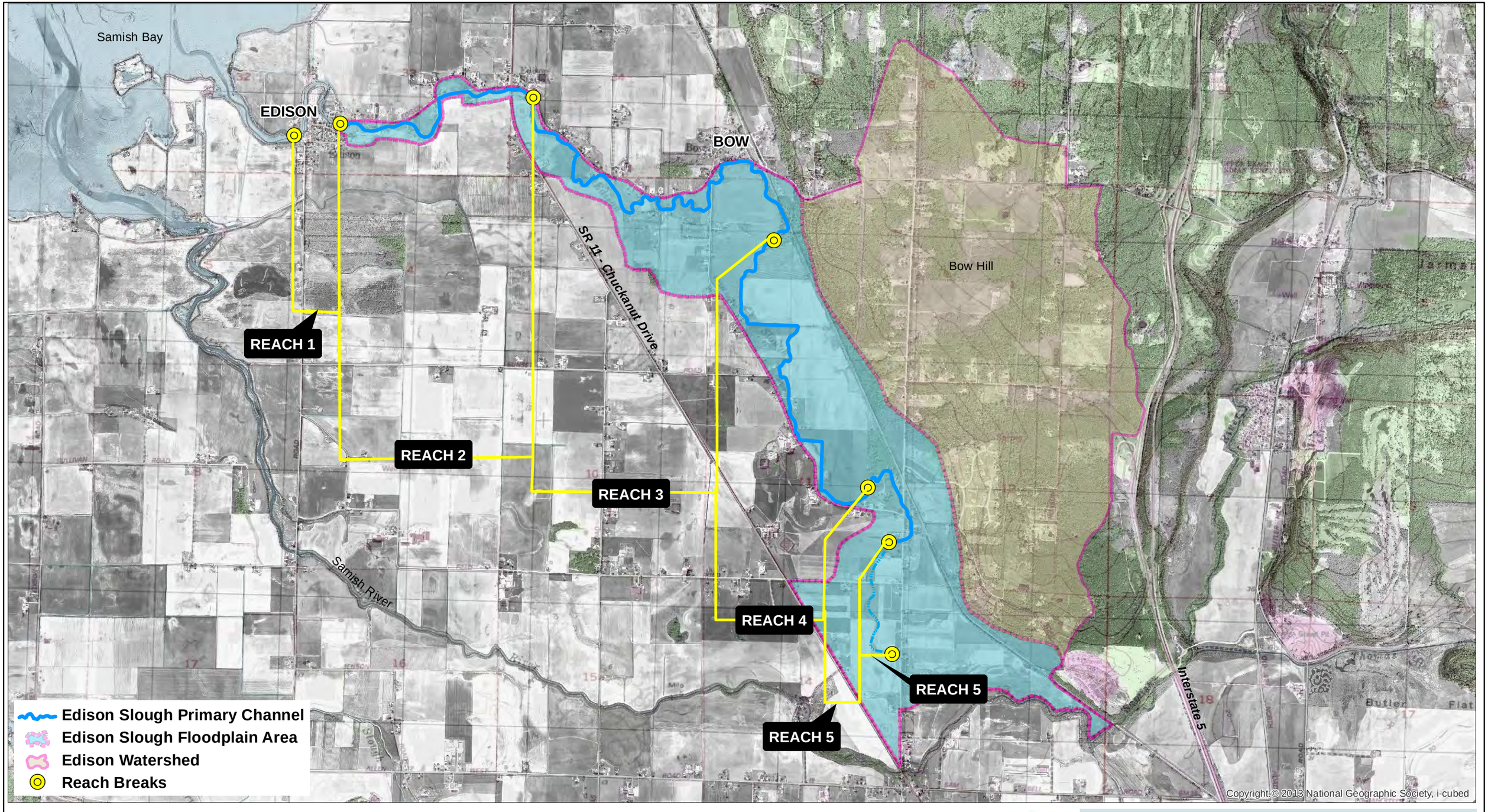
FIGURE 5
Mapped Soils
NRCS 2013 Soil Survey

Date: 3/5/2015



0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG6_REACH-BRKS.mxd

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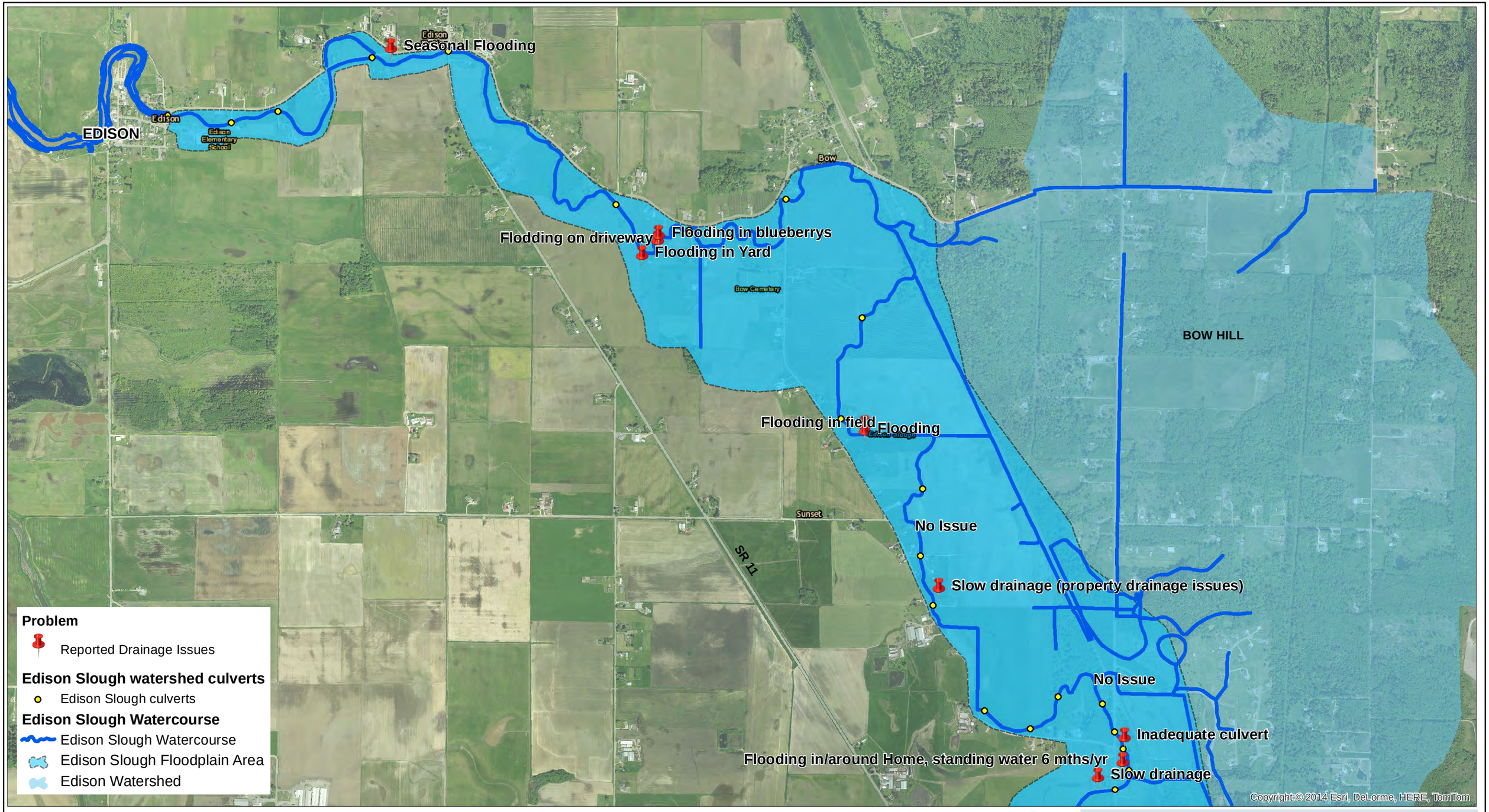
FIGURE 6
Geomorphic Reach Breaks

Date: 3/5/2015



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0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

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FIGURE 7
Reported Drainage Concerns

Date: 3/5/2015

EDISON

Edison Elementary School

CHANNEL STRAIGHTENING

LEVEE/SEA-WALL & TIDE GATES

Bow

Bow Cemetery

BOW HILL

CHANNELIZATION

CHANNEL STRAIGHTENING

RAILWAY GRADE "LEVEE"

LEVEE

SR 11

SAMISH RIVER

Samish River

Tide Gates

Edison Slough watershed culverts

Edison Slough culverts

Edison Slough Watercourse

Edison Slough Watercourse

Edison Slough Floodplain Area

Edison Watershed

0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG8_HYDROMODIFICATIONS.mxd

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FIGURE 8
Hydromodifications

Date: 3/5/2015

Samish Bay

EDISON

BOW

Bow Hill

SR 11- Chuckanut Drive

Samish River

Interstate 5

Copyright: © 2013 National Geographic Society, i-cubed

National Wetland Inventory

Edison Slough Watercourse

Edison Slough Watercourse

Edison Slough Floodplain Area

Edison Watershed

N

0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG9_WETLANDS.mxd

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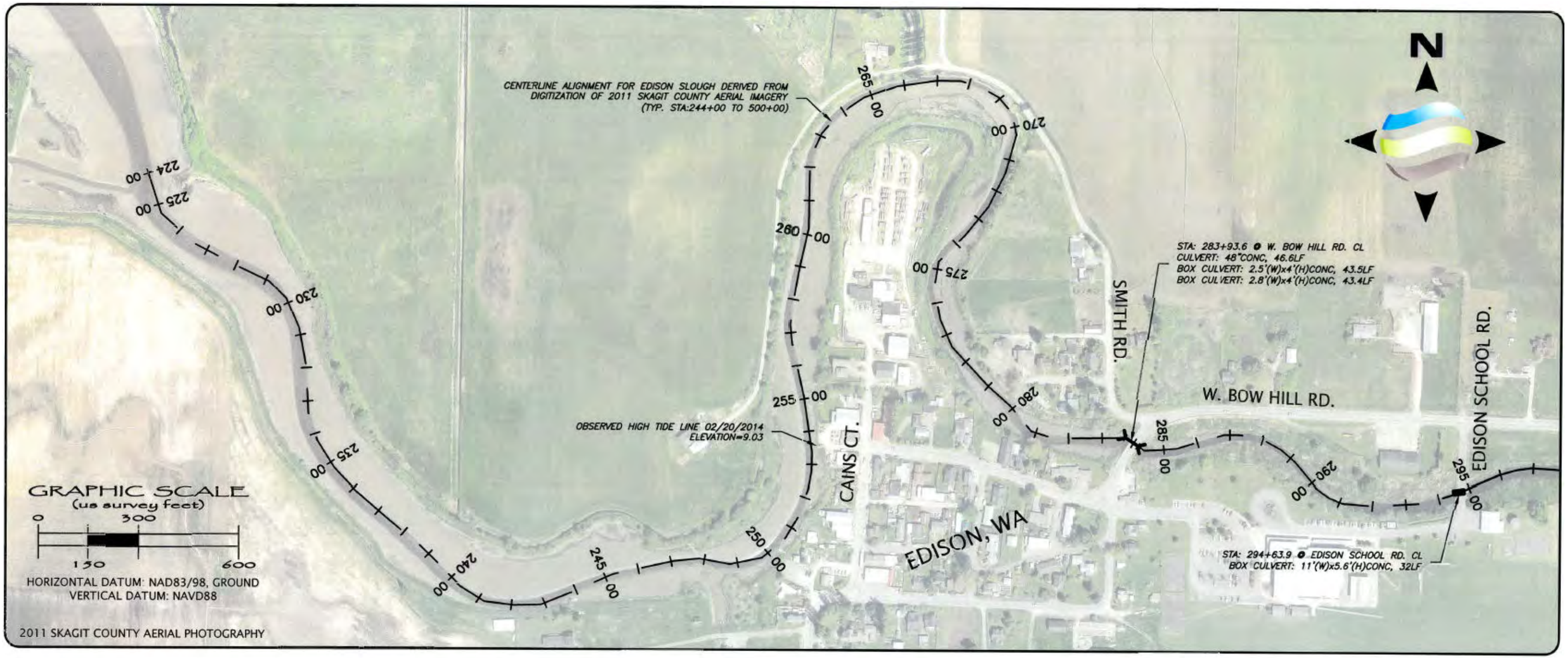
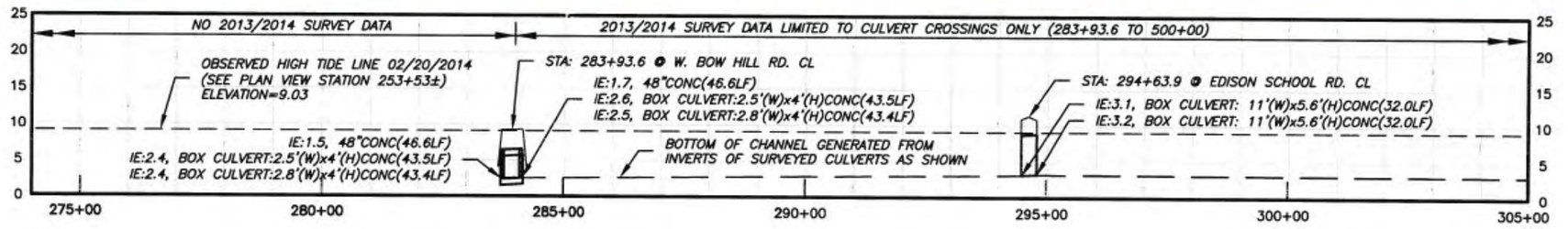
FIGURE 9
Mapped Wetland Areas
National Wetland Inventory

Date: 3/5/2015





HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'

EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

FIGURE 10 (SHEET 1 of 12) CHANNEL SURVEY

Notes: CAD linework from Skagit County Public

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Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-1_SURVEY.mxd

GRAPHIC SCALE
(us survey feet)
0 300
150 600
HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

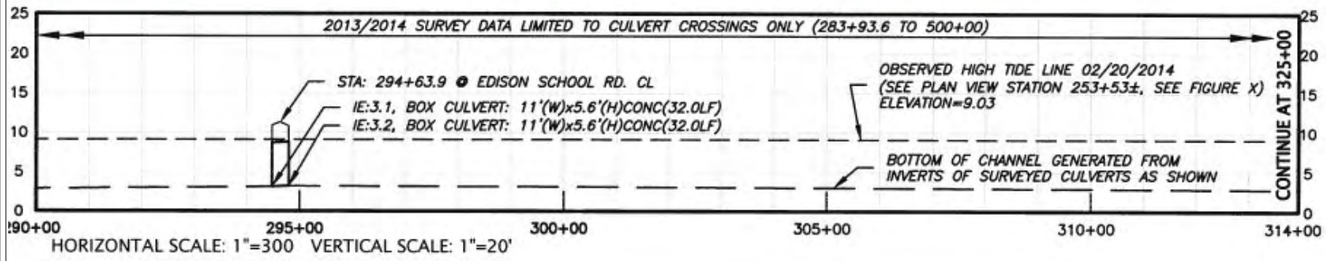
CENTERLINE ALIGNMENT FOR EDISON SLOUGH DERIVED FROM DIGITIZATION OF 2011 SKAGIT COUNTY AERIAL IMAGERY (TYP. STA:244+00 TO 500+00)

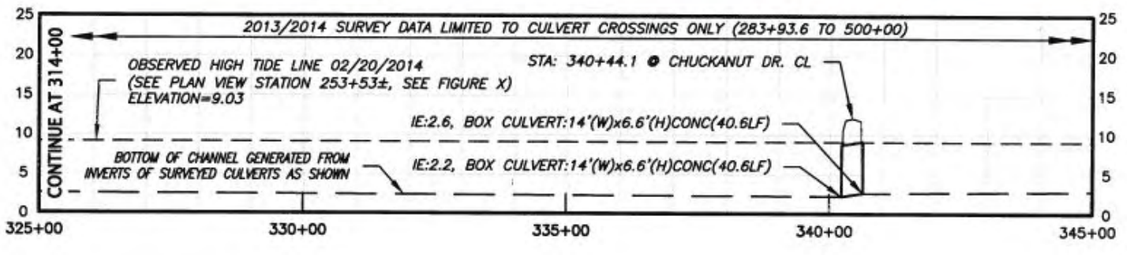
STA: 340+44.1 @ CHUCKANUT DR. CL
BOX CULVERT: 14'(W)x6.6'(H)CONC, 40.6LF

STA: 294+63.9 @ EDISON SCHOOL RD. CL
BOX CULVERT: 11'(W)x5.6'(H)CONC, 32LF

WEST BOW HILL RD.
EDISON SCHOOL RD.
CHUCKANUT DR. (SR11)
BOW HILL RD.

2011 SKAGIT COUNTY AERIAL PHOTOGRAPHY





HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'

EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

Notes: CAD linework from Skagit County Public

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FIGURE 10 (SHEET 2 of 12)
CHANNEL SURVEY

Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-2_SURVEY.mxd

GRAPHIC SCALE
(us survey feet)
0 300 150 600

HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

CAPRICORN LN.

CEMETERY RD.

CENTERLINE ALIGNMENT FOR EDISON SLOUGH DERIVED FROM DIGITIZATION OF 2011 SKAGIT COUNTY AERIAL IMAGERY (TYP. STA:244+00 TO 500+00)

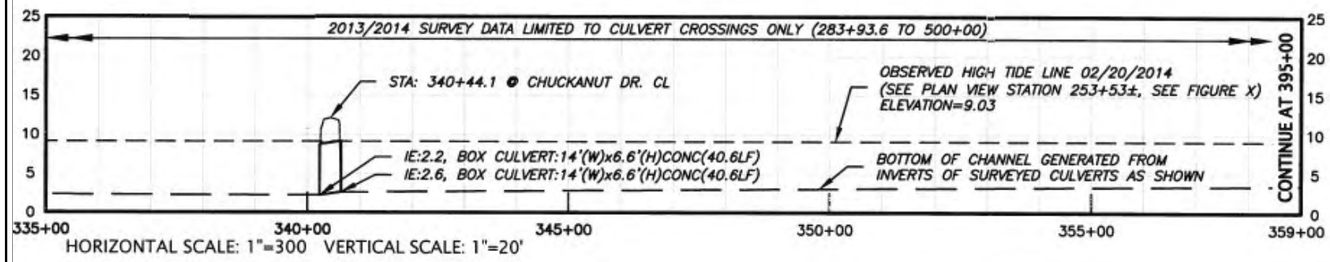
STA: 409+69.9 ● CEMETERY RD. CL
CULVERT: 48"CONC, 36.2LF
CULVERT: 36"CONC, 32.3LF
CULVERT: 30"CONC, 31.9LF

BOW HILL RD.

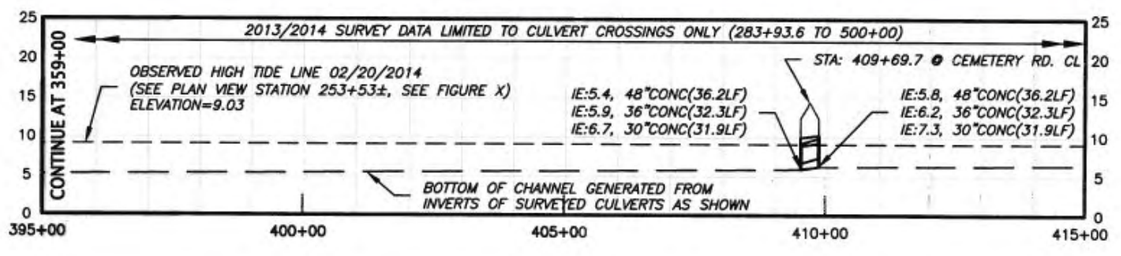
STA: 340+44.1 ● CHUCKANUT DR. CL
BOX CULVERT: 14'(W)x6.6'(H)CONC, 40.6LF

CHUCKANUT DR. (SR11)

2011 SKAGIT COUNTY AERIAL PHOTOGRAPHY



HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'



EDISON SLOUGH DRAINAGE IMPROVEMENT
MANAGEMENT PLAN

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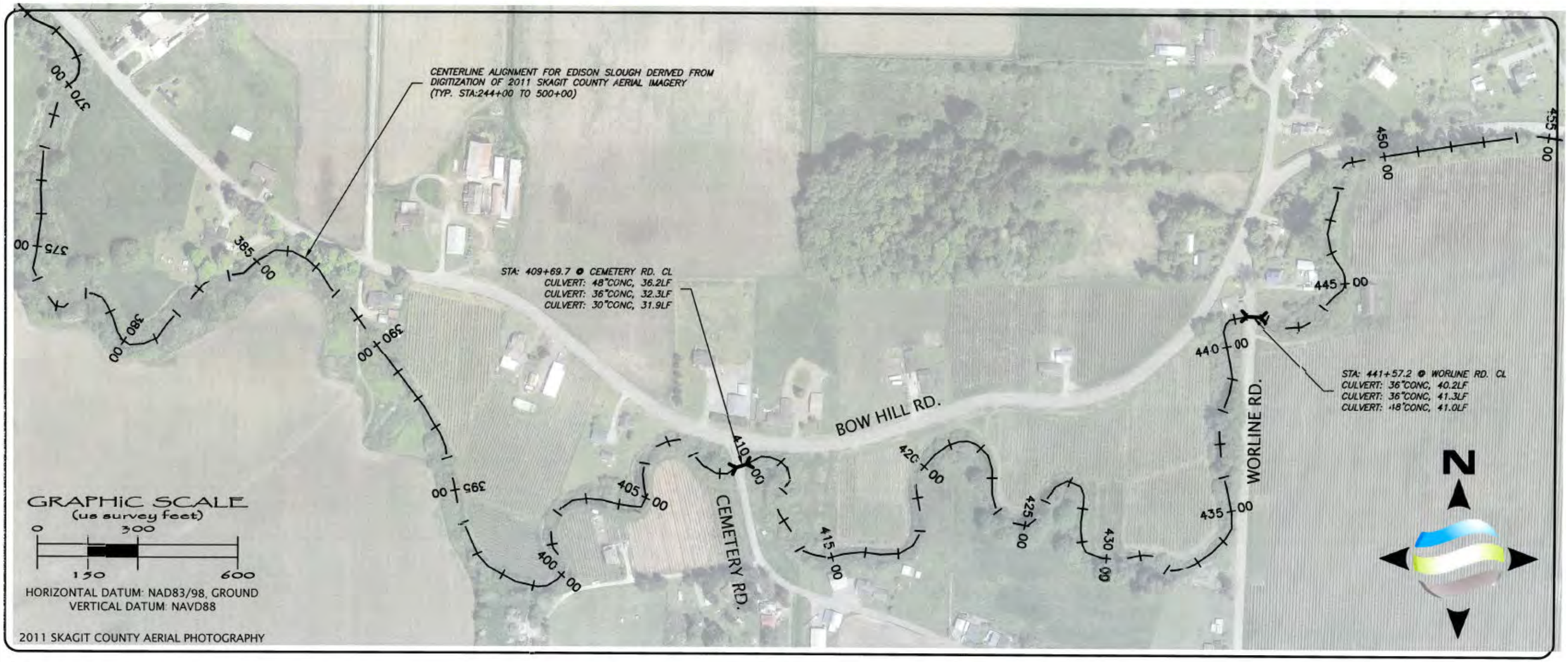
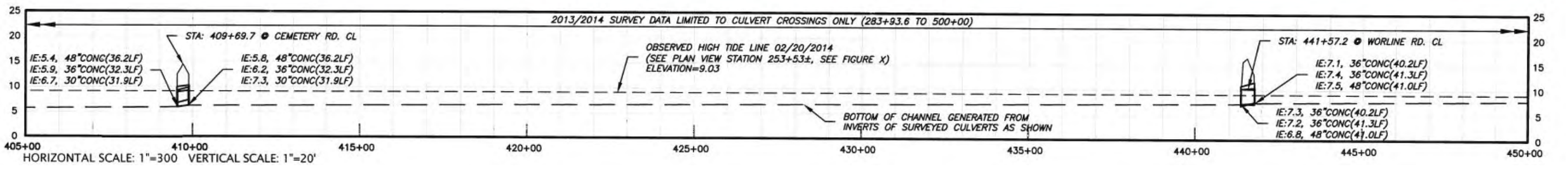
FIGURE 10 (SHEET 3 of 12)
CHANNEL SURVEY

Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-3_SURVEY.mxd





EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

FIGURE 10 (SHEET 4 of 12) CHANNEL SURVEY

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Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-4_SURVEY.mxd

GRAPHIC SCALE
(us survey feet)
0 300 150 600
HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

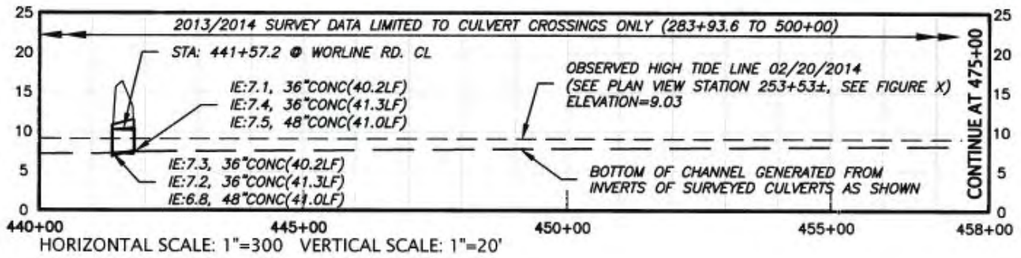
BOW HILL RD.

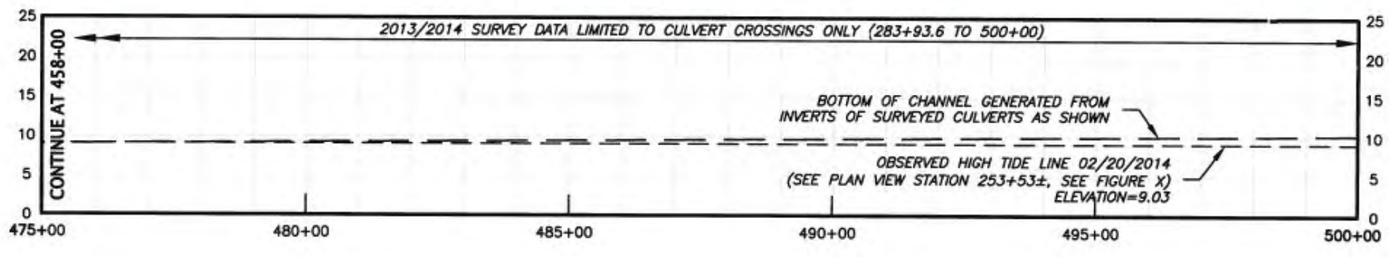
WORLINE RD.

CENTERLINE ALIGNMENT FOR EDISON SLOUGH DERIVED FROM DIGITIZATION OF 2011 SKAGIT COUNTY AERIAL IMAGERY (TYP. STA:244+00 TO 500+00)

STA: 441+57.2 @ WORLINE RD. CL
CULVERT: 36"CONC, 40.2LF
CULVERT: 36"CONC, 41.3LF
CULVERT: 48"CONC, 41.0LF

2011 SKAGIT COUNTY AERIAL PHOTOGRAPHY





HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'

EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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FIGURE 10 (SHEET 5 of 12)
CHANNEL SURVEY

Date: 3/5/2015

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GRAPHIC SCALE
(us survey feet)
0 300
150 600
HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

N

STA: 509+24.0 ● GRAVEL ROAD CL
CULVERT: 30"CMP, 60.9LF

STA: 534+69.9 ● DIRT ROAD CL
CULVERT: 24"CMP, 17.9LF

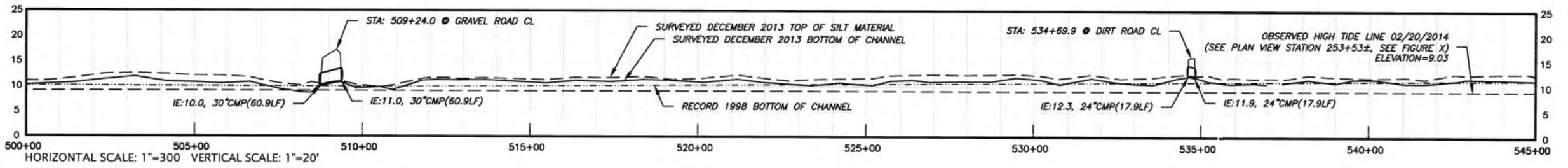
SURVEYED DECEMBER 2013 CHANNEL
NOTE STRETCHES NOT SURVEYED IN PROFILE
RECORD 1998 CENTERLINE OF CHANNEL

STA: 556+50.2 ● GRAVEL ROAD CL
CULVERT: 18"CPP, 26.8LF
CULVERT: 18"CPP, 28.3LF
CULVERT: 30"CPP, 30.4LF

WORLINE RD.

SUNSET RD.

2011 SKAGIT COUNTY AERIAL PHOTOGRAPHY



HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'

EDISON SLOUGH DRAINAGE IMPROVEMENT
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FIGURE 10 (SHEET 6 of 12)
CHANNEL SURVEY

Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-6_SURVEY.mxd

GRAPHIC SCALE
(us survey feet)
0 300
150 600
HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

STA: 599+10.0 @ DIRT ROAD CL
CULVERT: 48"CMP, 18.3LF

SURVEYED DECEMBER 2013 CHANNEL
NOTE STRETCHES NOT SURVEYED IN PROFILE

RECORD 1998 CENTERLINE OF CHANNEL

STA: 588+24.3 @ DIRT ROAD CL
CULVERT: 36"CONC, 16.1LF

SURVEYED DECEMBER 2013 CHANNEL
NOTE STRETCHES NOT SURVEYED IN PROFILE

RECORD 1998 CENTERLINE OF CHANNEL

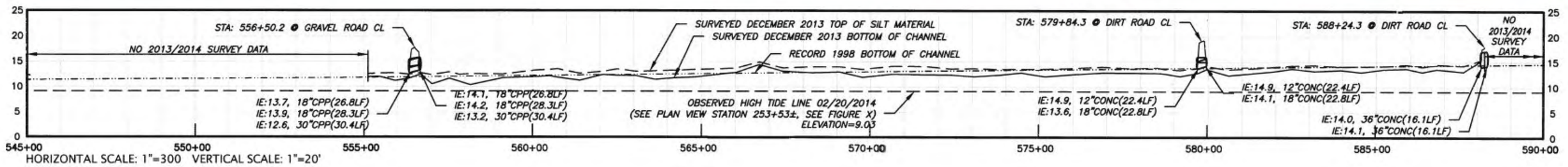
WORLINE RD.

STA: 556+50.2 @ GRAVEL ROAD CL
CULVERT: 18"CPP, 26.8LF
CULVERT: 18"CPP, 28.3LF
CULVERT: 30"CPP, 30.4LF

STA: 579+84.3 @ DIRT ROAD CL
CULVERT: 12"CONC, 22.4LF
CULVERT: 18"CONC, 22.8LF

N

2011 SKAGIT COUNTY AERIAL PHOTOGRAPHY



HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'

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FIGURE 10 (SHEET 7 of 12)
CHANNEL SURVEY

Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-7_SURVEY.mxd

GRAPHIC SCALE
(us survey feet)
0 300
150 600
HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

STA: 609+13.6 @ DIRT ROAD CL
CULVERT: 12"CPP, 21.7LF
CULVERT: 24"CONC, 20.3LF

STA: 617+28.3 @ WORLINE ROAD CL
CULVERT: 24"CONC, 29.1LF
CULVERT: 24"CONC, 28.9LF

STA: 620+99.0 @ DIRT ROAD CL
CULVERT: 12"CONC, 20.8LF

STA: 614+17.9 @ ERSHIG ROAD CL
CULVERT: 56"CMP, 61.1LF
CULVERT: 56"CMP, 61.7LF

STA: 625+29.2 @ ERSHIG ROAD CL
CULVERT: 36"CONC, 38.2LF
CULVERT: 36"CONC, 40.3LF

STA: 599+10.0 @ DIRT ROAD CL
CULVERT: 48"CMP, 18.3LF

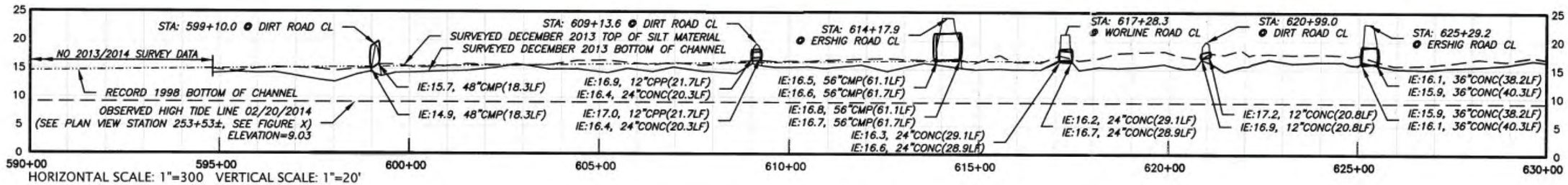
SURVEYED DECEMBER 2013 CHANNEL
NOTE STRETCHES NOT SURVEYED IN PROFILE

RECORD 1998 CENTERLINE OF CHANNEL

STA: 588+24.3 @ DIRT ROAD CL
CULVERT: 36"CONC, 16.1LF

ERSHIG RD.
WORLINE RD.
605+00
610+00
615+00
620+00
625+00
630+00
600+00
595+00
590+00
35.6

2011 SKAGIT COUNTY AERIAL PHOTOGRAPHY



HORIZONTAL SCALE: 1"=300 VERTICAL SCALE: 1"=20'

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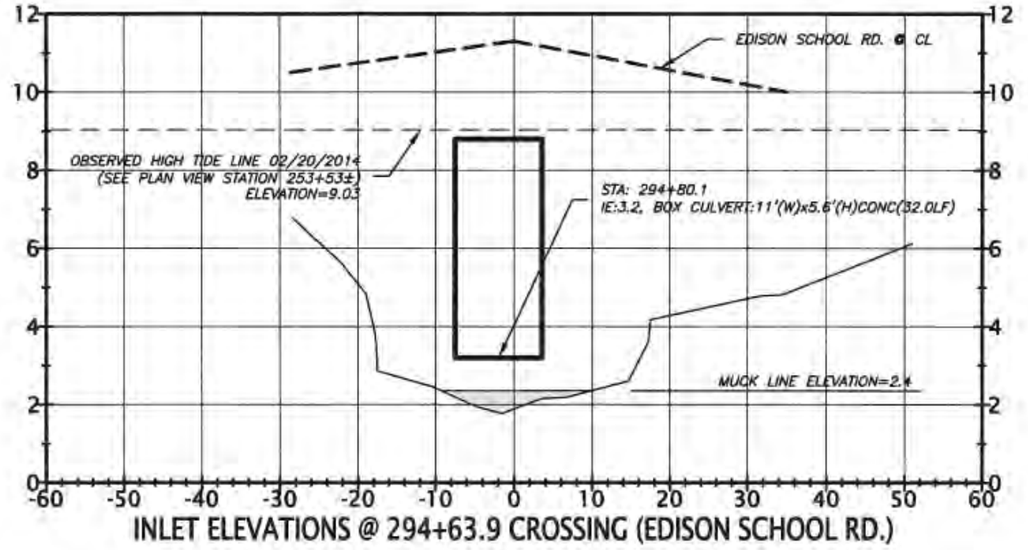
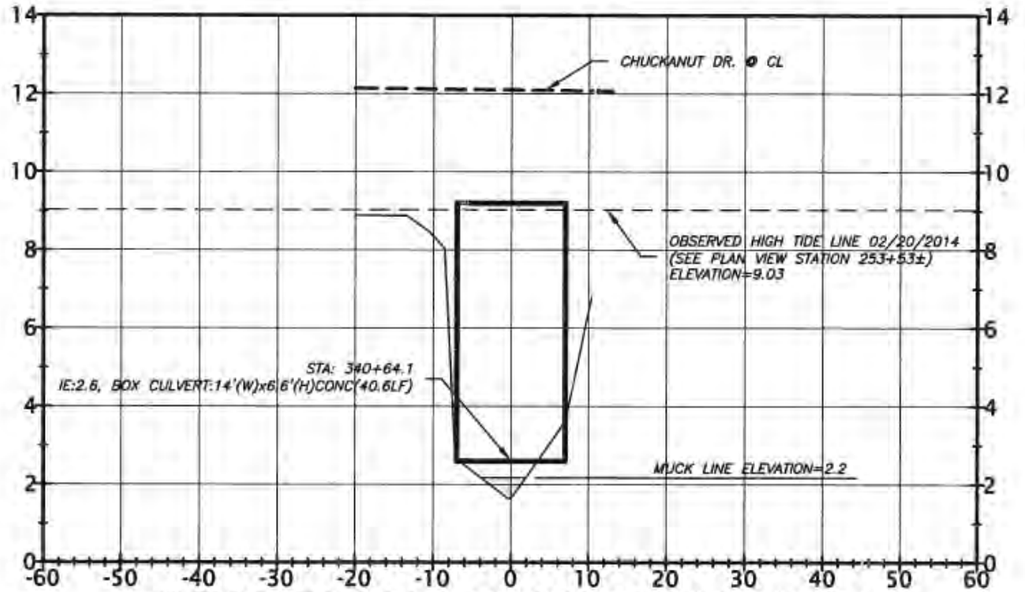
FIGURE 10 (SHEET 8 of 12)
CHANNEL SURVEY

Date: 3/5/2015

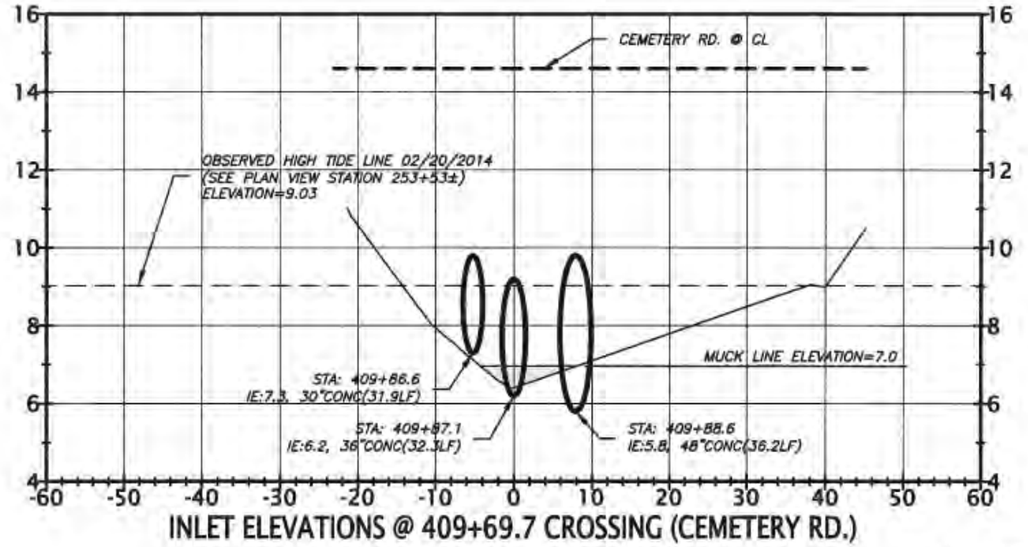
Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-8_SURVEY.mxd



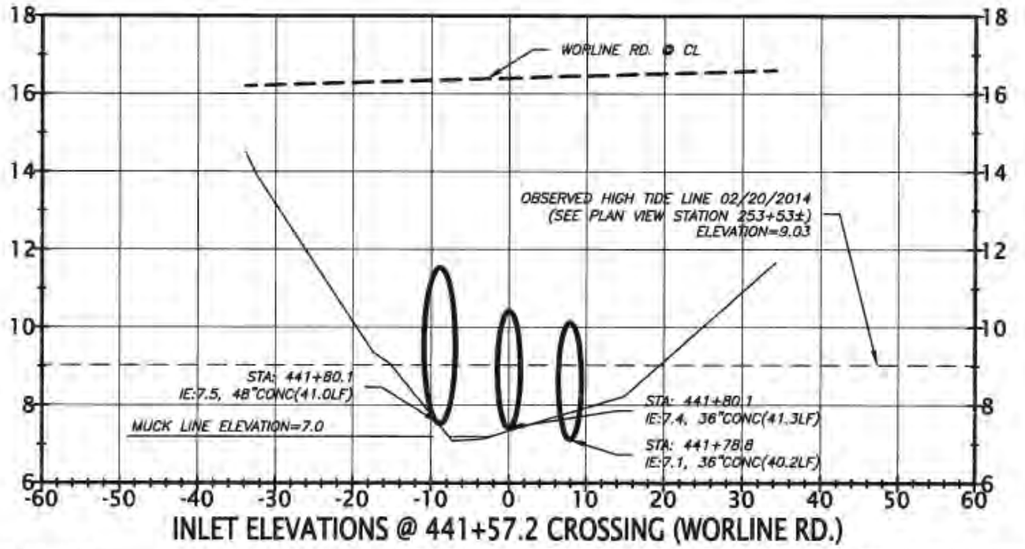
INLET ELEVATIONS @ 294+63.9 CROSSING (EDISON SCHOOL RD.)



INLET ELEVATIONS @ 340+44.1 CROSSING (CHUCKANUT DR.)



INLET ELEVATIONS @ 409+69.7 CROSSING (CEMETERY RD.)



INLET ELEVATIONS @ 441+57.2 CROSSING (WORLINE RD.)

HORIZONTAL SCALE: 1"=20' VERTICAL SCALE: 1"=4'

HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

NOTE ALL SECTIONS SHOWN ARE LOOKING DOWNSTREAM (BACKWARDS ON STATION)
SECTIONS HAVE BEEN CUT ACROSS INLET OF CULVERT

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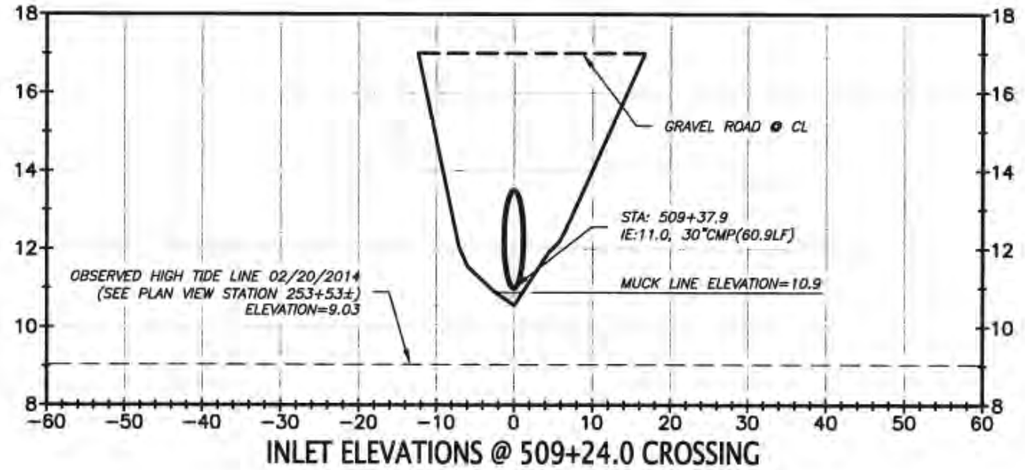
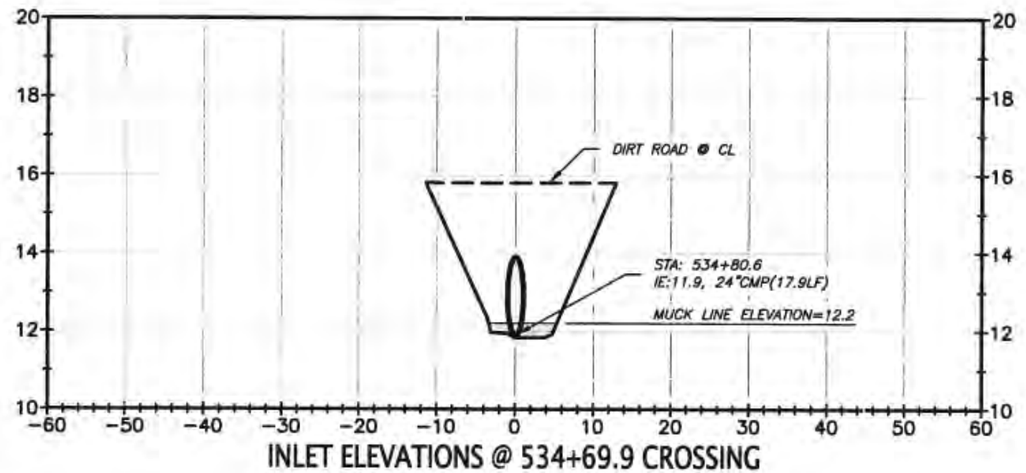
FIGURE 10 (SHEET 9 of 12)
CHANNEL SURVEY

Date: 3/5/2015

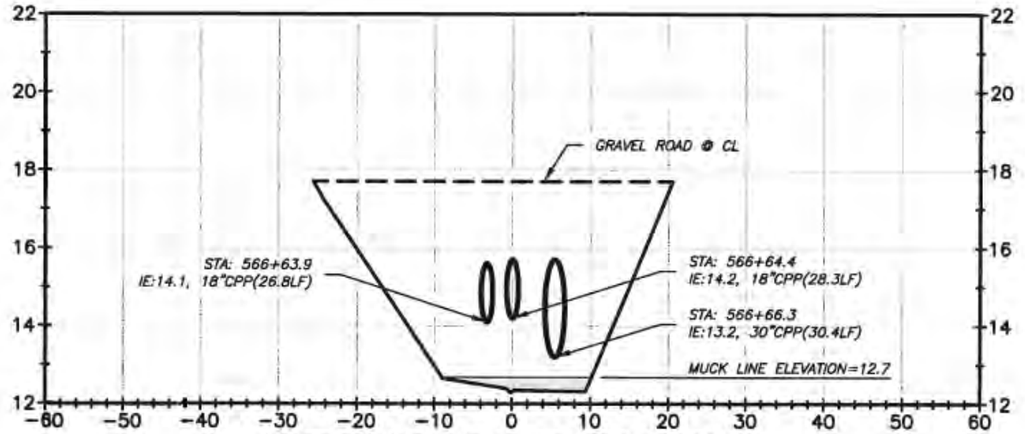
Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-9_SURVEY.mxd



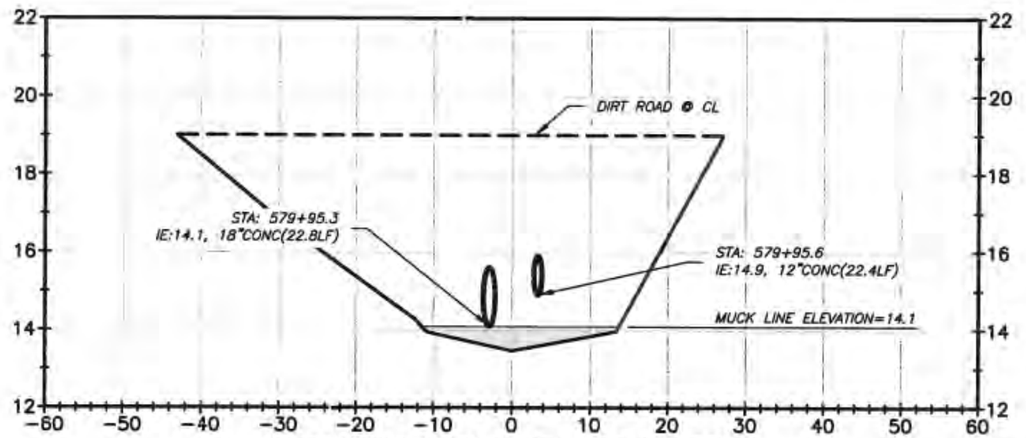
INLET ELEVATIONS @ 509+24.0 CROSSING



INLET ELEVATIONS @ 534+69.9 CROSSING



INLET ELEVATIONS @ 556+50.2 CROSSING



INLET ELEVATIONS @ 579+84.3 CROSSING

HORIZONTAL SCALE: 1"=20' VERTICAL SCALE: 1"=4'

HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

NOTE ALL SECTIONS SHOWN ARE LOOKING DOWNSTREAM (BACKWARDS ON STATION)
SECTIONS HAVE BEEN CUT ACROSS INLET OF CULVERT

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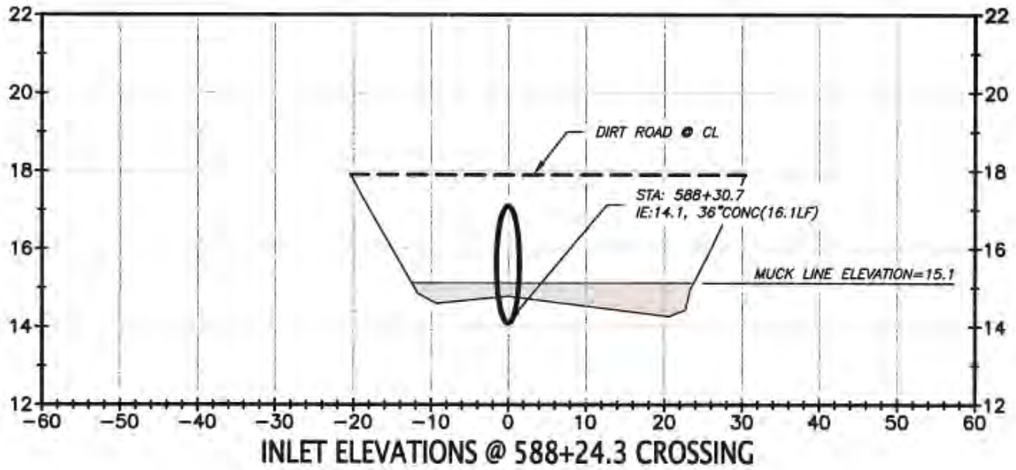
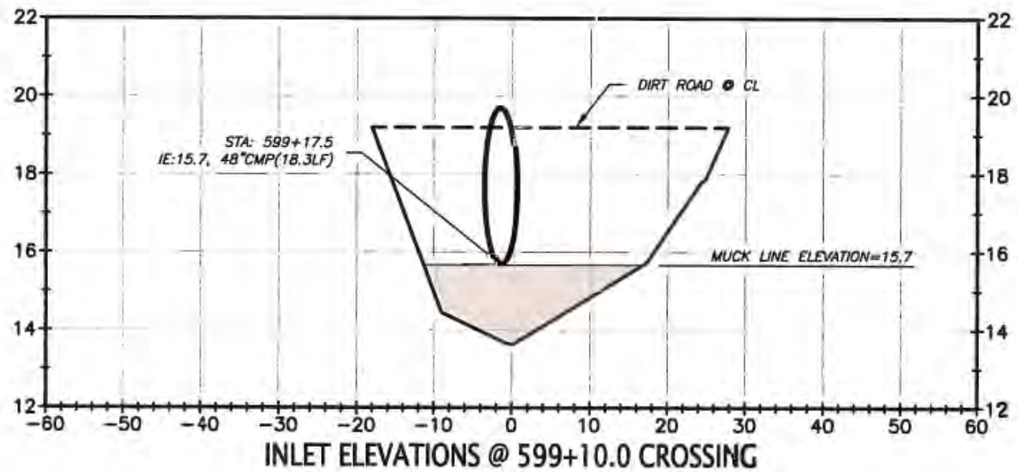
FIGURE 10 (SHEET 10 of 12)
CHANNEL SURVEY

Date: 3/5/2015

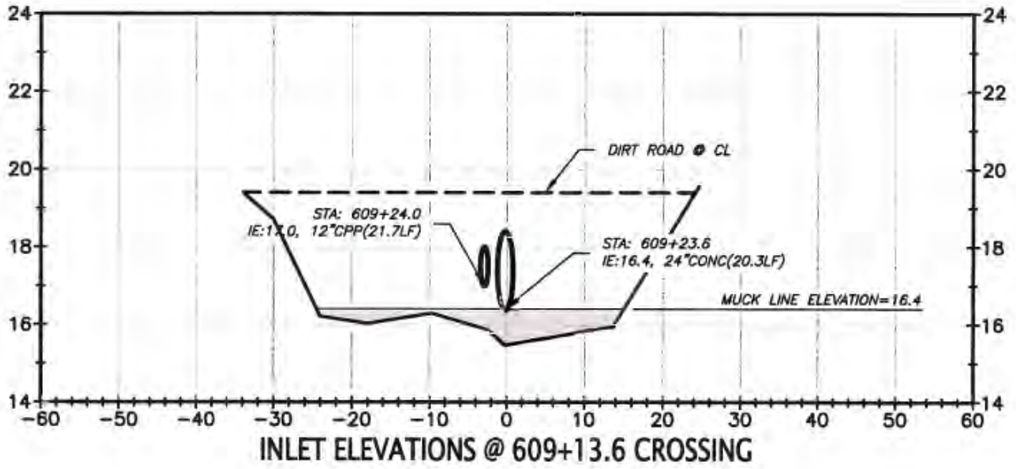
Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-10_SURVEY.mxd



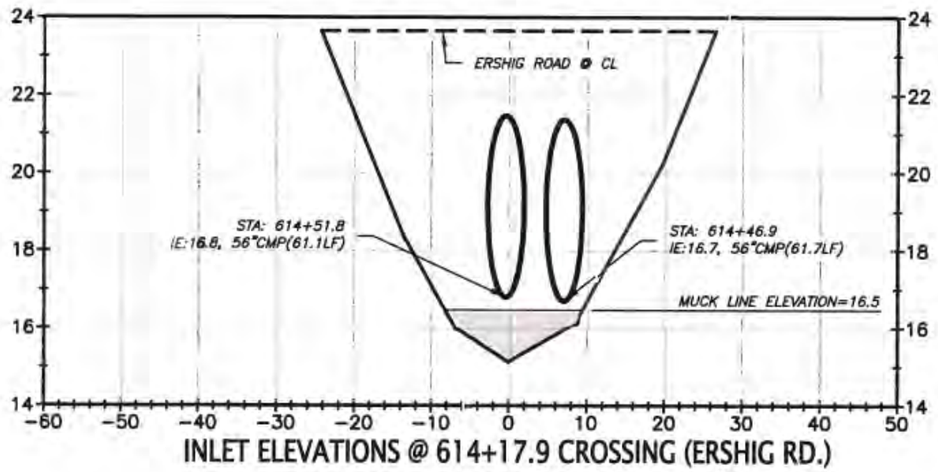
INLET ELEVATIONS @ 588+24.3 CROSSING



INLET ELEVATIONS @ 599+10.0 CROSSING



INLET ELEVATIONS @ 609+13.6 CROSSING



INLET ELEVATIONS @ 614+17.9 CROSSING (ERSHIG RD.)

HORIZONTAL SCALE: 1"=20' VERTICAL SCALE: 1"=4'

HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

NOTE ALL SECTIONS SHOWN ARE LOOKING DOWNSTREAM (BACKWARDS ON STATION)
SECTIONS HAVE BEEN CUT ACROSS INLET OF CULVERT

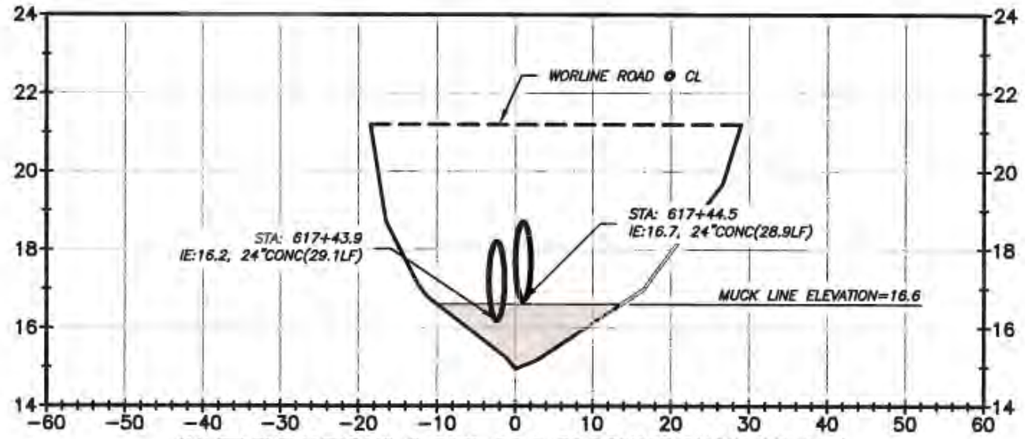
EDISON SLOUGH DRAINAGE IMPROVEMENT
MANAGEMENT PLAN

ELEMENT solutions
1812 Cornwall Ave.
Bellingham, WA 98225
360.671.9172
info@elementsolutions.org

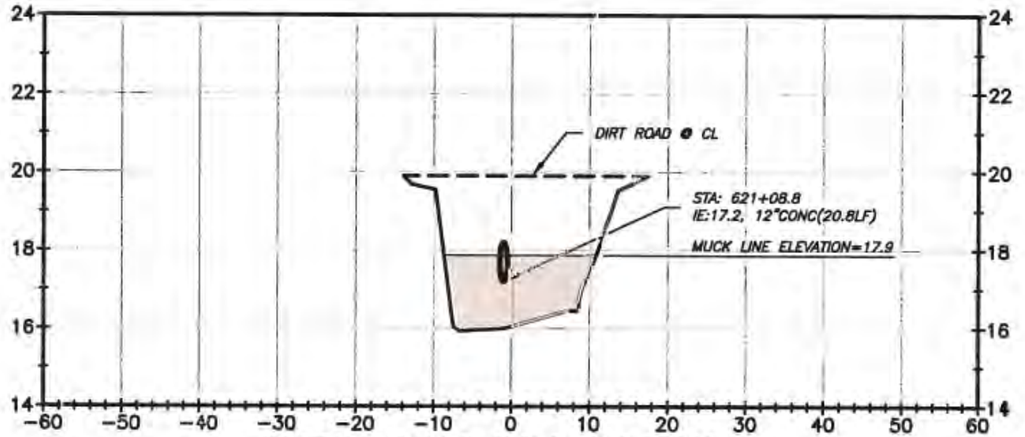
FIGURE 10 (SHEET 11 of 12)
CHANNEL SURVEY

Date: 3/5/2015

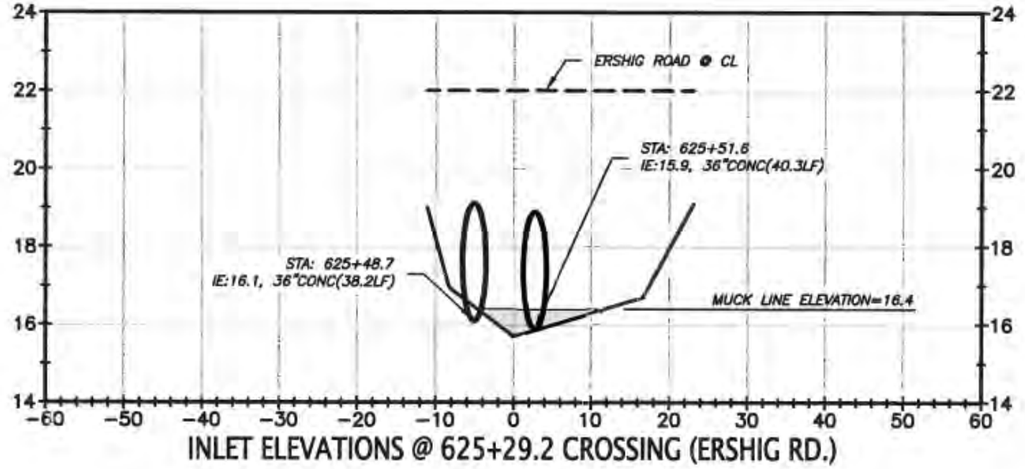
Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-11_SURVEY.mxd



INLET ELEVATIONS @ 617+28.3 CROSSING (WORLINE RD.)



INLET ELEVATIONS @ 620+99.0 CROSSING



INLET ELEVATIONS @ 625+29.2 CROSSING (ERSHIG RD.)

HORIZONTAL SCALE: 1"=20' VERTICAL SCALE: 1"=4'

HORIZONTAL DATUM: NAD83/98, GROUND
VERTICAL DATUM: NAVD88

NOTE ALL SECTIONS SHOWN ARE LOOKING DOWNSTREAM (BACKWARDS ON STATION)
SECTIONS HAVE BEEN CUT ACROSS INLET OF CULVERT

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MANAGEMENT PLAN

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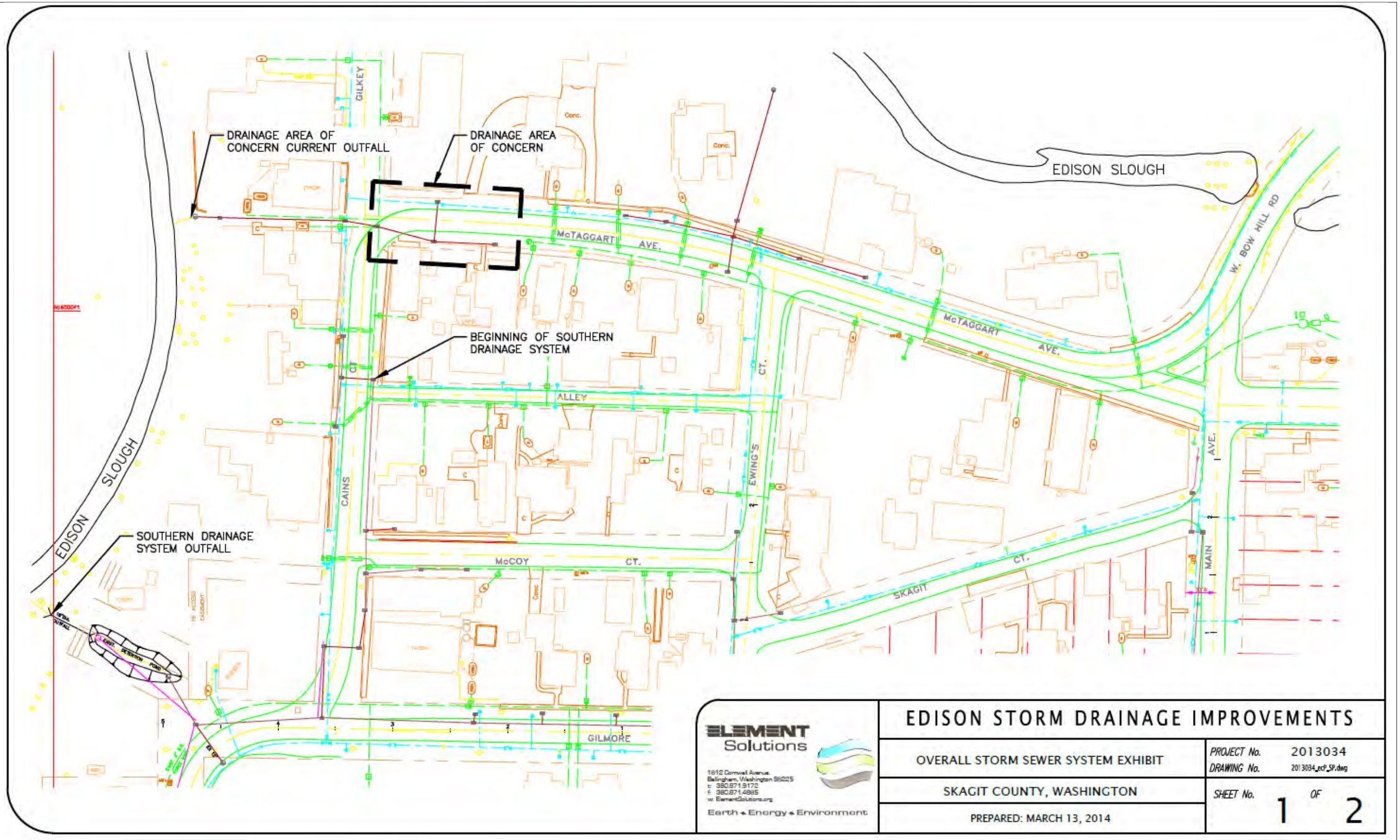
FIGURE 10 (SHEET 12 of 12)
CHANNEL SURVEY

Date: 3/5/2015

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG10-12_SURVEY.mxd



EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

FIGURE 11 (1 of 2)
EDISON DRAINAGE ALTERNATIVES

Notes: CAD linework from Skagit County Public

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG11-1_EDISON-PROJECTS.mxd

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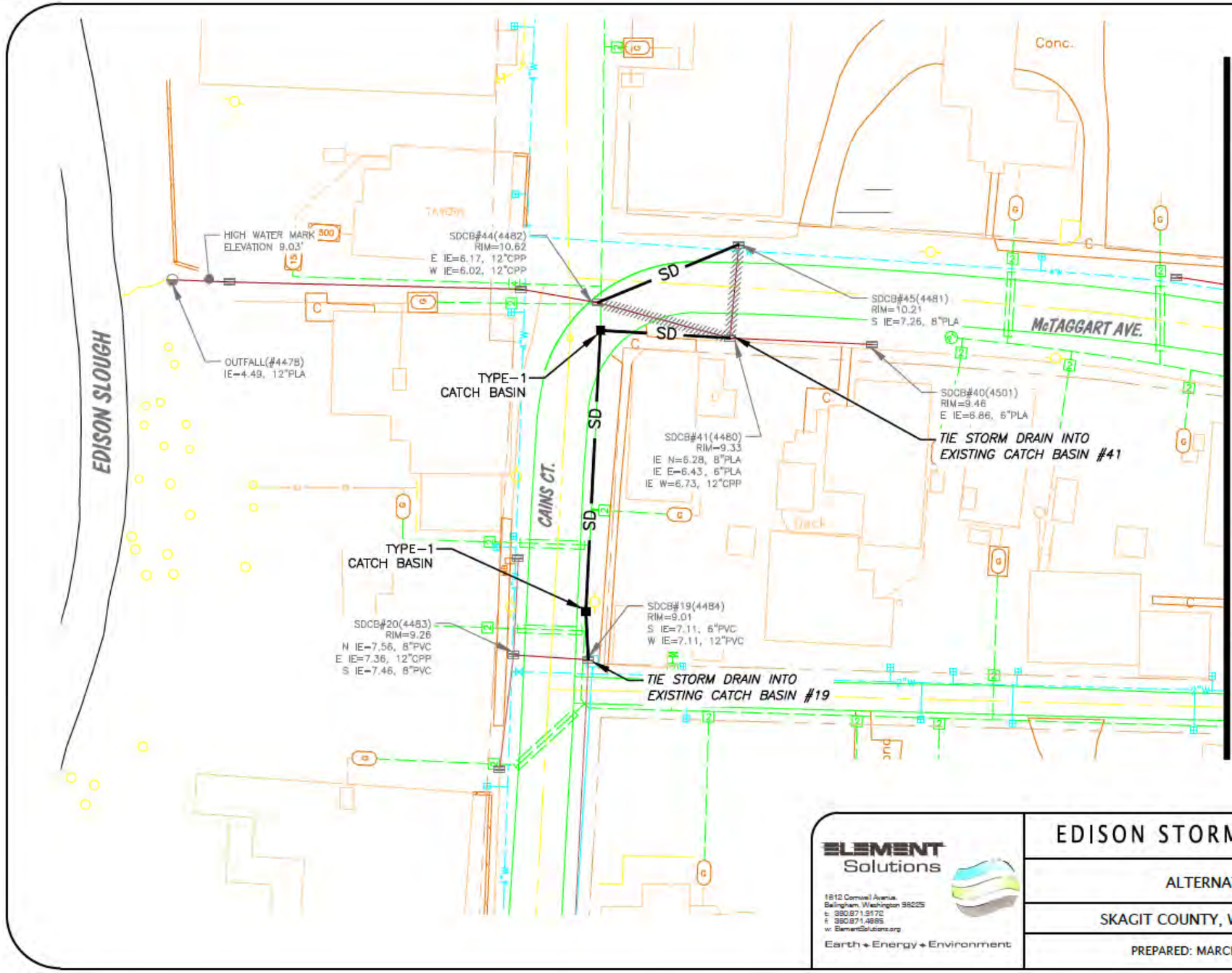
Date: 3/5/2015



ALTERNATE ELEMENTS

- AREA OF CONCERN ROUTED TO EXISTING SOUTHERN DETENTION POND
- INSTALL 2EA TYPE-1 CATCH BASINS (SDCB #40 & #41 LIKELY NEED TO BE REPLACED AS WELL)
- INSTALL NEW STORM DRAINAGE PIPE ALONG McTAGGART AVENUE AND CAINS COURT.
- IMPROVEMENTS REQUIRE SAW CUTTING, REMOVING AND REPLACING EXISTING ASPHALT.
- ABONDON TWO EXISTING STORM DRAIN PIPES IN PLACE

SCALE: 1"=40'

LEGEND

- PROPOSED CATCH BASIN
- SD — PROPOSED STORM DRAIN LINE
- ABANDON EXISTING STORM DRAIN LINE

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w: ElementSolutions.org
Earth + Energy + Environment

EDISON STORM DRAINAGE IMPROVEMENTS

ALTERNATE 3

SKAGIT COUNTY, WASHINGTON

PREPARED: MARCH 13, 2014

PROJECT No. 2013034
DRAWING No. 2013034_ecP_SP.dwg

SHEET No. 2 OF 2

EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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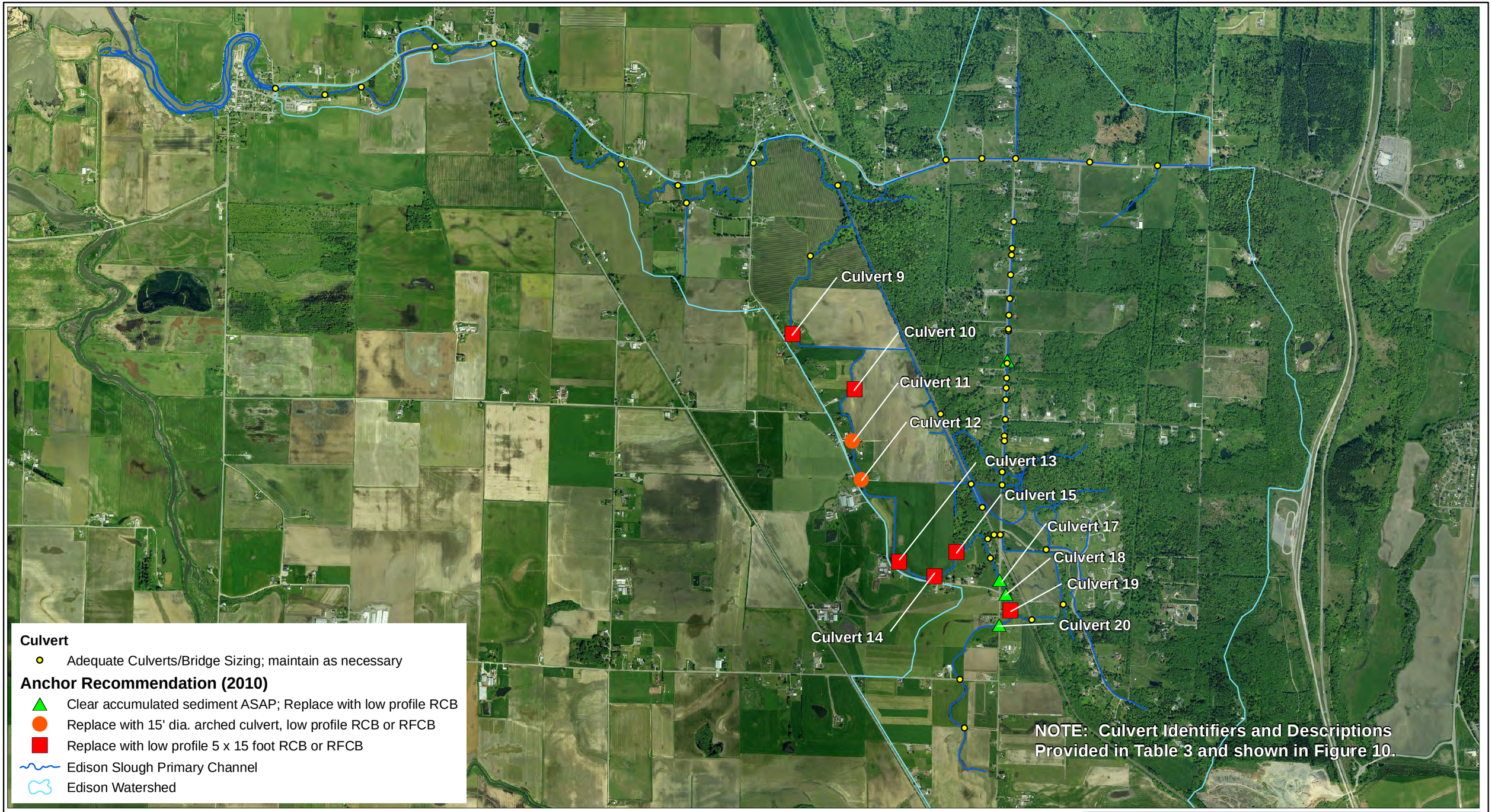
FIGURE 11 (2 of 2)
EDISON DRAINAGE ALTERNATIVES

Date: 3/5/2015

Notes: CAD linework from Skagit County Public

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG11-2_EDISON-PROJECTS.mxd



Culvert

- Adequate Culverts/Bridge Sizing; maintain as necessary

Anchor Recommendation (2010)

- Clear accumulated sediment ASAP; Replace with low profile RCB
- Replace with 15' dia. arched culvert, low profile RCB or RFCB
- Replace with low profile 5 x 15 foot RCB or RFCB
- Edison Slough Primary Channel
- Edison Watershed

N

0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG12_CULVERT-REPLACEMENT.mxd

EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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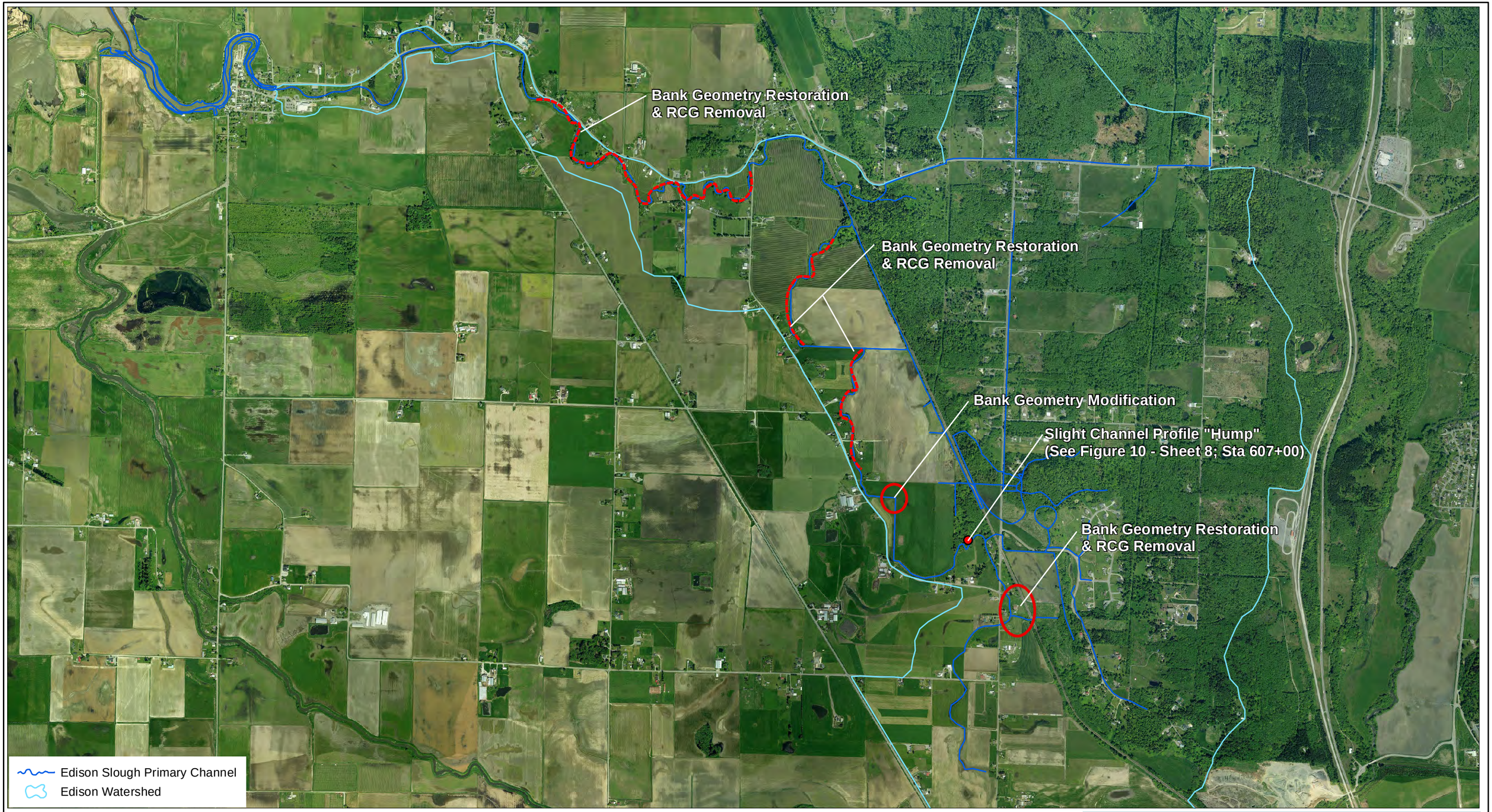
FIGURE 12
Recommended Culvert Replacement Plan (Modified from Anchor, 2010)

Date: 3/5/2015



N

0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG13_CHANNEL-WIDENING.mxd

EDISON SLOUGH DRAINAGE IMPROVEMENT
MANAGEMENT PLAN

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FIGURE 13
Potential Areas Well Suited for Channel Bank Work (Geometry Restoration or Dredging)

Date: 3/5/2015

Edison Slough Primary Channel or Drainage Networks

Riparian Vegetation Conditions

Emergent Vegetation - Higher Potential Priority Restoration

Partially Covered Shrub-Tree - Moderate Priority

Closed Canopy Cover Tree - Low Priority

Edison Watershed

0 2,000 4,000 6,000 8,000

FEET

Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG14_WINDROWS.mxd

EDISON SLOUGH DRAINAGE IMPROVEMENT MANAGEMENT PLAN

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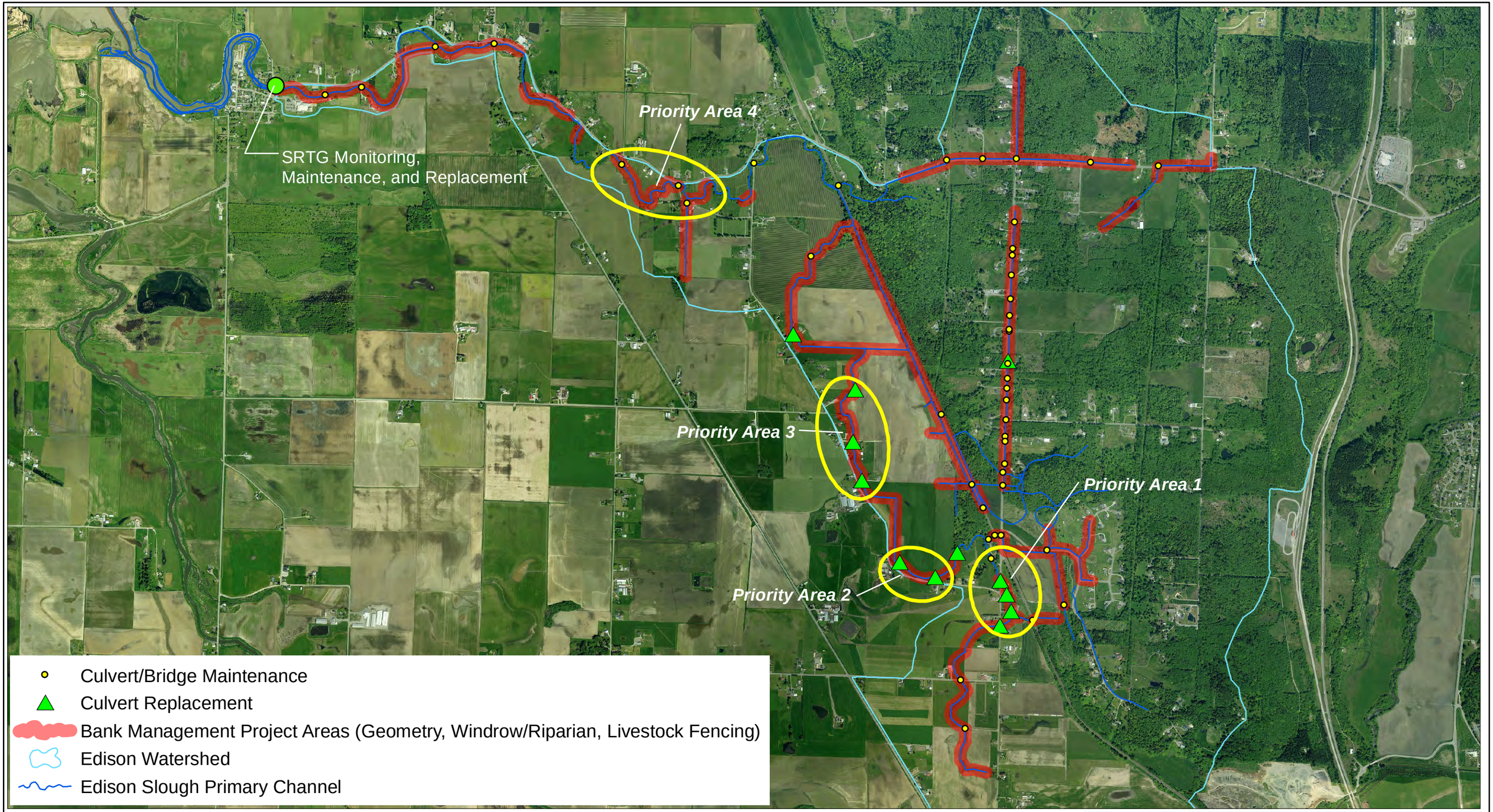
FIGURE 14
Potential Areas Well Suited for Windrows or Bank Vegetation to Improve Water Quality

Date: 3/5/2015



Notes: 2011 Pictometry Air Photo

Path: P:\Pse Project\2013034\REPORT\DRAINAGE-IMPROVEMENT-PLAN\EDISONSLOUGH_DIP_FIGURES\FINAL-FIGURES\FIG15_RECOMMENDED-PROJECTS.mxd

EDISON SLOUGH DRAINAGE IMPROVEMENT
MANAGEMENT PLAN

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FIGURE 15
Recommended Drainage Improvement Plan Actions

Date: 3/5/2015

APPENDIX A: PUBLIC INFORMATION ON FLOODING AND OUTREACH

Edison Slough September 11, 2013 Community Informational Meeting

Attendance: Paul Pittman and Jeff Ninnemann (Element Solutions); Dianne Crane, Kara Symonds, Dan Berentson, Jan Flagan, Henry Hash (Skagit County Staff); Commissioner Ron Wesen (Skagit County Elected Official); members of the Edison Slough floodplain public (signup sheet attached).

The following is a summary of the comments and concerns that were brought up by the public in our meeting on September 11, 2013.

Summary of comments from the public:

- Many in the community felt the presence of fish is low as the slough is often dry for extended periods
- Several wanted to know if we would be surveying the elevation of the slough
- Some were worried about saltwater coming up the slough
    - There was a statement made that there was no saltwater in the slough for the past 30 years, but now there is
- Stated that they thought the North Samish Levee was put in around 1921
- Tide gate reliability and function seems to change – getting worse
    - They recommended a schedule for tide gate maintenance
- What is the study/watershed area?
    - Does study area connect to Samish River?
- What happened to the previous studies? Why can't we use them?
- What do we mean by mitigation? What is involved?
- Thomas Creek was a good example of increasing conveyance through maintenance and increasing fish habitat through enhancement.
- Is the project intended to increase the numbers of fish?
- What happens to the water quality if we increase conveyance?
- What happens to the wetlands if we increase conveyance?
- Have we looked at storage as a way to help water quality?
- Have we considered the increased flooding that might occur in the lower sections of the watershed if we increase conveyance in the upper watershed and the tide gate is closed?
    - Would storage help? Do we have a storage plan?
- Have we looked at the channel below Edison?

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    - Can we make a plan to deal with the tide gates in the town of Edison?
    - Both tide gates needs adjusting.
- Can Fish and Wildlife claim ownership of the stream bottom or their land if property owners open their land for this assessment?
- Are we going to take trees out of the stream that are blocking the conveyance?
- There is a 1999 letter that states that the County was planning on raising the sea level by 3 feet (*comment unclear*)
- Is there going to be a long term maintenance plan?
- Who pays for this study?
- Will the property owners have a say in the plan?
- Is the ROE permanent?
    - Can we put an expiration date on the ROE?
- Pumping cost drainage district #16 approximately $10,000 in electricity per year (mostly in the winter months)
    - Amount of water that is pumped is limited and doesn't compare to an open tide gate.

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Meeting Attendance Sign-in Sheet

Name	Phone	email
Jerry Mastbell	766-6378	
Thomas Fox	766-6363	
Rocky Long	766-5021	
Rebecca Peek	766-6260	
Laura Engebretsen	766-4228	
Val Matthews	757-7730	
Laura Matthews	757-7730	lmatthews@wavecable.com
JAN BUDDEN	766 4126	
Hobie Claire Hansen	766-6093	hobiehansen@gmail.com
Duane Ethen	766 6128	
Darlene Wright	360-661-6204	
Rob Goodell	766-9950	
Linda Goodell	766-9950	
Tony Breckenridge	661-6673	
Cheryl Conner	766-6837	cheryl conner@wavecable.com
Ted Conner	766-6837	
Cathy Butler	540-1270	
Lyle Wesen	766-6163	WESENLR@MCIA.COM
Ken Codling (Rep)	630-3942	Ken.Codling@shell.com
Robert Pass	766 6985	jean_skip@yahoo.com
~~GREENWELL~~	~~7666697~~	
HENRY HOSH	336-9400	
Brandon Roozen	360 424 7327	
BOND OWENS	766-8414	
Rick Pickens	766-6039	

Representing 19 PARCELS

23 Signatures

although 35 attended

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Survey Responses

SKAGIT COUNTY
PUBLIC WORKS DEPARTMENT
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(360) 336-9400 FAX (360) 336-9478

RECEIVED AUG - 9 2013 SKAGIT COUNTY PUBLIC WORKS ADMIN

The Skagit County Drainage Utility assists property owners in the resolution of private and regional drainage concerns. The Drainage Utility plans to develop a Drainage and Fish Initiative (DFI) Agreement for Edison Slough with Washington Department of Fish and Wildlife and a maintenance plan to improve drainage and manage habitat conditions.

As a first step, we would appreciate it if you would respond to the enclosed survey. Your response will enable our Engineer to properly evaluate the drainage issues.

EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Mitch Blair
Address: 7597 Worline Rd
City: Bow State: WA Zip: 98232
Phone: 757-6188 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor?

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects?

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

SKAGIT COUNTY
PUBLIC WORKS DEPARTMENT
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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Laura Engebretson
Address: 7033 Worline Rd.
City: Bow State: WA Zip: 98232
Phone: 360-766-4228 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number: My property drains pretty well. The garden pot in the center of my property fills with a few inches of water during flood times but isn't a problem.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? I don't know.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? Yes

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Gary & Sue Moulton
Address: 7801 Fashig Rd.
City: Bow State: WA Zip: 98232
Phone: 360-757-0275 Email: smbrook@wavecable.com

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number: Since the development on the hill we have seen more runoff. The water in the slough seems more sluggish and unmoving. It is choked with grass & weeds

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? Water would be able to flow better and empty out into the bay.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? yes

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name:
Address:
City: State: Zip:
Phone: Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number:

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor?

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects?

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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RECEIVED
AUG - 9 2013
SKAGIT COUNTY PUBLIC WORKS DEPT

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Cathy BUTLER
Address: 7727 Ershig Rd
City: Bow State: WA Zip: 98232
Phone: 360 540 1270 Email: cathybutler518@hotmail.com

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. 7727 Ershig Rd Bow Parcel # P34145 Yearly flooding and standing water 6 months each year, water in home and surrounding homes every year, inadequate culverts under Llama Lane, Slough is completely clogged by vegetation, run offs from housing development on hill directly into slough with no where for the water to drain.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? Less damage to homes and property, better utilization of property, better habitat for wildlife, less chance of road being closed due to water over roadway, we pay drainage taxes and get no drainage.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? yes !!

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time! Survey was post marked 8/6/13, I recieved 8/7/13, you wanted back by 8/9/13? Better turn around time please so homeowner input is effective.

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: LYLE R. WESEN FOR WESEN LAND LLC
Address: 7280 WORLINE ROAD
City: BOW State: WA. Zip: 98232
Phone: 360 - 766 - 6163 Email: WESENLR@NCIA.COM

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. WE FARM 30 ACRES THAT IS NOT FARMABLE BECAUSE OF RUN OFF FROM ERSHIG ROAD. THIS IS COMPOUNDED BECAUSE OF THE VERY POOR OUTLET THE EDISON SLOUGH PROVIDES.
PARCEL NUMBERS 34080, 34090, 33714 & 113105

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? A MUCH BETTER OUTLET FOR THE WATER!!

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? YES

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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Sorry didn't get this in time to reply

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EDISON SLOUGH DRAINAGE SURVEY

Response appreciated by Friday, August 9, 2013.

Name: Margaret Groth 96 yrs old
Address: 7181 Worline Rd
City: Bow State: WA Zip: 98232
Phone: 3607704671 Email:
Jeanne

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. No drainage for property behind homes on hill on other side of railroads. Developed land drains into field and makes it unusable.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? Drainage is so slow - the ditches that drain into it back up.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects?

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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As a first step, we would appreciate it if you would respond to the enclosed survey. Your response will enable our Engineer to properly evaluate the drainage issues.

EDISON SLOUGH DRAINAGE SURVEY

Response appreciated by Friday, August 9, 2013.

Name: Diane Mears
Address: 14671 W. Bow Hill Road
City: Bow State: WA Zip: 98232
Phone: 360-766-6356 Email: —

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. House for Sale

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor?

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects?

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Daniel Peck
Address: 6859 Worline Rd
City: Bow State: WA Zip: 98232
Phone: 360 766-6260 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor?

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? Perhaps

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: VAL & LAURA MATTHEWS
Address: 7550 ERSHIG RD.
City: BOW State: WASH Zip: 98232
Phone: 360-757-7730 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. WE HAVE LIVED HERE SINCE 1987, THROUGH SEVERAL HIGH WATER EVENTS. THESE HAVE NOT BEEN A PROBLEM FOR US. IF ANYTHING, SINCE UPLAND DEVELOPMENT; PAVING, DITCHES AND RETENTION PONDS, THE WATER RUNS THROUGH HERE IN A RUSH AND IS GONE. THIS LEAVES US WITH A DRY SLOUGH BED FOR MANY MONTHS OF THE YEAR. FORMERLY TIMBERED HILLSIDES WOULD RELEASE THE WATER SLOWLY, KEEPING THE SLOUGH BED WET MOST OF THE YEAR.

YOU MAY BE AWARE THAT SAMISH BAY HAS POLUTION PROBLEMS AFTER HEAVY RAIN EVENTS, REQUIRING CLOSURE OF OYSTER HARVESTING. YOU WILL HAVE TO EXPLAIN TO US HOW FLUSHING WATER THROUGH EDISON SLOUGH FASTER WILL HELP THIS SITUATION.

WETLANDS ARE NATURES WATER FILTER AND NEED TO BE PRESERVED. WHEN THE SLOUGH DRYS UP, ALL THE WILDLIFE WE ENJOY ALL WINTER DISAPEARS.

THANKS FOR TAKING TIME TO READ THIS.

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The Skagit County Drainage Utility assists property owners in the resolution of private and regional drainage concerns. The Drainage Utility plans to develop a Drainage and Fish Initiative (DFI) Agreement for Edison Slough with Washington Department of Fish and Wildlife and a maintenance plan to improve drainage and manage habitat conditions.

As a first step, we would appreciate it if you would respond to the enclosed survey. Your response will enable our Engineer to properly evaluate the drainage issues.

EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: JAN RUDDEN
Address: 14962 WEST BOW HILL RD. P.O. BOX 313
City: BOW State: WA Zip: 98232
Phone: 360 766 4126 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. PROP ID # 48589 — 48590
MY PROPERTY HAS SEASONAL FLOODING
WE NEED MORE SUMMER FLOW

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? I WOULD PREFER A COMPREHENSIVE RESTORATION THAT WOULD REQUIRE LESS TO NO REGULAR MAINTENANCE.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? YES, THIS SHOULD HAPPEN FIRST SO WE ALL KNOW WHAT IS BEING PROPOSED. THIS WOULD EFFECT HOW TO ANSWER QUESTION #2.

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Dean Wesen
Address: 7390 Worline Rd.
City: Bow State: WA Zip: 98232
Phone: 360 630 1216 Email: wesendm@msn.com

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. P 33714 - There is a drainage problem on this parcel for 8 months a year. We were unable to plant is corn about 25 Acres along the tractor because it was too wet too long into June.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? It would tremendously help the 25 Acres previously mentioned.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? possibly

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Stanton Peterson
Address: 19797 Kellsher Rd.
City: Burlington State: Wash Zip: 98233
Phone: 757-6433 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. None

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? None

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? No

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Gerald MASKELL
Address: P.O. Box 751
City: Bow State: WA Zip: 98232
Phone: (360) 766-6378 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? The Edison Slough is About 5 miles Long. What are your plans for this "maintance Project" And in what Area of the Slough Will you be working on ??

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? Yes

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Cavin and Misty Philbin
Address: 15912 Bow Hill Rd
City: Bow State: WA Zip: 98232
Phone: 360 766 5200 Email: cavin@ocnfoods.com

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. Field partial flood occasional

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? better flow, better maintenance less potential for flooding, cleaner water

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? Yes

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Kenny Reijm
Address: 7860 Ensley Rd
City: Bow State: WA Zip: 98273
Phone: 360-661-4497 Email: dmreijm@gmail.com

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. the slough does not drain fast enough the in the rainy season

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? The field would drain properly Home wildl nit be surfaces water collecting which then floods fields

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? yes

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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As a first step, we would appreciate it if you would respond to the enclosed survey. Your response will enable our Engineer to properly evaluate the drainage issues.

EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: BOND OWENS
Address: 6805 WORKING RD, P.O. BOX 236
City: BOW State: WA Zip: 98232
Phone: 360-766-8414 Email:

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. SOME FLOODING ALONG MINOR 1/3 ~~TO THE~~ OF MY PROPERTY LINE ALONG THE DITCH (NORTH SIDE) AND ABOUT 1/3 TO NOT QUITE 1/2 INTO ~~OF~~ MY FIELD FROM DITCH TO THE SOUTH DURING ABOUT 2 MONTHS OF WETTEST WEATHER.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? SEE (1) ABOVE

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? NO

We look forward to working cooperatively with landowners and involved agencies to improve this integral drainage system. Thank you for your time!

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EDISON SLOUGH DRAINAGE SURVEY
Response appreciated by Friday, August 9, 2013.

Name: Harley Gaines
Address: 15628 Bow Hill Rd
City: Bow State: WA Zip: 98232
Phone: 360-399 1006 Email: harley@bowhillblueberries.com

1.) If you have observed any drainage problems on or surrounding your property, please describe the problem in as much detail as possible. Please include address, and, if known, parcel number. Extensive flooding in Blueberry Fields NOW → June causing economic damage to crops. (15628 Bow Hill Road Bow Hill Blueberries) We are unable to mow, weed or Spray the fields when we need to.

2.) How would your property and surrounding area benefit from regular maintenance of the Edison Slough corridor? Decrease Fall → Spring flooding of crops.

3.) Washington Department of Fish and Wildlife will require habitat improvement measures as mitigation for slough channel maintenance. This may involve planting a buffer area along the slough in some areas. Would you be interested in attending an informational community meeting regarding any proposed projects? Yes

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APPENDIX B: PHOTO POINTS - SEPTEMBER 2013

	**Photo Point 1** W. Bow Hill Rd- bridge taken from Edison Slough sign facing south. N 48° 33’ 45.10” W 122° 26’ 25.3”
	**Photo Point 2** W. Bow Hill Rd- bridge - Downstream Taken on street side of wooden guardrail post left of flood gate control box N 48° 33’ 44.7” W 122° 26’ 25.5”

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	**Photo Point 3** W. Bow Hill Rd- bridge - Upstream Taken on streamside of wooden guardrail post across from Photo Point 1, 2nd post from right N 48° 33’ 44.5” W 122° 26’ 25.1”
	**Photo Point 4** Road east of Fire Station-bridge - Downstream Taken from 1st wooden guardrail post to left of metal posts N 48° 33’ 43.4” W 122° 26’ 10.9”

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	**Photo Point 5** Road east of Fire Station- bridge - Upstream Taken at right metal guardpost N 48° 33’ 43.5” W 122° 26’ 10.3”
	**Photo Point 6** Highway 11/ W. Bow Hill Rd - Downstream Taken from north most wooden guardrail post attached to metal N 48° 33’ 54.7” W 122° 25’ 20.3”

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	**Photo Point 7** Highway 11/ W. Bow Hill Rd - Upstream Taken from 4th wood guardrail post from north (attached to metal post) N 48° 33’ 54.7” W 122° 25’ 19.5”
	**Photo Point 8** Bow Cemetery Rd - Downstream Taken from 4th wood guardrail post from 25mph sign N 48° 33’ 27.1” W 122° 24’ 23.5”

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	**Photo Point 9** Bow Cemetery Rd - Upstream Taken from 1st wooden guardrail post south of fish sign N 48° 33’ 27.1” W 122° 24’ 23.1”

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APPENDIX C: PRELIMINARY BIOLOGICAL ASSESSMENT & INFORMATION FOR PERMITTING

NOTE: YELLOW HIGHLIGHTED AREAS TO BE COMPLETED FOR SELECTED PROJECT(S)

Introduction

This Biological Assessment addresses the proposed Skagit County Public Works Edison Slough project. This proposal includes the replacement of culverts and dredging of waterways. The benefits will include improved salmonid passage and increased allowance for high water flows without overtopping.

Edison Slough is located in rural Skagit County immediately east of the town of Edison. Edison Slough flows through farmland and into the southeast end of Samish Bay, north of the mouth of the Samish River. The project is located within section _____ *(TO BE DETERMINED BY SELECTED PROJECT DESCIPTIONS)*

Table 1: Edison Slough Project Data- includes applicant contact info, official location coordinates, project number, wria name and number

Project Goals and Objectives

The purpose of this biological assessment is to identify potential impacts of the proposed Edison Slough maintenance activities on species listed under the federal Endangered Species Act (ESA) and habitat designated by the Pacific Fisheries Management Council as requiring protection under the Magnuson-Stevens Fishery Conservation and Management Act. Biological Assessments are prepared as required under Section 7(c) of the ESA to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of an endangered or threatened species, or result in the destruction or adverse modification of critical habitat of a protected species.

Action Area

The action area was defined as all areas that may be affected directly or indirectly by the proposed maintanence actions and was not merely the immediate area involved in the action. It encompassed the geographic extent of environmental changes (i.e., the physical, chemical and biotic effects) that will result directly and indirectly from the action.

The action area of this project included the area within 1 miles of the proposed maintenance action, the whole Edison Slough stream networks, and ended in Samish Bay. Describe the physical and biological attributes of the action area (e.g., topography, vegetation, condition and trend). It is helpful to include a map delineating where the action will occur. Also, identify any management or activities already occurring in the area.

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Site History

Edison Slough is a tidal arm of Puget Sound and part of the Skagit-Samish River Basin. Diking in the early 1900's cut off the old North Fork Samish River, creating Edison Slough. The entrance to Edison Slough is across expansive tide flats of Samish Bay, which are exposed at low water. Historically, vessels could enter the slough and reach the town of Edison at high water, though navigation was challenging. Commerce in the early 1900s consisted of the towing of logs up the channel to supply a small shingle mill at Edison (Willis 1975).

In 1915 the Corps of Engineers determined that the slough was "worthy of improvement" but only for debris and projecting points removal, and deepening and widening of the channel at bends to improve water flow for irrigation to local agricultural sites (USCOE 1915).

In 2002, Skagit County Public Works removed fill material and an undersized culvert to facilitate flow within the slough and improve fish passage. The Biological Assessment at that time concentrated on two sites located within section 33, T36N, R3E.W.M. (Wheeler, 2002). Site 1A was located 700 feet from the mouth of Edison Slough. At this site, fill material placed for support of a long ago removed tide gate was an impediment to flow during high flow intervals, and was removed. Site 3 was located 3,400 feet upstream of the mouth of Edison Slough. A culvert was replaced with a larger one at this site to accommodate wet season flows and prevent the slough from overtopping and covering adjacent driveways.

A Habitat Survey of the Edison Slough Watershed was conducted by WDFW in 2004 (Warriner 2004). The evaluation divided the habitat into two types: the upland stream survey and the lowland channel survey. The results are shown below.

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Upland Stream Results

Table 1: Upland Stream Habitat Units

Unit Type	% of total	Unit Length (M)	Unit Area (M^2)
Riffle	43	370.1	408.5
Pool	15	131	201.1
Glide	17	148	40.7
Cascade	7	65	49.5
Sub-Surface	16	134	N/A
total		**861.2**	

Spawning area (table 2) is separated into existing and potential; existing spawning area represents wetted areas containing suitable spawning habitat available at the time of the survey. Potential spawning areas area areas that were dewatered during the survey but contain spawning habitat at higher flows. Most of the spawning habitat occurred in riffles however some areas associated with pools such as tailouts and point bars were suitable for spawning.

Table 2: Upland Stream Spawning Area

Unit Type	Existing M^2	Potential M^2
Riffle	77.7	81.7
Pool	3.84	6.5
Total	81.5	88.2

Table 3: Upland Stream Substrate Composition

Substrate Type	Dominant	Sub-Dominant
Cobble	16%	7%
Clay	3%	N/A
Gravel	53%	52%
Mud/Muck	22%	4%
Sand	6%	37%

Table 4: Large Woody Debris (LWD)

Small (10-20cm width)	38
Medium (20 – 50 cm width)	24
Large (50+ cm Width)	4
Total	66
Pieces of LWD/M	.077

Table 5: Upland Stream Riparian Conditions

	Average % Cover	Deciduous Only	Mixed Conifer & Deciduous
Canopy Cover	60	20	80

	Native Only	Mixed Native & Non-native
Understory	88%	12%

Lowland and Tidally Influenced Channel Results

Table 6: Lowland Channel Habitat Data

Channel Category	Length (M)	% Length	Average Width (M)	Average Depth (M)	Riparian Cover
Tidally Influenced*	1563	13	3.20	0.64	0
Lower	7,370	60	4.94	0.49	43%
Upper	3,289	27	3.87	0.37	13%
Total	12222		4.42	0.48	20%

* The portion of the channel denoted here as tidally influenced is composed of the estuary portion of the channel and a portion of the channel that fluctuates with tides that may not contain brackish water. The study concluded that Edison Slough provided habitat for Chinook salmon (*Oncorhynchus tshawytsha*), Coho salmon (*Oncorhynchus kisutch*), Chum salmon, (*Oncorhynchus keta)* and Cutthroat trout (*Oncorhynchus clarki*). The habitat quality and accessibility was in need of improvement through fish barrier removal and riparian restoration.

Existing Habitat Characteristics

Edison Slough currently serves as a source of irrigation water to the surrounding crop lands. Tide gates control salt water intrusion. Edison Slough originates in farmland southeast of the project area and flows

approximately 8.3 miles through flat to moderately sloped agricultural land. The average slough gradient is approximately 0.03 percent over the entire slough.

Edison Slough offers one basic type of aquatic environment. A flat gradient offering a continuous slow moving water course 10 to 30 feet wide. Tidal influences extend to the project area and beyond. Cattle were routinely observed in and adjacent to the slough. This usage would indicate that fecal coliform levels in the slough waters are relatively high and discourage many aquatic species through water quality degradation.

Existing Water Quality

Edison Slough water quality was investigated as part of the Samish Bay Watershed Water Quality Monitoring Program from April of 2000 through June 2003. Skagit County continued data collection from October 2003 through September 2011 to help determine if the Skagit County Critical Areas Ordinance for Ongoing Agriculture (SCC 14.24.120) was sufficiently protecting water quality in areas of ongoing agriculture. A complete set of results can be found at http://www.skagitcounty.net/.

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Table C-1. Sample Sites at Edison Slough for Skagit County Monitoring Program

Site Number	Watercourse	Location	Latitude	Longitude	Site Type[1]
36	Edison Slough at school	W. Bow Hill Rd	48.562	-122.435	3
37	Edison Pump Station	Farm to Market Rd	48.561	-122.444	3
38	North Edison Pump Station	North Edison Rd	48.572	-122.441	3

[1]Ag-downstream: Located to determine status/trends at downstream end of a watercourse in agricultural areas.

Table C-2. Temperature Results Maximum temperature recorded during biweekly sampling for watercourses in the last six years of the Skagit County Monitoring Program.

Site Number	Watercourse	Location	Highest daily temperature (°C)					
			2006	2007	2008	2009	2010	2011
36	Edison Slough at school	W. Bow Hill Rd	27.8	24.6	23.8	31.3	32.4	24.6
37	Edison Pump Station	Farm to Market Rd	24.6	24.5	20.4	24.7	26.5	23.6
38	North Edison Pump Station	North Edison Rd	24.4	22.4	21.6	22.8	25.4	20.1

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Table C-3. Six-Year Temperature Results Summary Maximum 7-day average maximum temperatures for 2004-2007 and 2009-2011 of the Skagit County Monitoring Program

Site Number	Watercourse	Location	Highest Daily Temperatures °C					
			2006	2007	2008	2009	2010	2011
36	Edison Slough at school	W. Bow Hill Rd	29.8	29.3	27.6	N/A	N/A	N/A
37	Edison Pump Station	Farm to Market Rd	27.1	26.8	27.9	N/A	N/A	N/A
38	North Edison Pump Station	North Edison Rd	N/A	28.1	N/A	N/A	N/A	N/A

Salmonid Use

Though the presence of salmonids in Edison Slough has been documented (Beamer et al. 2003, (WDFW, WDFW 2003, Warriner 2004, 2005), additional information such as population estimates and distribution is still unknown.

Priority Species and Habitat Information

This section describes existing species and habitats given special protections and/or considerations within Skagit County, Washington State and Federal jurisdiction through (Washington Department of Fish and Wildlife (WDFW), United States Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS).

Regulatory Overview

This Biological Assessment has been prepared in accordance with Section 7(c) of the Federal Endangered Species Act of 1973 and includes elements to satisfy additional guidelines set forth in the Federal Migratory Bird Treaty Act of 1918 (16 USC 703-712), State of Washington's Growth Management Act (RCW 36.70A), Shoreline Management Act (RCW 90.58), State Environmental Policy Act (WAC 197-11), and the SCC 16.24 and 16.26.

The following regulatory agencies provide the jurisdictional authority of critical areas and priority habitat and species on the subject property: U.S. Department of Environmental Protection, U.S. Army Corp of Engineers, U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service, Washington State Department of Ecology, Washington State Department of Fish and Wildlife (WSFW), Washington State Department of Natural Resources, and the Skagit County Planning and Development Service (Planning).

Washington State governs critical areas primarily through the Growth Management Act (GMA) and the Shoreline Management Act (SMA). The GMA RCW 36.70A.172 and RCW 36.70A.170 delegate the authority to describe and regulate critical areas to the local county or city regulatory agencies and states, "In designating and protecting critical areas under this chapter, counties and cities shall include the best available science in developing policies and development regulations to protect the functions and values of critical areas. In addition, counties and cities shall give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries." While the cities and counties have been granted authority for general oversight of critical areas protection, Washington State retains its right to regulate critical areas under RCW 90.48.030, which states "The department shall have the jurisdiction to control and prevent the pollution of streams, lakes, rivers, ponds, inland waters, salt waters, water courses, and other surface and underground waters of the state of Washington."

Listed Species and Habitats Criteria

Species and habitats that receive special protections and/or considerations within Skagit County, Washington State, and Federal jurisdiction are listed on the WDFW Priority Habitat and Species List, U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). Priority species are fish and wildlife species that require protective measures and/or management. Species identified and mapped as priority species fit one or more of the following criteria:

1) State and/or Federally listed species legally designated as Endangered, Threatened, or Sensitive, or candidate species that will be reviewed by agency(s) for possible listing as Endangered, Threatened, or Sensitive.

2) Vulnerable Aggregations, which include species or groups of animals susceptible to significant population declines.

3) Species of recreational, commercial, and/or tribal importance for ceremonial and subsistence purposes, and are biologically or ecologically vulnerable to decline or are dependent on habitats that are highly vulnerable or are in limited availability.

Habitats that receive special protections or management considerations are habitats with unique or significant value to many species or specific protected species. Priority habitats have one or more of the following attributes:

- Comparatively high fish and wildlife density
- Comparatively high fish and wildlife species diversity
- Important fish and wildlife breeding habitat
- Important fish and wildlife seasonal ranges
- Important fish and wildlife movement corridors
- Limited availability

- High vulnerability to habitat alteration
- Unique or dependent species

The subject property and surrounding areas were observed for potential Priority Habitats and Species. The site was also observed for any species or habitats listed in the Skagit County Critical Areas Ordinance (CAO) that are not specifically protected by state or federal authorities. The site and project plans were then considered to determine the potential effects on the species and habitats present on and in the property vicinity and site-specific best management practices were recommended and are summarized in this report.

Listed Species That May be Present in the Area

Washington Department of Fish and Wildlife (WDFW)

The following species were listed in the Priority Habitats and Species list delivered from WDFW. Priority habitats are those habitat types with unique or significant value to many fish or wildlife species.

- Bald Eagle (*Haliaeetus leucocephalus*)
  WDFW has identified one nest within a 1-mile radius. Small mammals in nearby cultivated fields and fish in the watercourses provide food for the eagles and their chicks.

- Coast Resident Cutthroat (*Oncorhynchus clarki clarki*)
  There are 4 presumed and 1 documented presence of coast resident Cutthroat in the project action area.

- Fall Chinook (*Oncorhynchus tshawytscha*)
  One presumed documentation of fall Chinook was made in the project action area.

- Fall Chum (*Oncorhynchus keta*)
  There is one documented presence of fall Chum in the action area.

Directions for buffers as stated in the WDFW Priority Habitat and Species document

For Bald Eagle Nests:

The buffers for bald eagle nests are defined in the National Bald Eagle Management Guidelines (2007) and summarized below as “Nest buffer guidelines”:

1a. If the proposed activity will be visible from the nest do not conduct the activity within 660 feet of the nest if there is no similar activity within one mile of the nest. Landscape buffers are recommended.

1b. If the activity will be visible from the nest and there is similar activity within 1 mile of the nest, do not conduct activity within 660 feet unless the existing similar activity is tolerated, in which case use the distance of known toleration. Landscape buffers are recommended.

2a. If the proposed activity will not be visible from the nest, there is no similar activity within 1 mile of the nest, and the activity is within Category A*, do not conduct the activity within 330 feet. Clearing, external construction, and landscaping between 330 and 660 feet should be done outside the breeding season.

2b. If the proposed activity will not be visible from the nest, there is no similar activity within 1 mile of the nest, and the activity is within Category B*, do not conduct the activity within 660 feet.

2c. If the activity will not be visible from the nest and there is similar activity closer than 1 mile from the nest that is tolerated, do not conduct activity within 330 feet, and/or limit the activity to the distance of known toleration. Clearing, external construction, and landscaping within 660 feet should be done outside the breeding season.

***Note on Category Type:**

Category A

1. Building construction, 1 or 2 story, with projected footprint = 1 acre; construction of roads trails, canals, power lines, and other linear features;
2. Agriculture or aquaculture, new or expanded operations;
3. Alteration of shorelines or wetlands;
4. Installation of docks or moorings; or water impoundment.

Category B

1. Building construction, 3 or more stories;
2. Building construction, 1 or 2 story, with project footprint of >1 acre;
3. Installation or expansion of marinas with a capacity of at least 6 boats;
4. Mining and associated activities;
5. Oil and natural gas drilling and refining and associated activities.

For activities involving explosives, the buffer for bald eagle roost sites is defined in the National Bald Eagle Management Guidelines (2007): Communal Roosts Do not use explosives within ½ miles (or within 1 mile in open areas) of communal roosts when eagles are congregating, without prior coordination with the U.S. Fish and Wildlife Service and your state wildlife agency.

- Fish

This source was provided by the Washington State Conservation Commission and the Northwest Indian Fisheries. StreamNet is a regional 1:100,000 (100K) scale database project funded by the Bonneville Power Administration and regionally managed by the Pacific States Marine Fisheries Commission (PSMFC). The database includes the National Environmental

Protection Agency (EPA) 100K streams with major lakes and double banked streams, anadromous and resident fish presence with known spawning and rearing and known barriers to anadromous fish. StreamNet contributions include "use type" information (i.e. known spawning and known juvenile rearing for resident and anadromous fish). Information was derived from data collection efforts between 1989 and 2008.

Information on resident fish is generalized to river reach. Washington Department of Fish and Wildlife biologists that provided the data relied upon professional knowledge based on field surveys, research projects and experience. They were encouraged to use reports and survey data when required or involved other professionals in the field who had knowledge of an area. Resident fish data are of 1990 and are not considered best available knowledge.

National Marine Fisheries Association

- Puget Sound steelhead listed in 2007 as threatened (noted as “in progress”)
- Puget Sound Chinook listed in 1999 as threatened
- Columbia river Chum listed in 1999 as threatened

U.S. Fish and Wildlife

- Bald eagle - delisted due to recovery in 2010
- Puget Sound Chinook listed as threatened
- Columbia river Chum listed as threatened
- Puget Sound steelhead listed as threatened

Skagit County Critical Areas Ordinance

- Bald Eagle

  Skagit County aligns with Washington State Bald Eagle Protection Rules (WAC 232-12-292). See WDFW above.

  “Critical areas” are defined as wetlands, aquifer recharge areas, frequently flooded areas, geologically hazardous areas, and fish and wildlife habitat conservation areas. Specific to this project, areas with which anadromous fish species have a primary association. This includes Chinook, Chum and steelhead found in the project area.

Analysis of Impacts

The Endangered Species Act requires that federal agencies consider several types of effects on potential habitat and species disturbance. Previous and potential future activities on the site are evaluated for their direct effects, indirect effects, interdependent effects, and cumulative effects on special status species and their habitats.

- ***Direct effects*** are effects from actions that would immediately remove or destroy habitat, harm (injure or kill) species, or adversely modify designated critical habitat. Direct effects include actions that would potentially remove or destroy habitat, or displace or otherwise influence the species, either positively (beneficial effects) or negatively (adverse effects).

  Proposed work will not have a direct effect on the bald eagle nest, but could affect foraging by disruption of prey habitat through grass removal and removal of fish during dredging. Direct effects on anadromous fish species are highly possible for in-water work depending upon the season and nature of activity. If performing work in-water or adjacent to water, confirmation of fish presence/absence and defishing and isolating the impact area as directed and supervised by a qualified fisheries biologist are recommended. BMPs to maintain water quality should also be employed.

- ***Indirect effects*** are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Indirect effects may include impacts to food resources or foraging areas, and impacts from increased long-term human access.

- ***Effects from interdependent and/or interrelated actions*** include effects from actions that (**1**) have no independent utility apart from the primary action, or (**2**) are part of a larger action and depend on the larger action for their justification, and/or (**3**) are required as part of the action, including maintenance and/or use of the project, as well as other actions that would be carried out to implement, maintain, and/or operate the project.

- ***Cumulative effects*** are those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the project area.

- ***Conservation measures*** (or mitigation) are measures proposed to minimize or compensate for project effects on the species under review. Unless stated otherwise, the effects determinations, as defined in the section below, are based on the assumption that conservation measures would be incorporated into the project.

The proposed action(s) are evaluated along with other activities that are interrelated or interdependent with the proposed action when added to the environmental baseline. The environmental baseline, as described in 50 CFR Part 402.02, includes the following:

- The past and present effects of all federal, state, or private actions and other human activities in the action area;
- The anticipated impact of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation;
- The impact of state or private actions, which are contemporaneous with the consultation in process.

TO BE UPDATED AND COMPLETED BY A QUALIFIED BIOLOGIST ONCE A SPECIFIC PROJECT SCOPE IS DETERMINED

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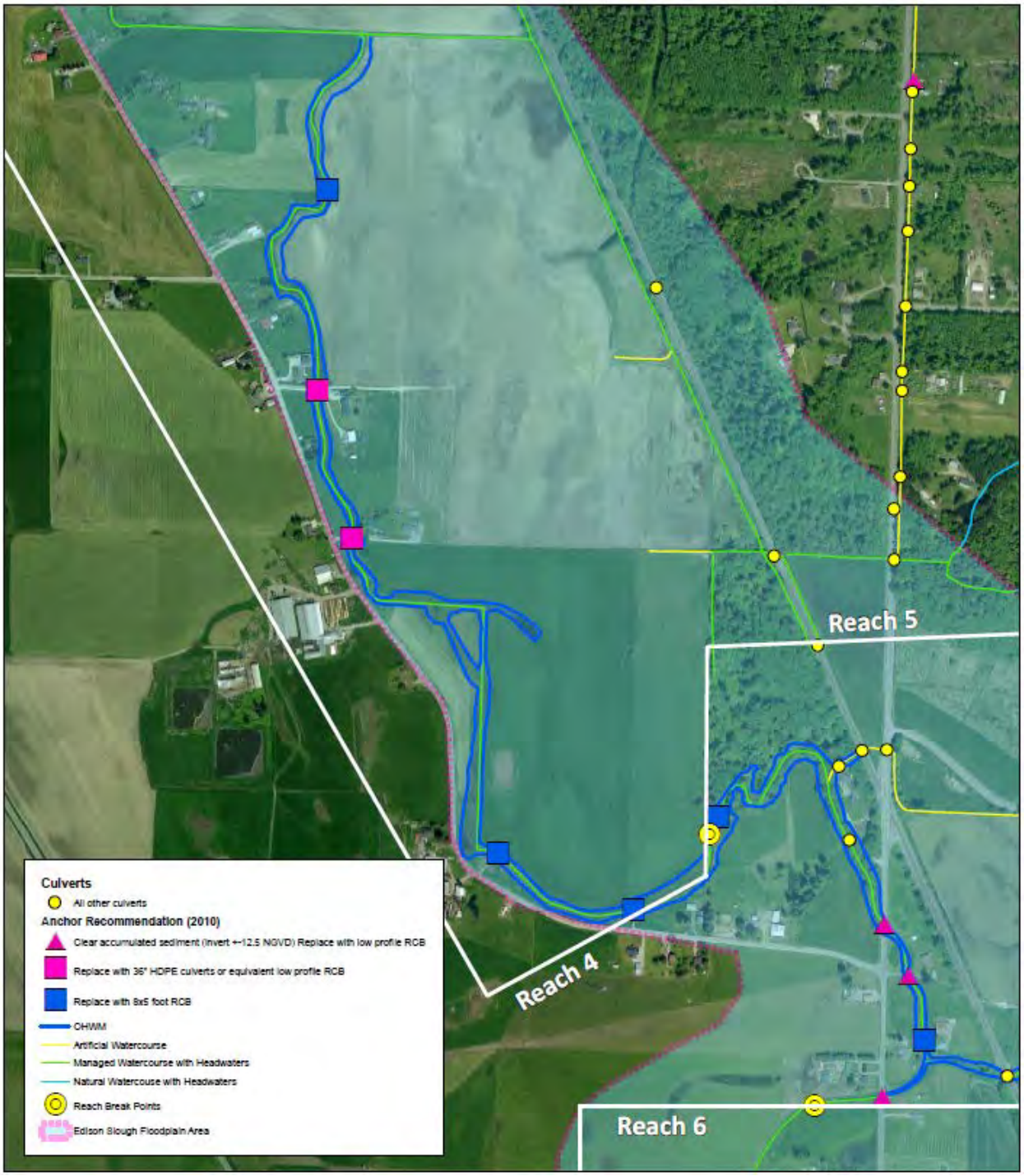

Ordinary High Water Mark determination – Reach 4 and 5 Priority Project Areas

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APPENDIX D: WDFW CLASSIFICATION OF WATERCOURSES

The Edison Slough floodplain area was considered for a Drainage and Fish Initiative (DFI) agreement between WDFW and Skagit County Drainage Utility acting as a Drainage Improvement District, but it was determined that the conditions of Edison Slough and role of the Skagit County Drainage Improvement District was not an ideal fit for this program. The following graphics represent the process to classify the Edison Slough watercourses under the DFI framework. Below are the Watercourse Classifications:

Natural Watercourses *(Color Code: **Blue**)*: Watercourses with headwaters that follow and/or replace a historic natural watercourse that has been altered, channelized, relocated, and/or constrained by dikes and that do not have flow control structures (tide gates, pump stations) at their confluence with marine waters. *(Examples: Skagit River, Samish River)*

Managed Watercourses with Headwaters *(Color Code: **Green**)*: Watercourses with headwaters that follow and/or replace a historic natural watercourse that has been significantly channelized, relocated, and/or constrained by dikes and that have flow control structures (tide gates, pump stations) at their confluence with marine waters. *(Examples: Edison Slough, No Name Slough, Big Indian Slough, Big Ditch, Hill Ditch)*

Managed Watercourses without Headwaters *(Color Code: **Magenta**)*: Watercourses without headwaters that follow and/or replace a historic natural watercourse that has been significantly channelized, relocated and/or constrained by dikes and that have flow control structures (tide gates, pump stations) at their confluence with marine waters. *(Examples: Wiley Slough, Dry Slough, Brown Slough, Hall Slough, Dodge Slough, Sullivan Slough, Joe Leary Slough)*

Artificial Watercourses *(Color Code: **Yellow**)*: Watercourses without headwaters that are wholly built by humans and that do not follow or replace a historic natural watercourse, and are designed to convey water from local surface areas or subsurface drains for the purpose of removing excess water in order to improve conditions for agriculture.

Fish Habitat Distribution using WDFW Watercourse Classification

Watercourses with headwaters (green) typically include suitable spawning, rearing and migration habitats for Coho salmon and Cutthroat trout. Spawning habitats typically occur in stream reaches that have gradients between 1-3% and are fed by flowing water with a steady supply of suitable sediments. These reaches tend to be found at the junction between low gradient tidally influenced reaches and the steeper gradient headwater reaches of the system.

Rearing habitats may be distributed throughout these watercourses, but are primarily located where there is sufficient channel complexity, riparian canopy, water quality, and invertebrate productivity (fish prey/forage). Upstream and downstream fish migration typically occurs throughout these watercourses; both natural and manmade barriers can and do restrict or block fish passage.

Artificial Watercourses (yellow) are wholly manmade systems constructed to convey water from a local surface or subsurface area for the purpose of improving the soil conditions for agriculture. Typically these watercourses are seasonal and do not have the habitat characteristics or natural processes necessary to support the rearing and spawning requirements of native cold water fish.

Edison Slough Watershed Channel Network

In total, the Edison Slough floodplain and primary drainage improvement area includes approximately 8.6 miles of channels. Edison slough flows primarily in a relict distributary of the Samish River, termed "North Fork Samish River" on the 1887 U.S. Coast and Geodetic Survey Map. In addition to the primary channel, numerous anthropogenic channel modifications, including re-routing of existing channels and the creation of new channels, have been implemented to help drain fields for land use activities. A preliminary WDFW watercourse classification was made using previously defined methods and nomenclature (Figures A, B, C). The total lengths of the two WDFW watercourses present in the floodplain area are:

1) Artificial Watercourses (yellow): 6,835 feet, 1.3 miles
2) Managed Watercourse with Headwaters (green): 38,511 feet, 7.3 miles.

Fish Distribution in the Edison Slough Watershed

Very limited actual fish survey data is available for the lowland reaches of Edison Slough either in *Managed Watercourses with Headwaters* (green) or *Artificial Watercourses* (yellow).

Lowland (green) watercourses in the Skagit basin (a.k.a *Managed Watercourses with Headwaters)* typically support Coho salmon, Cutthroat trout, and steelhead (Vasak, unpub data). For the purposes of this document, fish distribution data and reports in the green waterways are derived from previous fish presence/absence studies. Fish survey data has not been collected for *Artificial Watercourses* (yellow).

Artificial Watercourses (yellow) are manmade channels designed to convey water from local surface and subsurface areas to improve the soil conditions for agriculture. These watercourses are typically dry in the summer. Water quality and quantity can negatively affect the suitability of the potential fish rearing habitat. The habitat characteristics and natural processes required by native cold water fish for rearing and spawning are not supported by these artificial watercourses. It is therefore assumed that the presence of native cold water fish is either very limited or absent in these watercourses.

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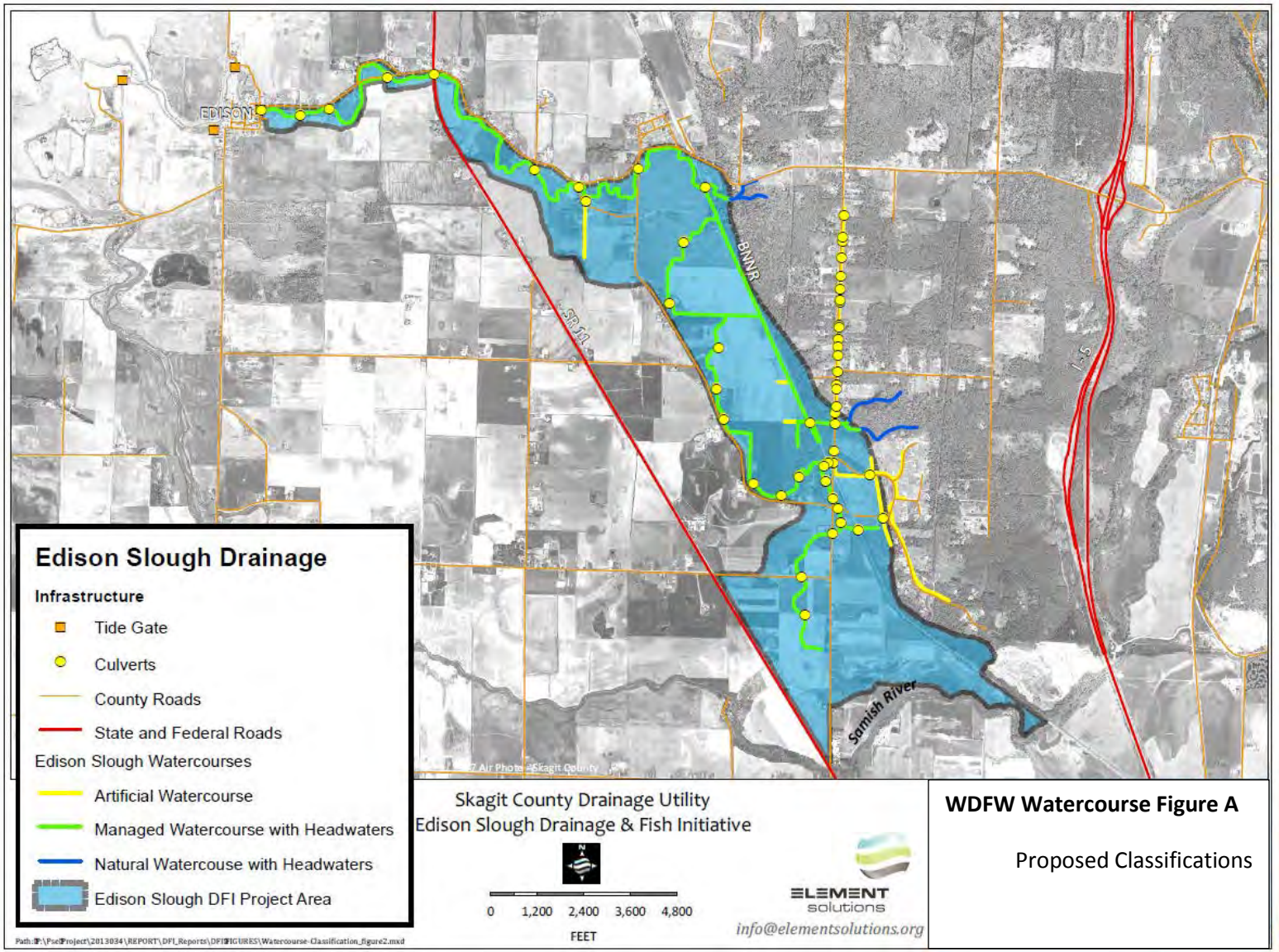

Skagit County Public Works – Edison Slough Drainage Improvement Plan

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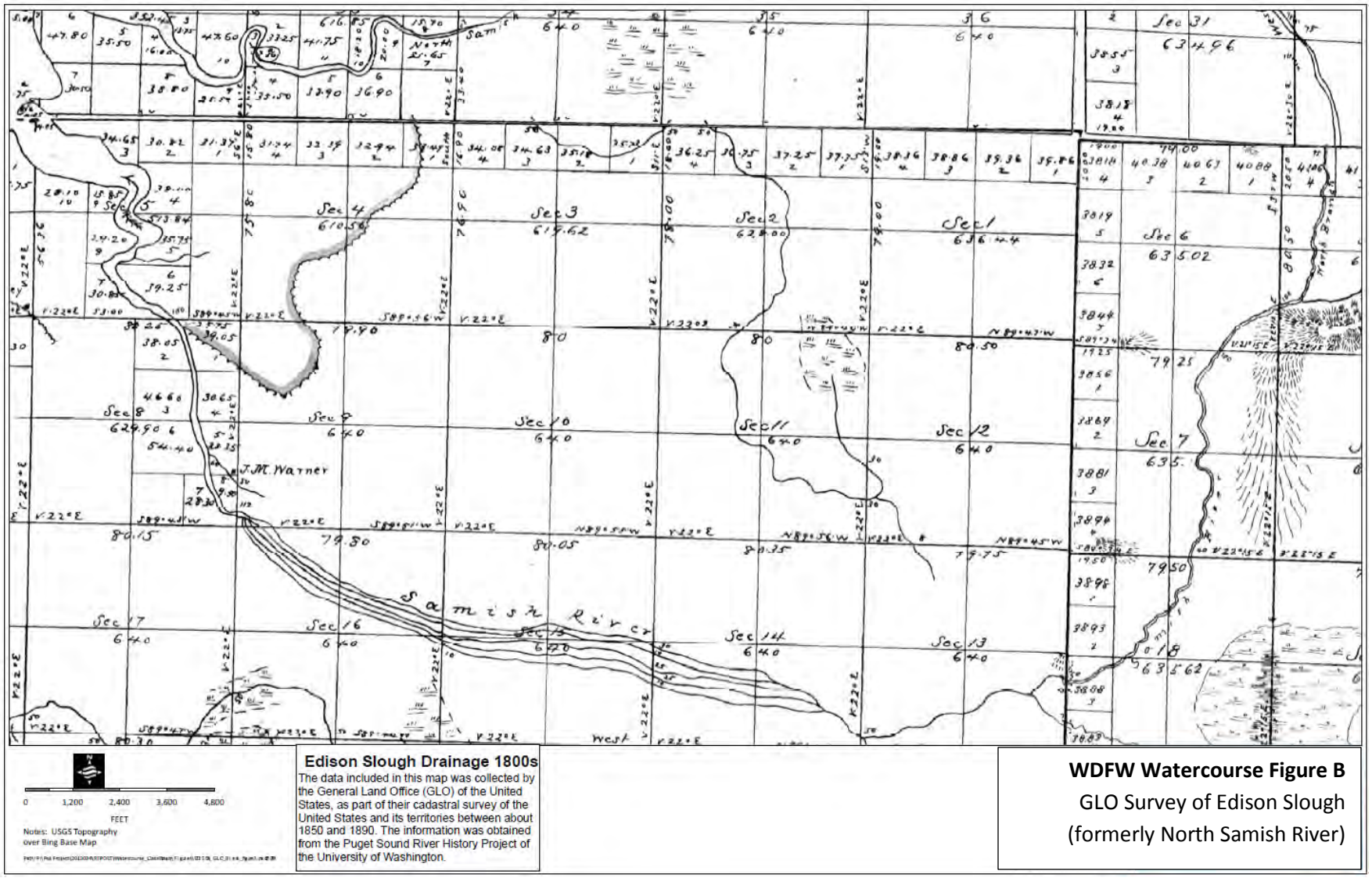

Edison Slough Drainage 1800s

The data included in this map was collected by the General Land Office (GLO) of the United States, as part of their cadastral survey of the United States and its territories between about 1850 and 1890. The information was obtained from the Puget Sound River History Project of the University of Washington.

WDFW Watercourse Figure B

GLO Survey of Edison Slough (formerly North Samish River)

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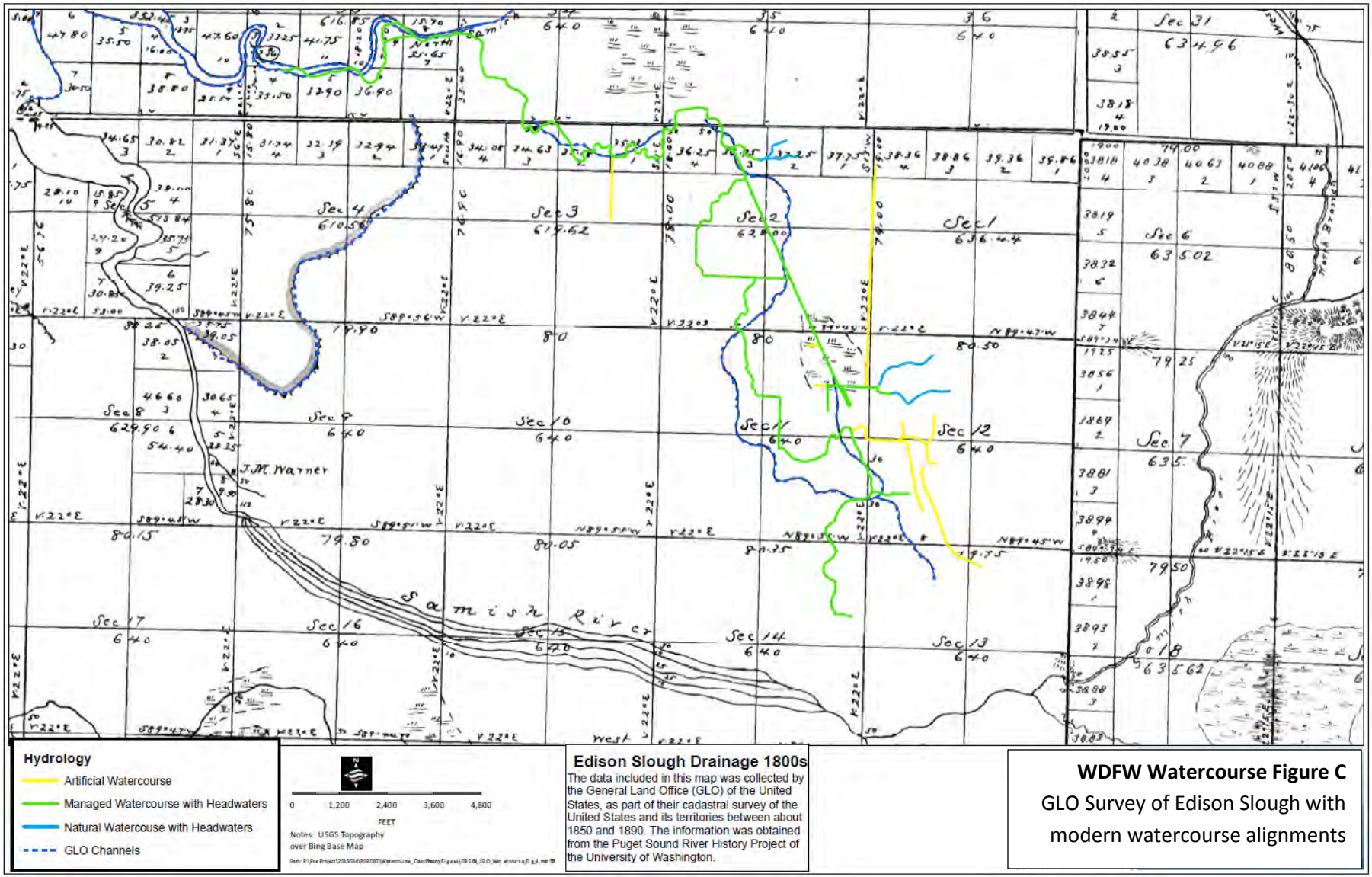

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APPENDIX E: HEDGE ROW PLANTING SEQUENCE (WHATCOM CONSERVATION DISTRICT)

Hedgerow Planting

Summer 2005 prior to planting

Summer 2006 after 6 months growth

Summer 2007 after 18 months growth

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Hedgerow and Field Border

Hedgerow Species Diversity

Open Stream Channel Below Hedgerow

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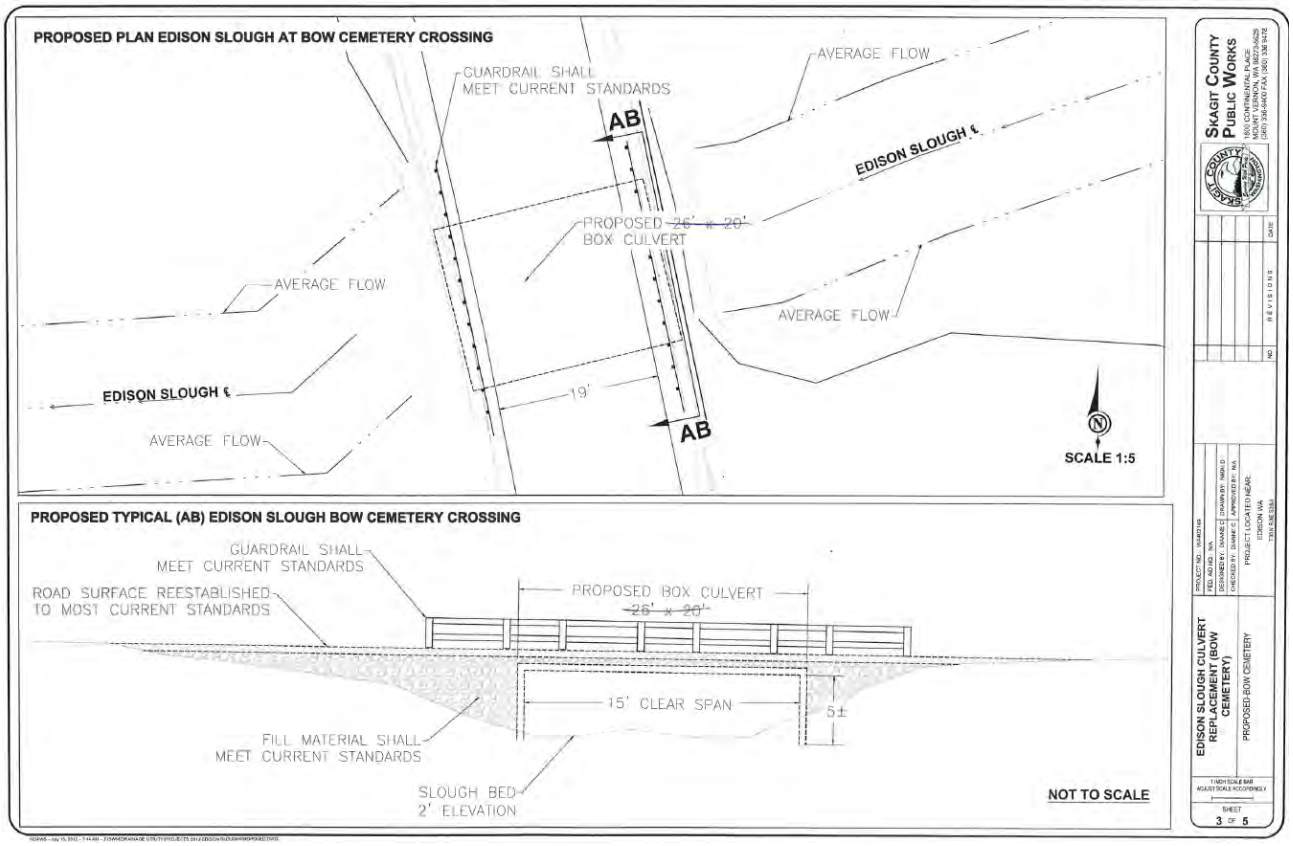
APPENDIX F: TYPICAL DESIGNS FOR CROSSINGS

Bow Cemetery Road Design - 15 x 8 Foot RCB



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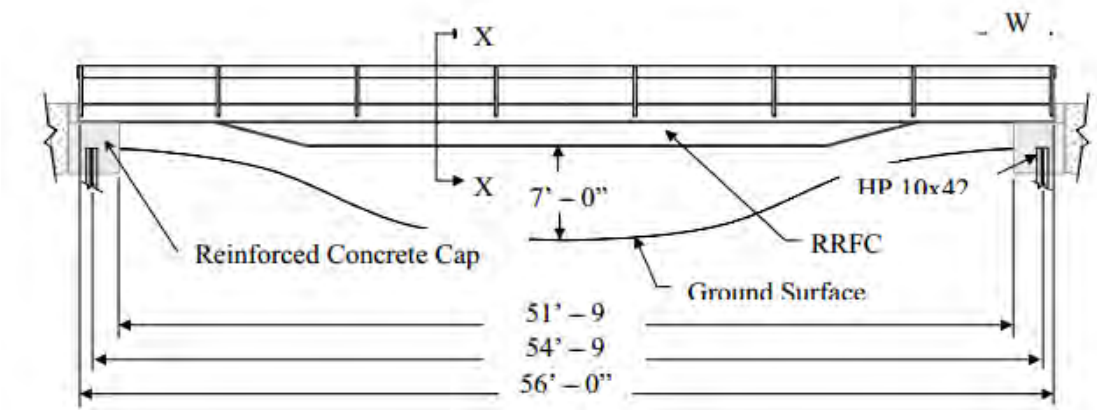
Railway Flat Car Bridge (RFCB) for Agricultural or Low-Volume Road Crossings

Technical Notes: Flatcars properly installed will provide HS-25 load capacity. Flatcars can be available in matched pairs for side by side installation. Flatcars can be custom cut to length. Concrete abutment are typically 2' x 2' x 11'. Typical material costs range from $10,000 to $20,000. Install can be completed with a hydraulic excavator.



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