5.2.4 HYDROLOGY

SURFACE WATER

There are three surface water bodies present on Mitigation Site 1: Crescent Harbor Creek, a small groundwater seep, and a series of shallow agricultural drainage ditches (Exhibit 5-13). Crescent Harbor Creek runs from north to south through the site in a narrow, straightened ditch. The existing channel within Mitigation Site 1 is generally approximately 5 feet wide. The banks are very steep, rising approximately 8 to nearly 15 feet in height above the channel bed (Exhibit 5-14). An earthen berm of varying height is adjacent to the left (east) top of bank. At the downstream end of the project site, the height of the berm tapers to zero and the existing creek channel becomes indistinguishable from the surrounding, flat, marsh area.

The creek passes under Crescent Harbor Road in a corrugated metal, oval-shaped culvert (6.7 feet wide by 4.9 feet tall by approximately 50 feet long). There is an approximately 2-feet drop from the downstream invert of the culvert outlet (elevation 26.7 NAVD) to the stream channel below. Field reconnaissance and topographic survey efforts for this project located several steeper sections in the creek channel's longitudinal profile in the 200 feet of the channel immediately downstream of the Crescent Harbor Road crossing (Exhibit 5-14). It is unclear if these are the result of head cuts (i.e., nickpoint migration), local plunge-pool erosion, a combination of both, or simply remnants of excavation from when the channel was constructed. Regardless, the culvert and road crossing are acting as an upstream grade control on the creek through the project site.

Winter base flow water depths in the deep, straightened channel (as observed in April 2008) average approximately 0.5 foot. At the downstream end of the site, water flowing in the creek becomes dispersed before coalescing further downstream into dredged channels within the former salt marsh.

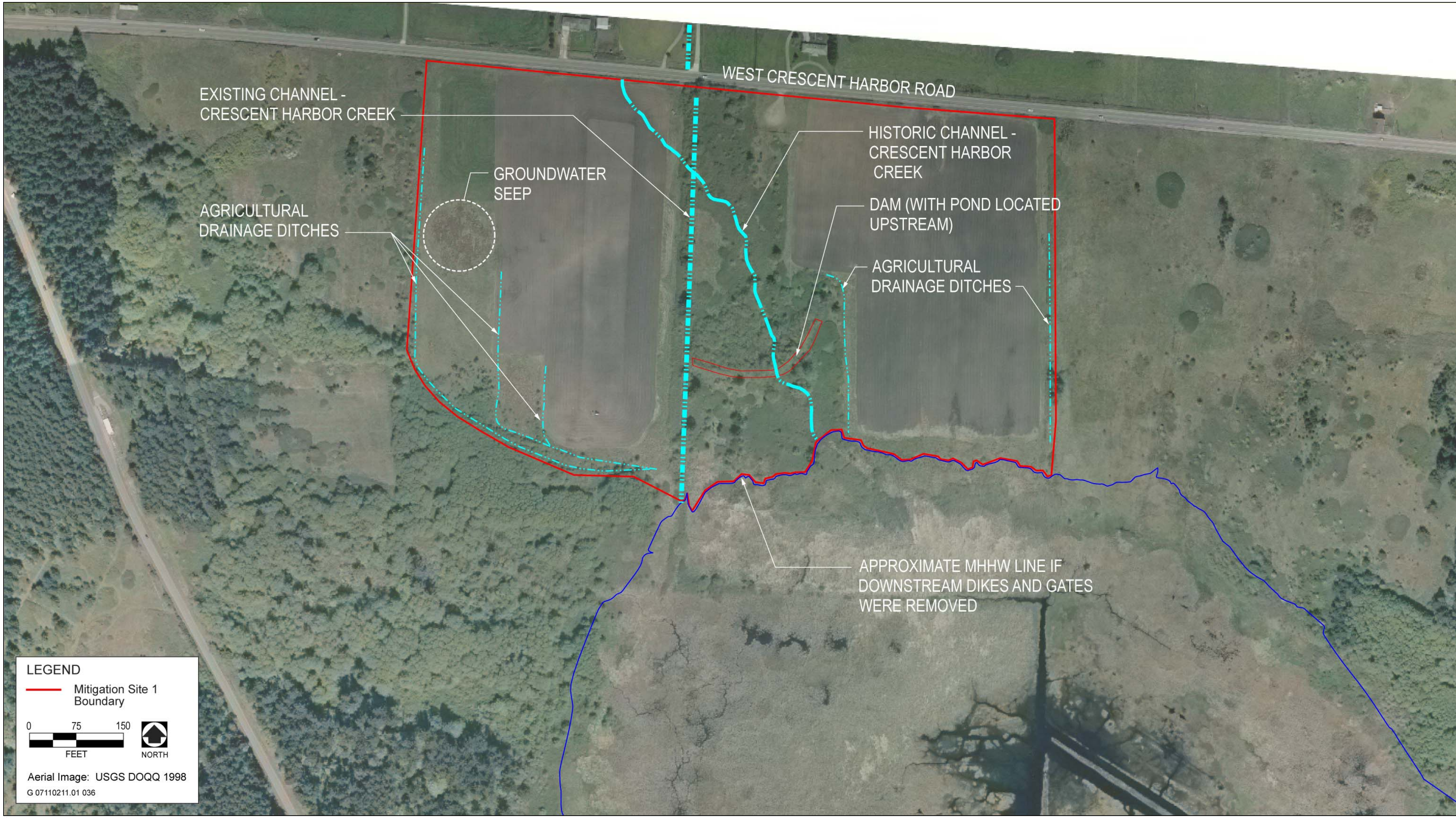
Historical aerial photographs suggest that the present alignment of Crescent Harbor Creek is anthropogenic, with the former creek alignment entering the project site approximately 180 feet west of its present location (Exhibit 5-9). Remnants of the historic channel immediately downstream of Crescent Harbor Road are visible as a slight depression in the topography of the site; however, the historic channel has been largely obliterated by tillage of the field. The historic channel alignment intersected the existing channel alignment approximately 300 feet downstream of the existing Crescent Harbor Road crossing. Downstream of this location, the general morphology of the historic channel/floodplain is largely intact as the channel meanders southeast through the middle portion of the site (Exhibit 5-15). The historic channel alignment is obliterated in the topographic depression of the pond upstream of the existing dam, and is also absent on the leveled land surface between the dam and the downstream marsh.

Crescent dam is approximately 5-feet tall (Exhibit 5-13) and provides an impoundment that is seasonally inundated. It appears that the land surface upslope of the dam was excavated using a bulldozer or other similar heavy equipment and pushed south to form the existing dam. The resulting topographic depression is lower than both the land surface upslope (to the north) and downslope of the dam (to the south). Field reconnaissance identified a 15-foot-wide unreinforced spillway located at the point where the alignment of the historic channel crosses the dam. While the EDAW project team observed some signs of past erosion of the spillway (now vegetated), no evidence of erosion was observed downstream of the dam. Based on monitoring data collected at this location (PWA 2008a), the pond area apparently fills to some degree in early autumn, and surface water elevations remain reasonably constant until antecedent groundwater and soil moisture conditions are sufficient to cause the pond elevation to increase. This suggests that the hydrology of the historic stream channel (that is, the connectivity of groundwater and surface water) is reasonably intact, despite the existing incised channel to the west.

In the open field on the western edge of the project site, field reconnaissance identified a prominent area of groundwater seepage (see circled location noted on Exhibit 5-13) situated in a topographically higher area compared to the surrounding land. At the center of this saturated area is a small, shallow area of open water (approximately 3 feet by 5 feet, as observed in April 2008) that was observed to be flowing/draining to the south. PWA hypothesizes that this wet area and open water are semi-artesian and gain hydrostatic pressure from source areas located at higher elevations in the watershed (i.e., the hillslope to the west of the project site and main watershed area up the valley to the north). Interbeds of coarse marine sands or gravel outwash are known to exist in the geologic formations of the site, and such materials are probably responsible for conveying upgradient groundwater to the land surface.

Field reconnaissance by the EDAW project team in April 2008 identified at least five small (approximately 1.5 feet wide by 0.75 to 1.0 feet deep) agricultural drainage channels (Exhibit 5-16). Some of these artificial channels are located immediately adjacent to the groundwater seepage area discussed above; others are distributed across the site. All of these artificial channels generally trend north to south (consistent with an upslope to downslope orientation) and several are linked together at their downstream ends. PWA hypothesizes that these channels were constructed to assist in draining the main seepage area (described above), as well as to drain the very shallow groundwater (hereto referred to as soilwater) that was likely more prevalent on the site prior to initiation of agricultural practices.

Because the soils overlying the glaciomarine drift are generally less than 2 feet thick and frequently have relatively high hydraulic conductivity compared to the glaciomarine drift below, precipitation moves into these overlying soils easily, and saturates the shallow soil layer relatively quickly.

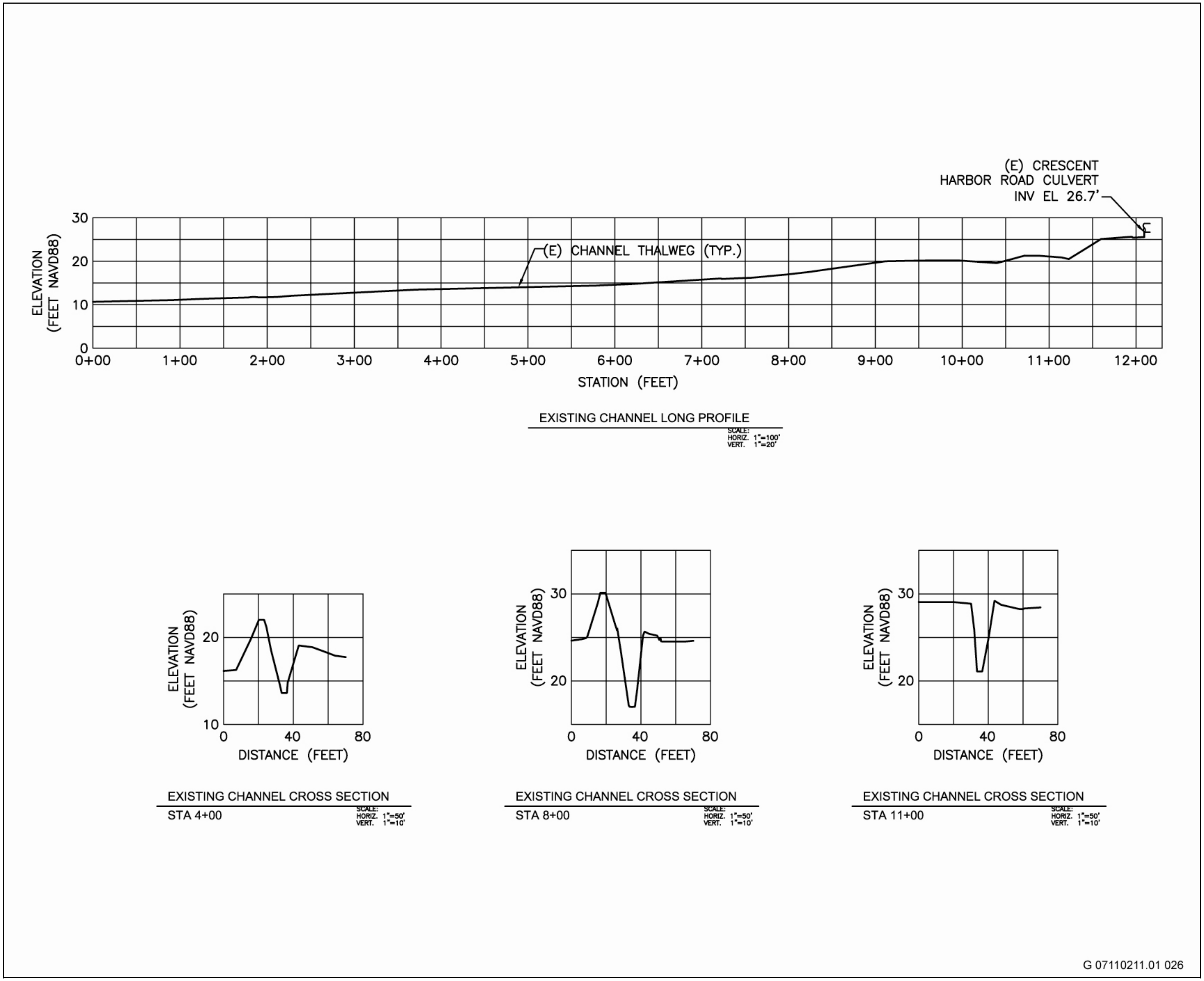


Source: Prepared by PWA and EDAW in 2008

Mitigation Site 1: Hydrologic Features **Exhibit 5-13**

Crescent Harbor Creek Existing Longitudinal Profile and Cross Sections at Mitigation Site 1 Exhibit 5-14

Source: Prepared by PWA in 2008

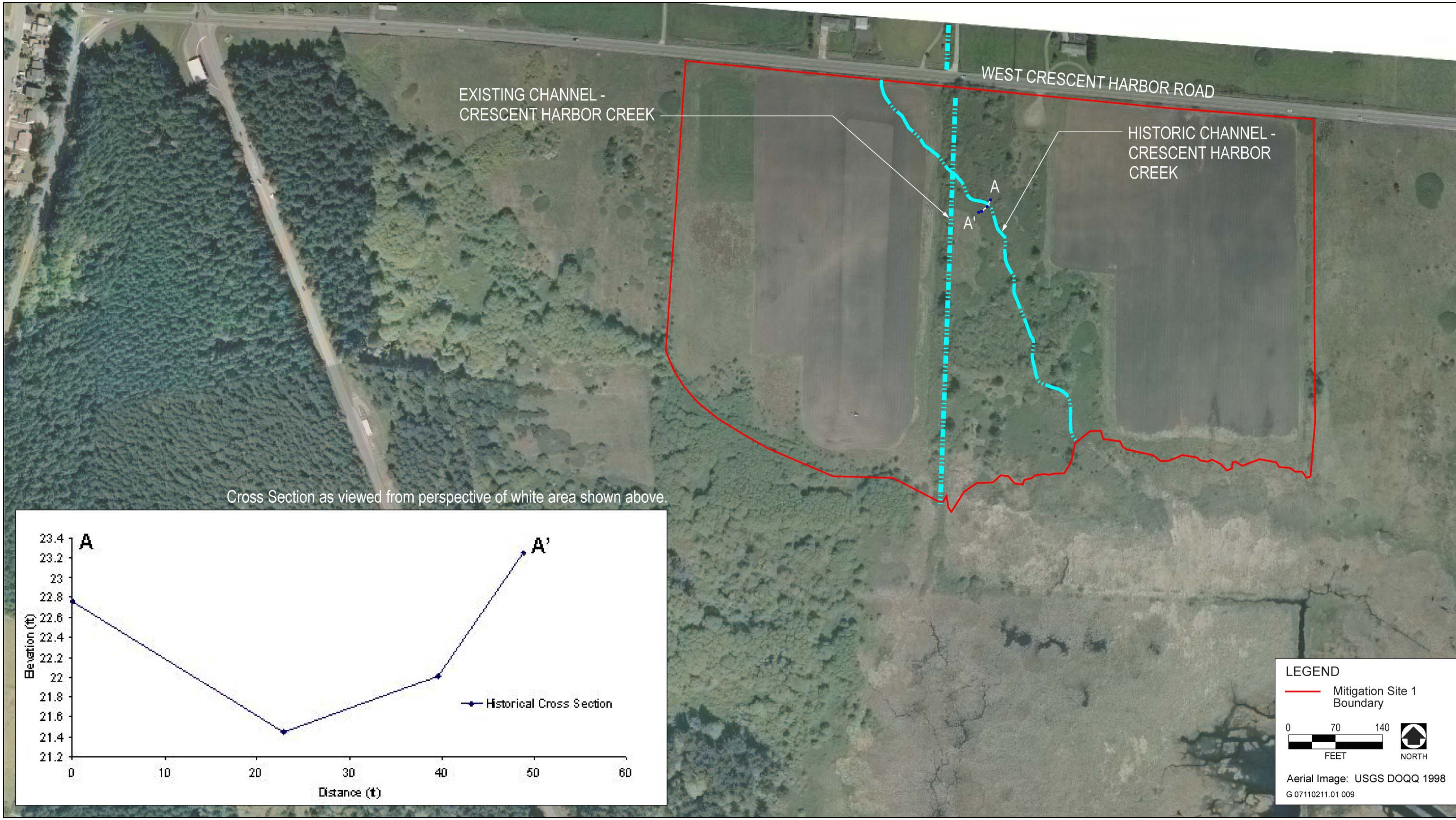


These surficial soils may become saturated and form wetlands (see the wetland at the top of the hill shown in Exhibit 5-11), or, if slopes are steep enough or if there is a lower-elevation conduit toward which those surface soils may drain (i.e., creation of a head differential strong enough to induce lateral subsurface flow), the surface soils will "drain" over the top of the glaciomarine drift. On this site, the agricultural drainage channels provide such a conduit, conveying the soilwater in a downslope direction far faster than if it were to drain there through the soil itself. This decreases the ability of major portions of the site to function as wetlands. Further, over longer periods of time the interception and drainage of shallow soilwater by the agricultural drainage ditches may substantially reduce the duration of saturated conditions in the upper soil horizons and decrease infiltration to the deeper hillslope groundwater within the glaciomarine drift. While the glaciomarine drift is relatively impermeable compared to the upper soil horizons, over time it does become saturated and groundwater levels increase—in some instances to the ground surface (see the section on groundwater below). However, if the soil surface atop the glaciomarine drift is artificially drained (in this case by the agricultural drainage channels), infiltration to the glaciomarine drift is decreased and the length of time until the glaciomarine drift becomes saturated increases. This may delay the seasonal recharge of groundwater levels (see the discussion on groundwater below) and therefore may have an adverse effect on vegetative communities and habitat.

GROUNDWATER

Based on known relations of site geology and wetland formation (Ecology 2008), available groundwater piezometer data (from piezometers installed as part of this project) were examined relative to transects extracted from the topographic surface model to assess any potential influence of surface water channels on groundwater levels (Exhibits 5-17 through 5-24). Piezometers were not installed near the groundwater seepage area on the western edge of the project site; however, based on field observations in autumn (end of the dry season) 2007 and winter 2007–2008, groundwater levels appear to be at, or very near, the ground surface.

In the middle and eastern portions of the Mitigation Site 1(i.e., closer to the existing creek channel), groundwater levels appear to be more variable through the water year. Generally, groundwater levels in upslope positions near the existing incised stream channel (e.g., TP2 in Exhibit 5-18) remain closer to the ground surface than do groundwater levels in downslope positions (e.g., TP6 in Exhibit 5-20). While there is seasonal variability in groundwater levels at all locations, it appears that the existing incised stream channel is lowering groundwater levels, and has an increasing influence with increasing distance downstream from Crescent Harbor Road. The artificially low channel of Crescent Harbor Creek may be draining local groundwater, providing a head differential (from the groundwater to the channel invert) such that there is no capacity for shallow groundwater (i.e., that which is in the upper 10 feet of the soil column) to accumulate and saturate to the ground surface near the channel. This, coupled with the draining of shallow soilwater by the agricultural drainage ditches (which



Source: Prepared by PWA in 2008

Typical Historic Crescent Harbor Creek Channel Cross Section at Mitigation Site 1 **Exhibit 5-15**

This photograph shows an example of the small agricultural drainage channels located on the edge of the open, grassy fields of Mitigation Site 1. *(Photo Source - PWA 2008)*

Agricultural Drainage Channels **Exhibit 5-16**

decreases the source of infiltration to the glaciomarine drift from above), may ultimately increase the delay in seasonal recovery of groundwater levels and adversely affect wetland and riparian habitats. The increasing effect on groundwater levels with downstream distance may occur because monitoring locations near the downstream end of the incised creek channel (as observed in TP49 and TP6) are situated downstream of progressively increasing lengths of channel that are draining adjacent groundwater. Upslope locations (such as groundwater levels at TP2) simply have less upslope channel-length draining them and are not as strongly influenced.

Seasonally, groundwater levels at measured locations fluctuate in response to precipitation events and antecedent soil moisture conditions. Groundwater monitoring data at upper and midslope locations (e.g., TP2 and TP49; Exhibits 5-18 and 5-19, respectively) indicate that Crescent Harbor Creek is a "gaining stream[7]" for most of the year[8]. However, because the anthropogenic channel is so deep relative to the surrounding ground surface areas,

[7] A gaining stream is a term used to describe a section of channel where groundwater levels adjacent to the stream are higher than the water surface in the creek, such that the stream is "gaining" water from the adjacent groundwater.
[8] This observation is based on groundwater monitoring results that do not include an entire water year.

this gaining stream configuration also suggests that the incised channel is probably artificially draining and lowering groundwater elevations in the local vicinity.

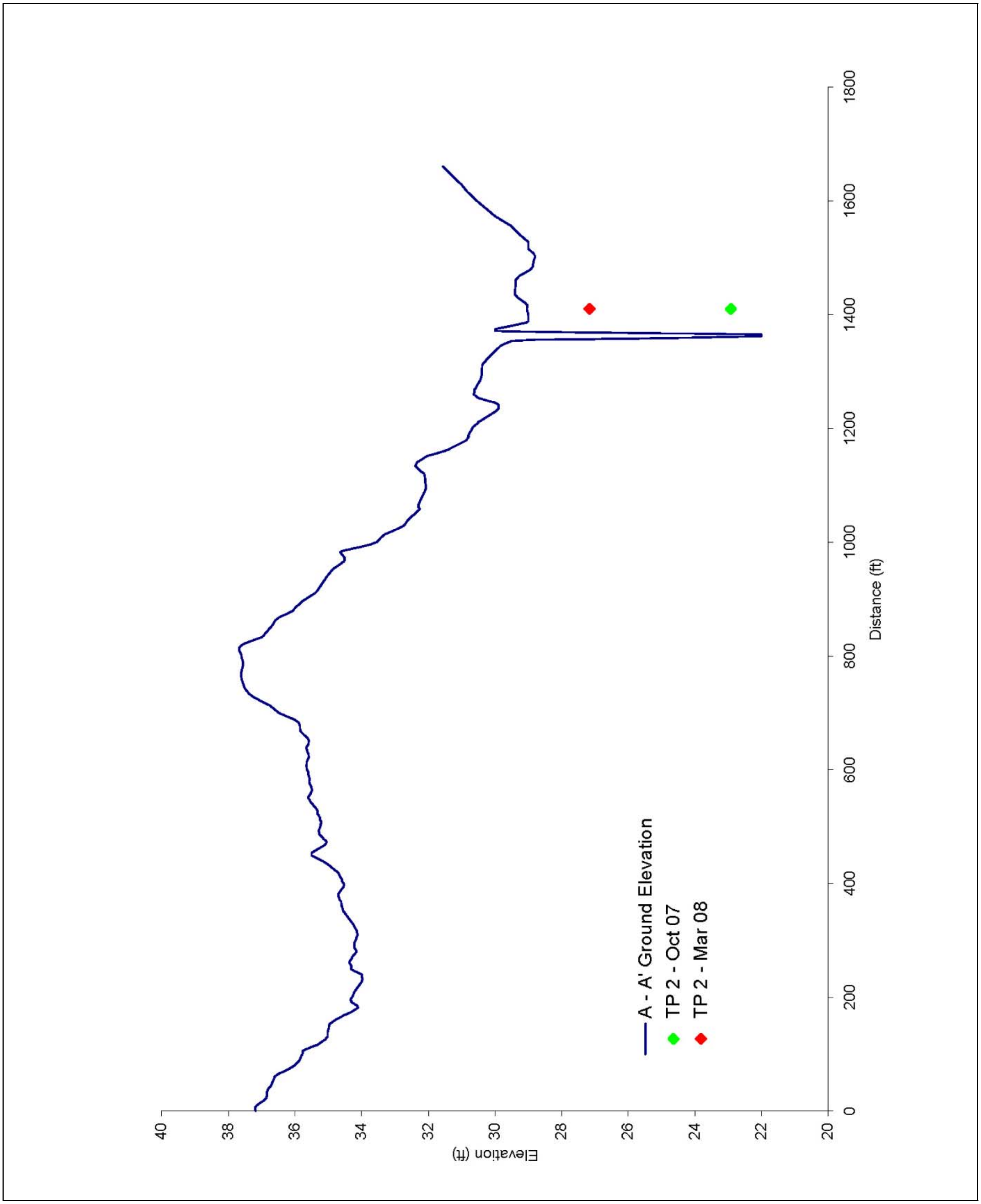
At the downstream end of the existing stream channel (e.g., cross section C-C’ in Exhibit 5-20), groundwater level observations indicate that during the winter, the existing creek channel is a gaining stream, with groundwater elevations higher than the water in the channel. At the end of the dry season in the autumn, however, groundwater elevations across the entire transect (i.e., in piezometers TP6, TP15, and TP17) were observed to be over 4 feet lower than the channel bed. For the existing incised channel, this represents a “losing stream” situation, where any water in the channel is perched above the local shallow groundwater table and would likely be “lost” to the groundwater via infiltration. This is consistent with observations in November 2007 where there was no flow coming out of the incised channel at the lower end of the site.

Note that groundwater interpretation was complicated across the site because of the incised and relocated stream channel. Cross section C-C’ (Exhibit 5-20) depicts how the existing stream alignment near TP6 is located west of the historic alignment (which was near TP15) and is perched in a relatively-high topographic position compared to the historic channel alignment. Prior to realignment, the downstream reaches of the creek were topographically-lower than adjacent areas and were probably the focus of groundwater flow. Presently, the existing channel alignment routes the most downstream section of the existing creek straight through a hillslope that—prior to alteration—was simply a gentle hillslope draining toward the historic channel alignment to the east (see slope from approximately station 1,000 to 1,300 in cross section C-C’). These conditions complicate the interpretation of data at TP6 in two ways. First, the incised stream channel drains upslope groundwater and hence depresses groundwater levels across the site, including at TP6. Further, at some times of the year, it appears that the incision drains so much groundwater that the stream loses surface water flow upstream of TP6. The second complication is the uncharacteristic landscape position for the stream channel near TP6, where despite the depth of the incised channel, hillslope groundwater (generally water within the hillslope at elevations between the ground surface and the channel invert) would not normally be expected to flow *toward* the existing channel alignment. This is because the existing channel is off to the west of the topographically lowest portions of the site, and is essentially on a small hill relative to those lower areas. Normally, hillslope groundwater would to some extent be draining away from TP6 and the incised channel. Thus, the TP6 location perhaps over-represents the draining influence of the incised channel on groundwater levels across that portion of the site, as they would already be somewhat lower due to the topographic position of the piezometer site.

At the downstream/downslope end of the site, groundwater remains somewhat elevated during the winter wet season, when it backs up against the interface with the managed marsh immediately to the south. The managed marsh is a diked former salt marsh, connected to Crescent Harbor by a series of undersized culverts that allow only limited flow. During winter months, backup of flow from Crescent Harbor Creek causes water to pond to

Source: Prepared by PWA in 2008

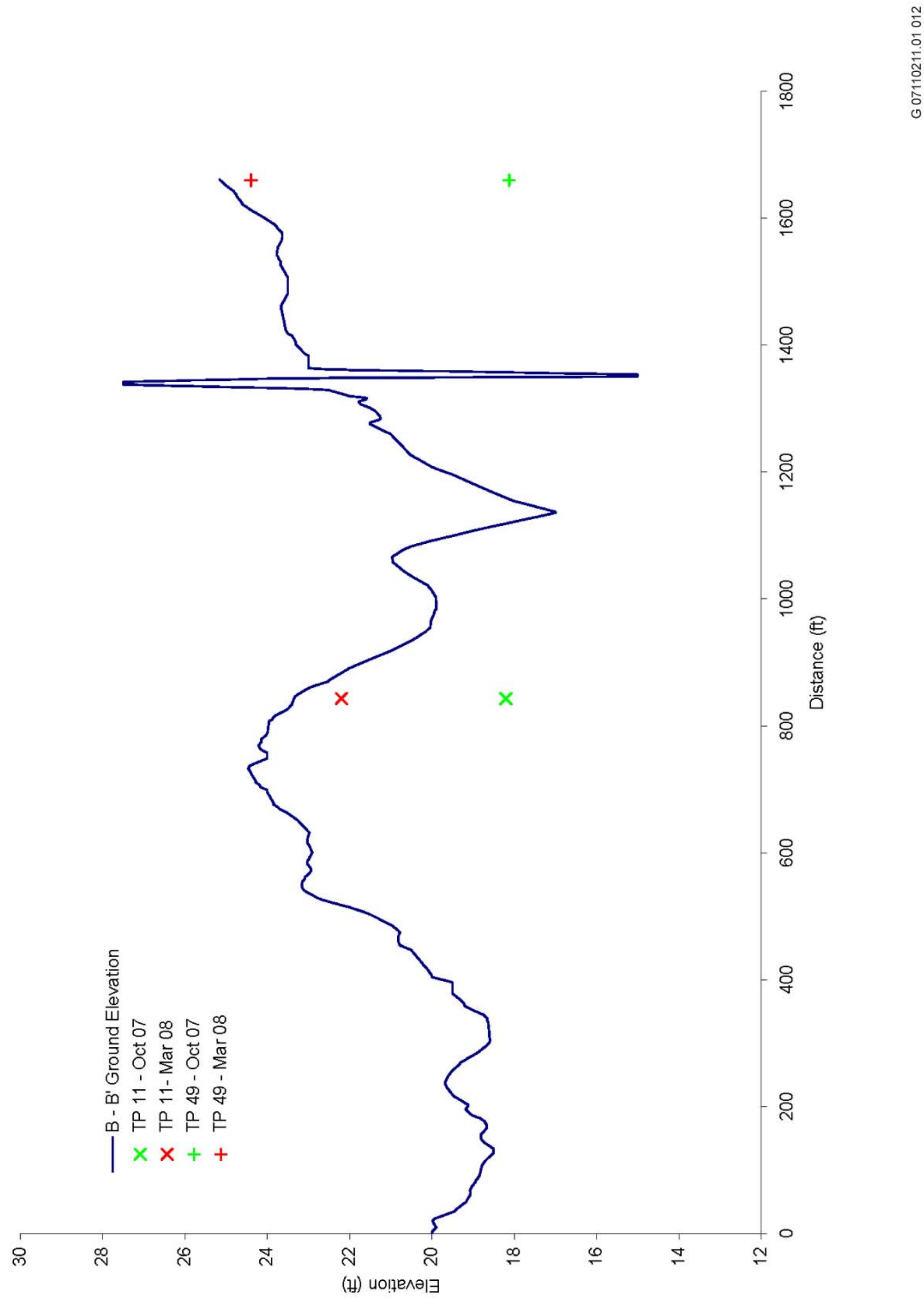
Mitigation Site 1: Groundwater Cross Section Locations **Exhibit 5-17**



Source: Prepared by PWA in 2008

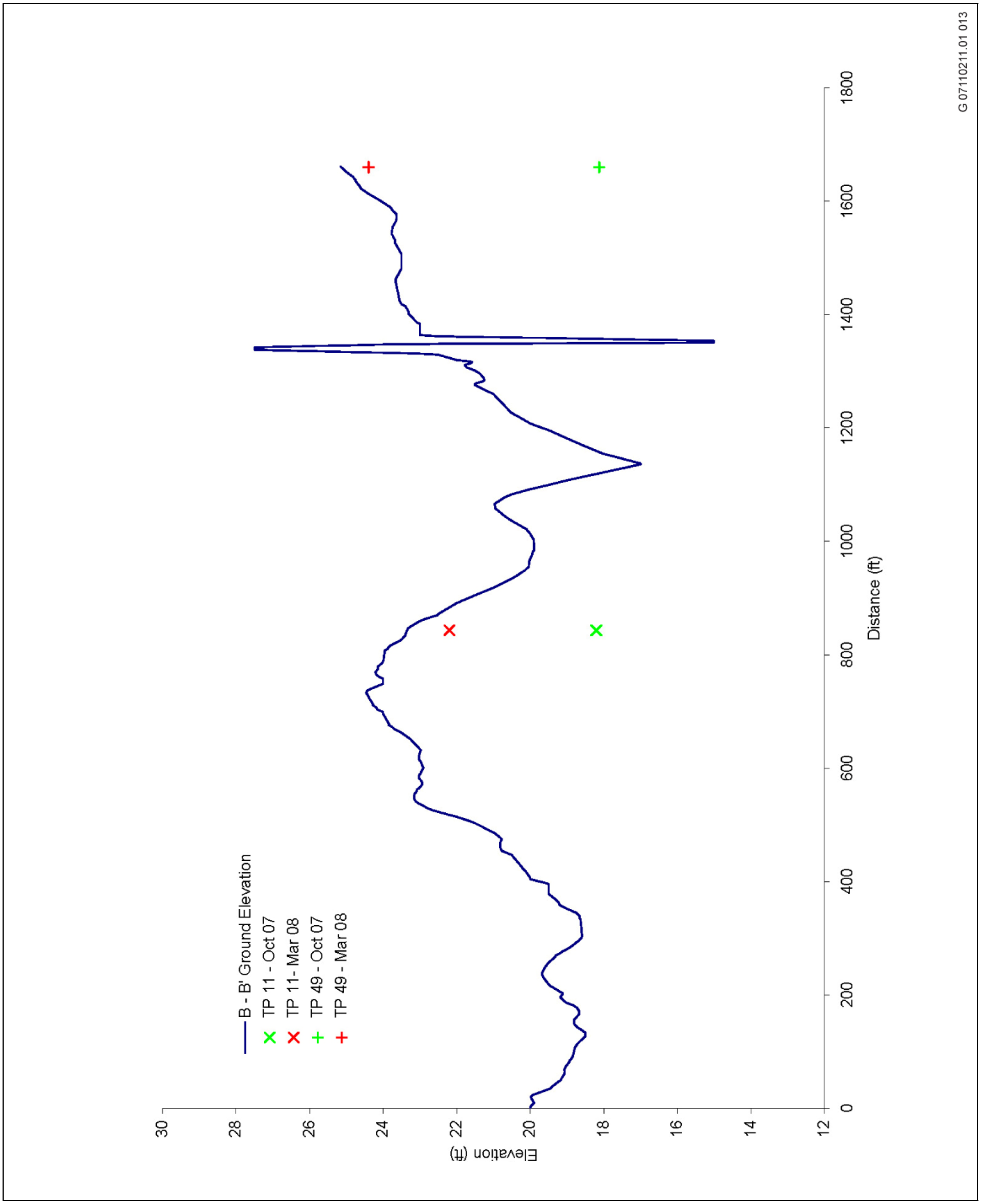
A – A' Groundwater Elevation

Exhibit 5-18



Source: Prepared by PWA in 2008

B – B' Groundwater Elevation **Exhibit 5-19**



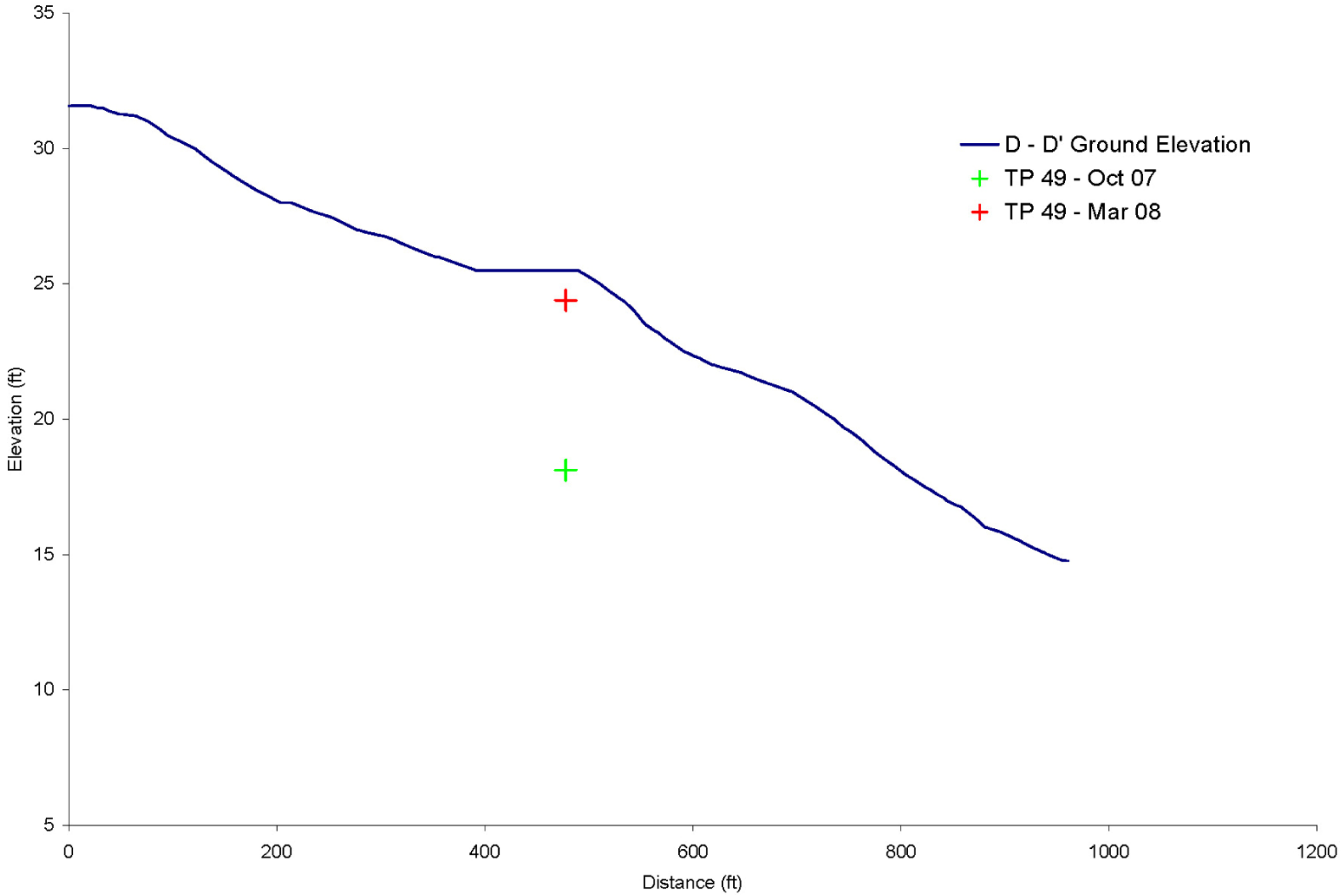
Source: Prepared by PWA in 2008

C – C' Groundwater Elevation **Exhibit 5-20**

D – D' Groundwater Elevation

Exhibit 5-21

Source: Prepared by PWA in 2008



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Wetland Mitigation Feasibility Report
NAS Whidbey Island P-8A MMA Introduction

E – E' Groundwater Elevation

Source: Prepared by PWA in 2008

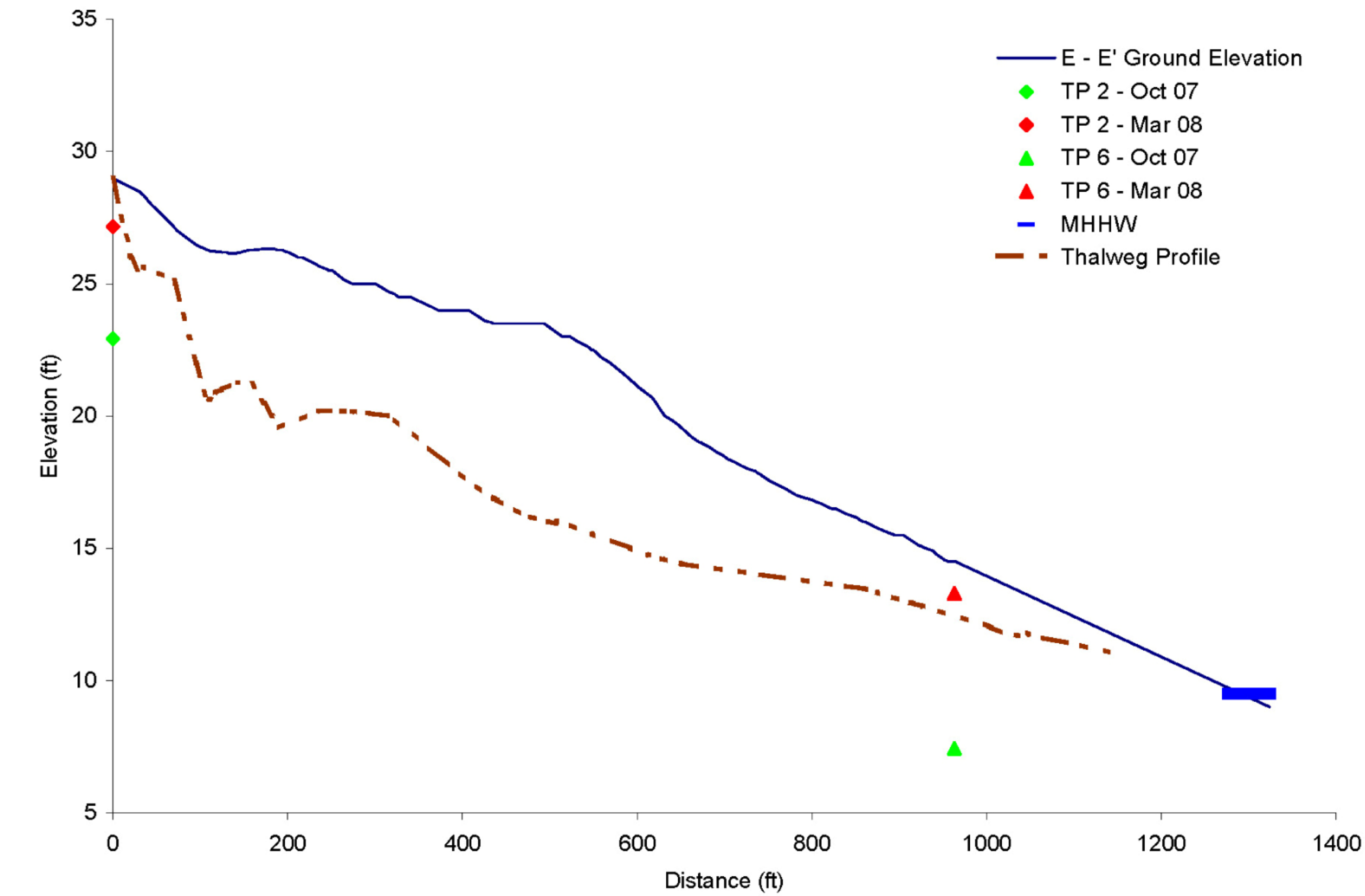
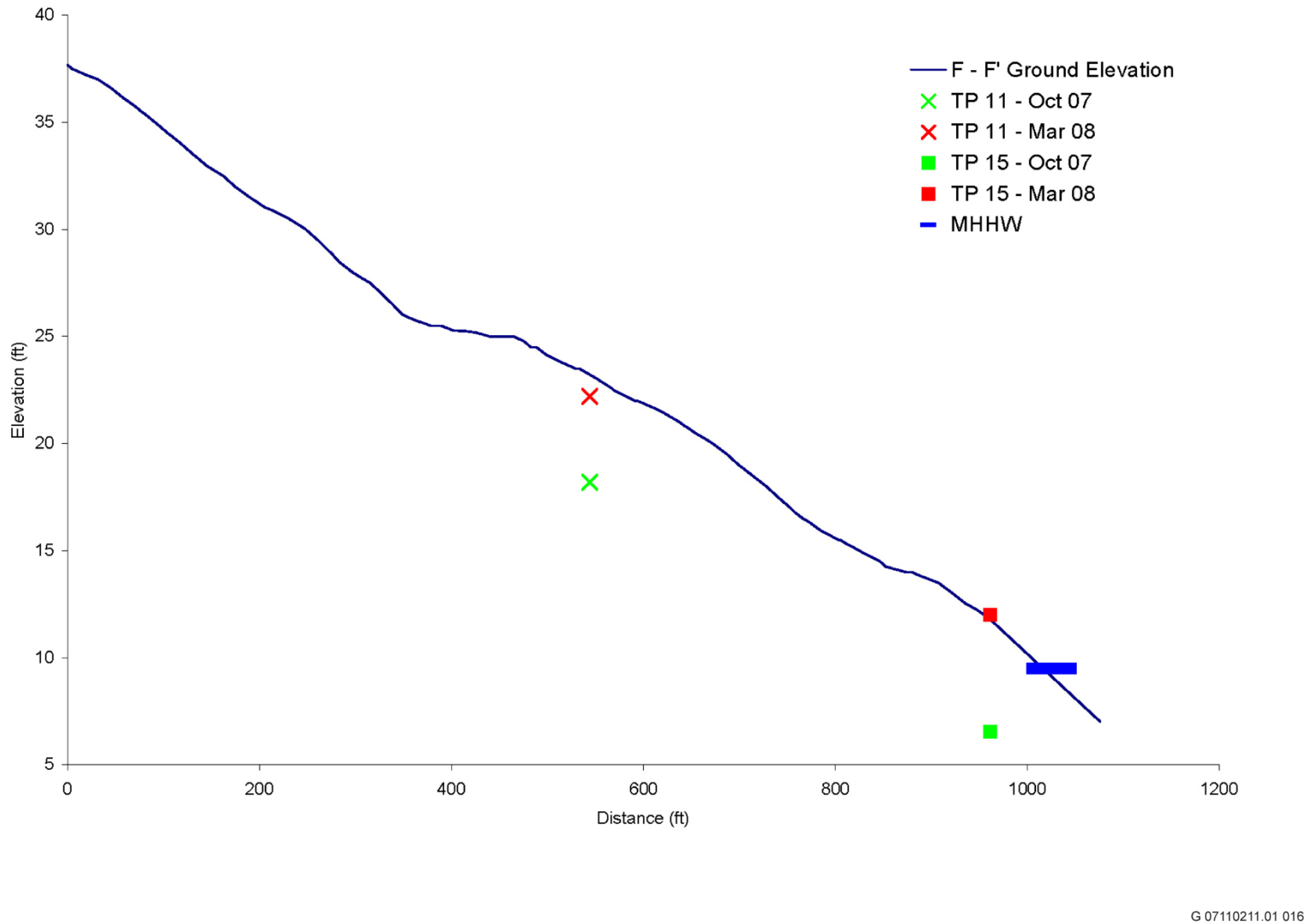


Exhibit 5-22

F – F' Groundwater Elevation

Exhibit 5-23

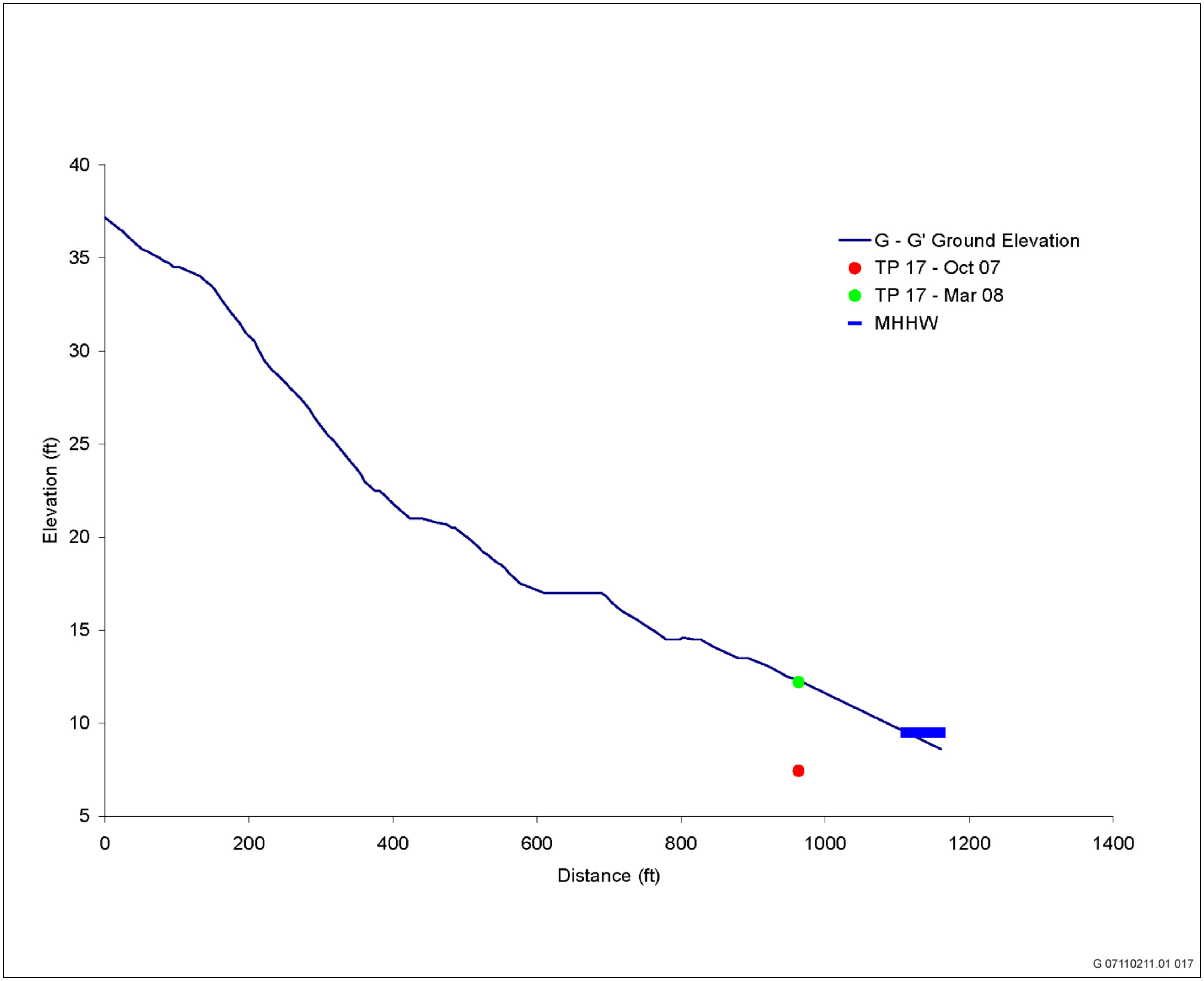
Source: Prepared by PWA in 2008



G – G' Groundwater Elevation

Exhibit 5-24

Source: Prepared by PWA in 2008



approximately 3 feet above the marsh surface for several months. During the drier months of the year, the tide range inside the managed marsh site is on the order of a few feet, fluctuating approximately 3 to 7 feet below mean higher high water (MHHW). Seasonal fluctuations in groundwater levels at the downstream/downslope end of the site are consistent with these seasonal fluctuations in surface water in the managed marsh (see cross section C-C' in Exhibit 5-20). Any actions to restore a full tidal regime and increase water levels in the marsh would likely also raise groundwater levels at the project site. This would likely result in synergistic beneficial effects for both physical processes and habitat within the marsh and Mitigation Site 1.

5.2.5 VEGETATION

The vegetation at Mitigation Site 1 has been modified by human land use and activities. Agricultural practices, including water diversion, tilling, grazing, and mowing, have altered vegetation patterns at Mitigation Site 1. The riparian vegetation associated with Crescent Harbor Creek was disturbed by the relocation of the stream channel to its current alignment. The incised channel has reduced the depth to readily available groundwater on the site, resulting in the establishment of wetland species suited to drier conditions. Dense stands of Nootka rose, snowberry, and Himalayan blackberry border the existing channel. Remnant stands of mature Scouler's willow, Pacific willow and black cottonwood (*Populus balsamifera*) are growing adjacent to the historic channel uphill of the Crescent dam; however, the site does not appear to support regeneration of these species under current topographic and hydrologic conditions. Lack of species diversity, and the density of vegetation associated with the existing and historic channel alignments, have resulted in poor habitat quality in this area. Current vegetation conditions present the opportunity to rehabilitate high quality wetland habitats associated with Crescent Harbor Creek, following restoration of the site's hydrology.

Efforts to drain the fields on the site have resulted in these areas being dominated by annual pasture grasses and species characteristic of transitional palustrine emergent habitats. The dominant species in the fields include redtop, sweet vernalgrass, common velvetgrass, and Kentucky bluegrass. In wetter areas, Baltic rush, scouring rush horsetail, Cusick's sedge, and Pacific rush are characteristic dominant species. An upland grass habitat located just east of gate B29 is dominated by redtop and sweet vernalgrass.

Areas adjacent to Mitigation Site 1 appear to have been unmanaged for a number of years, and exhibit a greater number of emergent wetland species, with dispersed stands of forested and scrub-shrub wetland species, such as twinberry, snowberry, Nootka rose, salmonberry, Scouler's willow, red osier dogwood, red alder, bigleaf maple, Indian plum, grand fir, Douglas fir, and Sitka spruce. Natural recruitment of red alder is highly likely. The EDAW project team observed snowberry and rose naturally spreading in unmowed areas. These species spread by runners and are likely to naturally recruit in forested and scrub-shrub wetland areas. The EDAW project team also observed red alder naturally recruiting into undisturbed areas at the southwest border of Mitigation Site 1.

It is likely that rehabilitation of the hydrology and cessation of mowing in the fields at Mitigation Site 1 would result in a gradual recolonization of the site by emergent, forested, and scrub-shrub, wetland species. Rehabilitation of the site would be accelerated by planting native species in accordance with the restored hydrology.

6.0 CONCEPTUAL MITIGATION PLAN

This conceptual mitigation plan was developed to demonstrate the potential for Mitigation Site 1 to satisfy the maximum anticipated compensatory mitigation requirements for the proposed project. Based on review of the Ecology, USACE Seattle District, and U.S. EPA, Region 10 Joint Guidance on *Wetland Mitigation in Washington State*, the type of mitigation being proposed at Mitigation Site 1 is considered to be "rehabilitation," as it would restore the functions and values of a degraded wetland. The wetlands that would be affected as a result of the proposed project are Category III wetlands (Navy 2008a). Based on the mitigation ratios for western Washington shown on Page 73, Table 1a of the *Wetland Mitigation in Washington State*, *Volume I*, rehabilitation requires a 4:1 mitigation ratio for all Category III wetland impacts. However, these mitigation ratios assume in-kind mitigation. Out-of-kind mitigation may increase requirements. Final mitigation ratios would be determined through discussions with the regulatory agencies (USACE and Ecology) during the final design and permitting phase of the proposed project.

A conservative mitigation ratio of 5:1 has been used to estimate mitigation acreage requirements in order to accommodate any potential increases in mitigation requirements that might arise as a result of changes in the proposed project prior to final design and implementation, which might increase wetland impacts. The maximum compensatory mitigation acreage requirement would likely be 33.8 acres under the current proposed project alternatives. However, Mitigation Site 1 has been designed to accommodate approximately 50 acres of compensatory wetland mitigation.

6.1 CONCEPTUAL SITE PLAN OVERVIEW

This conceptual mitigation site plan (site plan) offers early guidance that will support later development of draft and final mitigation plans pursuant to USACE and Ecology guidelines. The site plan describes recommended approaches for the use of Mitigation Site 1 for compensatory wetland mitigation. Development of the site plan is based on an understanding of Mitigation Site 1 resulting from the site evaluations and investigations discussed in Chapter 5, site visits, and the need for compensatory mitigation resulting from the proposed project. The site plan addresses two primary components: hydrology and vegetation. The site plan presents recommended strategies for both restoring the site's hydrology and revegetating the site with native species suitable for the restored hydrologic conditions.

Rehabilitation of wetland functions at Mitigation Site 1 would be achieved through implementation of the following objectives for the site, which are described in more detail in Section 6.3:

1. Restoration of the site hydrology through realignment and restoration of proper channel morphology of Crescent Harbor Creek as well as filling the existing channel.

2. Rehabilitation of wetland habitats through riparian corridor rehabilitation and rehabilitation/enhancement of existing low-quality, degraded wetland habitats beyond the riparian corridor.

3. Restoration of localized site hydrology through the filling of small artificial drainage channels to allow for rehabilitation of wetland habitats in lower topographic positions in the fields that are currently artificially drained.

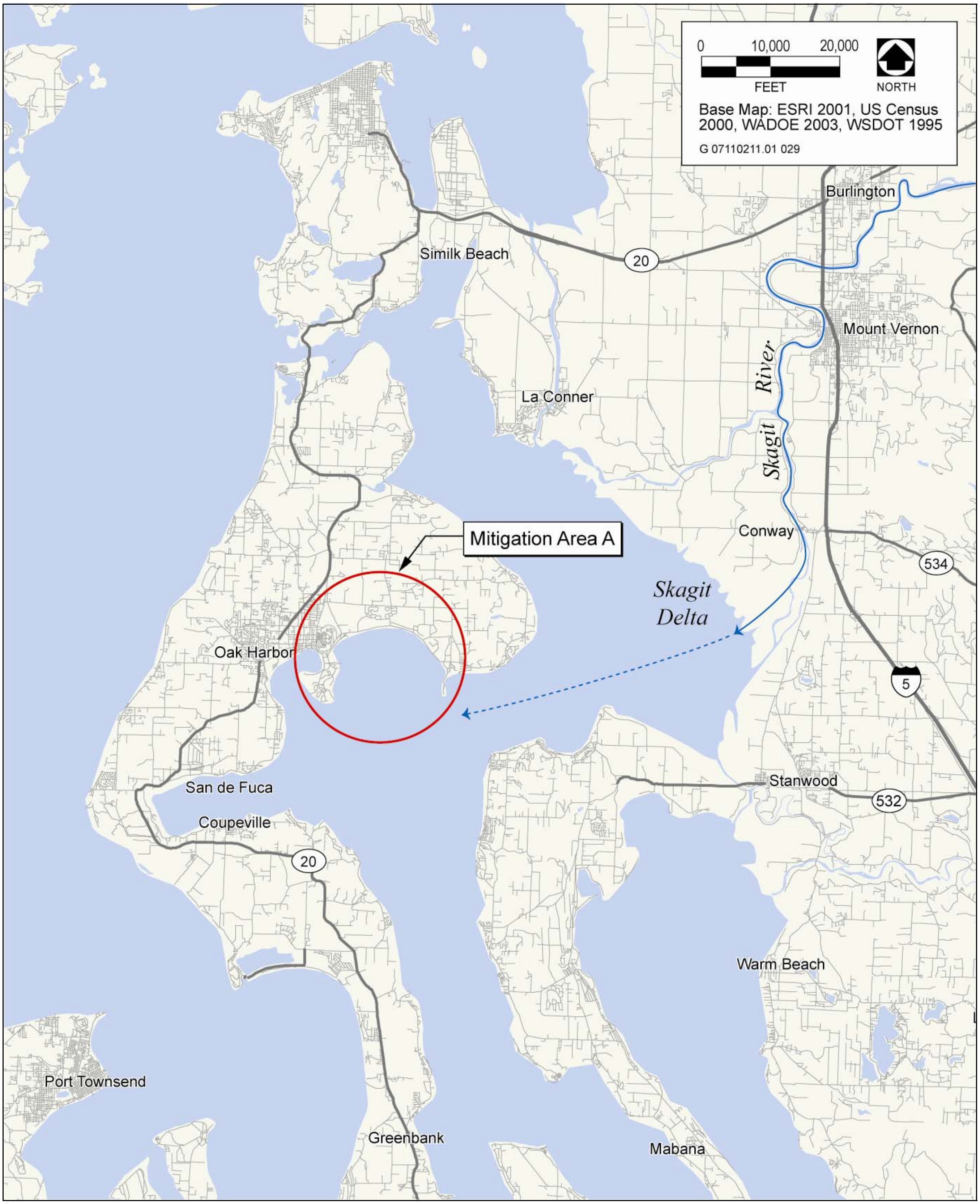
4. Rehabilitation of wetland habitats in lower and higher topographic positions in the fields that are currently artificially drained, through establishment of a range of native wetland plant communities according to restored hydrology, topography, and position in the landscape.

6.2 POSITION IN THE LANDSCAPE

At the regional scale, Mitigation Site 1 is situated at the downstream end of the Crescent Harbor Creek watershed, located in the northern portion of Whidbey Island, roughly west/southwest of the mouth of the Skagit River (Exhibit 6-1). The Skagit River watershed encompasses more than 3,100 square miles (8,030 square kilometers) and is one of the largest and last remaining strongholds of anadromous fish in the Puget Sound region. At the local scale, Mitigation Site 1 is located at the distal end of a shallow valley that drains to Crescent Harbor. The site is located immediately upstream of a salt marsh and is bisected by the most downstream reaches of Crescent Harbor Creek. The marsh is presently disconnected from the tidal action of Crescent Harbor by a shoreline dike, and the marsh morphology is altered by a waste water treatment facility and its appurtenant dikes and water control features. PWA conducted initial feasibility work related to restoration of tidal function in the marsh. See PWA (2003) for additional information on the existing conditions of the marsh and for feasibility-level plans that were prepared for restoration of the tidal marsh.

Because of conversion for agriculture and residential uses, pristine estuarine delta habitat on the Skagit System has shrunk by approximately 80% (Collins and Montgomery 2001). This reduction in habitat has prompted research to assess whether existing estuarine habitat conditions may be adversely influencing wild Skagit-origin chinook salmon populations, which have been shown to extensively use the delta for rearing (Beamer *et al.* 2003). During the last decade, research on habitat use of Skagit-origin juvenile Chinook salmon (Beamer *et al.* 2003) directed attention toward Skagit Bay nearshore habitats—including pocket estuaries (small sub-estuaries connected to Skagit Bay)—as a priority opportunity for habitat restoration.

Pocket estuaries are defined by Beamer *et al.* (2003) as "small sub-estuaries within the larger Skagit Bay estuary, that form behind spit or barrier beach landforms at submerged, tectonically or glacially derived valleys or at small creek deltas. They are typically tidal lagoons with fringing unvegetated flats, saltmarsh, and tidal channels. Compared to adjacent intertidal habitat in Skagit Bay, pocket estuaries: (1) reflect habitat types consistent with



Source: Prepared by EDAW and PWA in 2008

Position in the Landscape **Exhibit 6-1**

lower wave or long-shore current energy, and (2) have local freshwater inputs (surface or groundwater sources) where salinity is depressed during some part of the year (usually winter and spring).” Mitigation Site 1—and Crescent Harbor Creek as a source of fresh water—appear to be crucial elements in the sustainability of habitat in the downstream marsh.

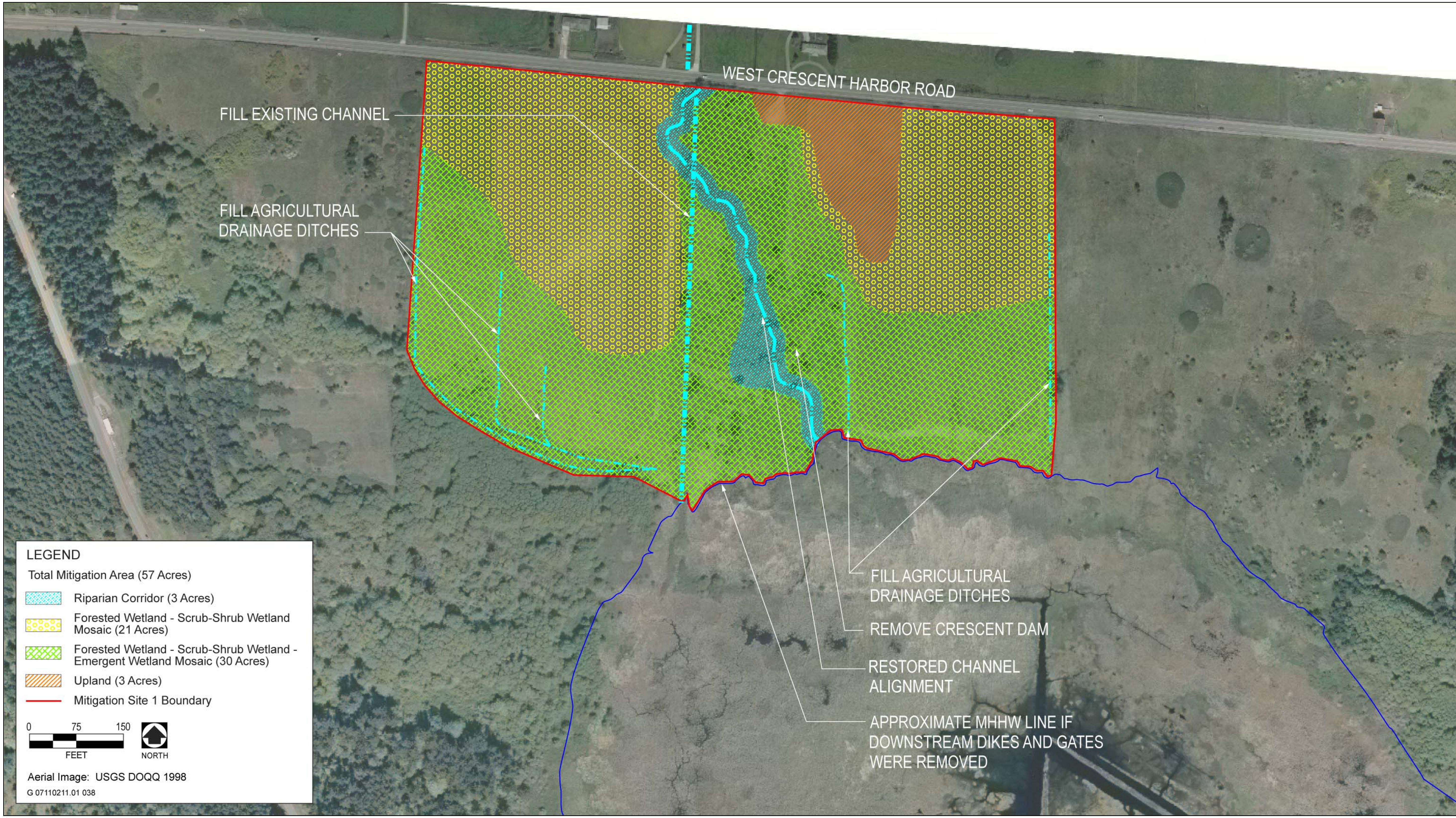
Research indicates that existing Skagit delta habitat conditions are likely limiting the capacity of delta-rearing Chinook (Beamer *et al.* 2003). Additionally, research (*ibid*) has shown:

- there appears to be a seasonal preference during the period from February through May when large numbers of fry migrant chinook utilize and appear to prefer pocket estuary habitat connected to Skagit Bay, compared to adjacent nearshore and offshore areas;
- pocket estuaries appear to offer a refuge from larger predatory fish for fry migrant Chinook, compared to the adjacent nearshore environment; and
- the shift in seasonal habitat occupancy also corresponds to fish size, which suggests that the fish within the pocket estuary may be a more isolated rearing (rather than migrating) population, or that pocket estuary habitat may be more productive than the more exposed nearshore environment.

The location of Mitigation Site 1 on the creek just upstream of a salt marsh that may soon be restored increases the potential of the conceptual restoration project to accrue environmental and societal benefits. These benefits include but are not limited to improving connectivity between Crescent Harbor Creek and the downstream salt marsh; increasing water quality in the creek and the downstream marsh; providing improved instream habitat; increasing the aesthetics of the site; and improving riparian and wetland habitats. These benefits are further described in Section 6.3.1 “Restored and Rehabilitated Functions.”

6.3 DESCRIPTION OF CONCEPTUAL SITE PLAN – CRESCENT HARBOR CREEK RESTORATION AND WETLAND HABITAT REHABILITATION

Mitigation Site 1 offers the opportunity for rehabilitation of part or all of the site. Successful rehabilitation of wetland habitats on the site requires the restoration of the site’s hydrology, which would be achieved by realigning Crescent Harbor Creek, filling the existing channel, and filling the small artificial drainage ditches. The resulting restored topography and hydrology would support the establishment of a diverse assemblage of wetland vegetation communities, including riparian wetland, forested wetland, scrub-shrub wetland, and emergent wetland (Exhibit 6-2).



Source: Prepared by EDAW in 2008

Mitigation Site 1: Conceptual Mitigation Plan **Exhibit 6-2**

Construction activities at Mitigation Site 1 site would involve excavation of the new stream channel and floodplain, placement of in-water features such as streambed gravel and large-woody debris, diversion of the stream to the new channel, filling the existing channel, removing Crescent dam, filling the small depressions and pond upstream of the dam, filling the small agricultural drainage ditches, and planting native species within the riparian corridor and associated wetlands.

CRESCENT HARBOR CREEK REALIGNMENT AND RIPARIAN CORRIDOR RESTORATION

The channel in which Crescent Harbor Creek currently flows will be filled along its entire length and a new channel will be constructed beginning just south of the culvert outlet at Crescent Harbor Road. The new channel alignment will be designed to follow the historic natural stream alignment as closely as possible, resulting in a shallower and more meandering configuration. The bed of the realigned channel will be higher in elevation than the existing, incised channel bed. The new, shallower channel will reestablish a more natural hydrologic connection between the creek, floodplain, and adjacent groundwater. The realigned stream channel will meet the existing downstream salt marsh at approximately the high tide water level. The channel design includes floodplain areas to reconnect the creek to a floodplain and associated wetlands. Exhibit 6-2 shows a 20 to 100-foot-wide riparian corridor within which the new creek alignment and associated floodplain would be located, contingent on further site investigations and final analysis of site data. Crescent dam would be removed and the spoils would be used to fill the isolated pond upstream of the dam. Data from the site investigations and technical studies described above were used to determine the preliminary channel gradient, alignment, dimensions, and other channel characteristics.

Design of the restored channel will include revegetation of the riparian corridor with site appropriate native species, and it will incorporate habitat features such as large woody debris (LWD), riffle-pool complexes, and off-channel wetland pools connected and filled during times of higher discharge (see the following paragraph).
The final planting plan along the proposed realigned channel and riparian corridor will be determined after final design of the channel is completed, and will be based on the water regime at different elevations along the realigned channel. It is anticipated that the proposed mitigation project will include the reestablishment of a forested wetland riparian corridor, with patches of scrub-shrub and emergent communities intermixed where appropriate. Existing high-value habitat features, such as large-diameter trees and any areas of high-quality wetland habitat, will be evaluated to determine whether they should be retained or relocated.

The existing hydrologically isolated pond, located west of the realigned channel and upslope from Crescent dam, will be partially filled and connected to the realigned channel as a potential high-discharge overflow area. The proposed reestablishment of a forested wetland riparian corridor along the realigned channel will include the area around the pond. Rehabilitation of this forested wetland area will entail removal of remnant piles of rock and soil left from excavation of the ponds; recontouring the area to enhance habitat quality; and establishment of site-appropriate native wetland species, especially along the shallow edges of the ponds. Rehabilitation of the vegetation in this area in association with the realigned channel will provide a seasonally inundated, near-channel habitat that would benefit, songbirds, and other wildlife through both improved habitat connectivity and improved foraging habitat.

To the northeast of Crescent dam is an artificial mosaic of low areas and sediment piles that are likely remnants of bulldozer work related to the construction of the dam and the pond. This area is drained on the northeast by an agricultural drainage ditch that is nearly 4 feet wide and up to 3 feet deep in places. Mitigation in this area will involve filling the ditch and incorporating this area into the realigned Crescent Harbor Creek riparian corridor and associated wetlands.

RESTORATION OF LOCALIZED SITE HYDROLOGY TO ALLOW FOR REHABILITATION OF ARTIFICIALLY DRAINED WETLAND HABITATS IN LOWER AND HIGHER TOPOGRAPHIC POSITIONS IN FIELDS

Several small agricultural drainage ditches located in the margins of the mowed fields on both the west and east sides of the proposed realigned Crescent Harbor Creek and riparian corridor will be modified to restore local site hydrology in lower topographic positions in the fields. These small ditches (approximately 1.5 feet wide by 0.75 to 1.0 feet deep) were likely constructed to drain surface and subsurface water on the site in order to use the land for agricultural purposes. Filling these ditches will reduce the drainage of shallow soilwater that currently occurs and will contribute to raised groundwater levels. It is proposed that these areas be allowed to recover for 2 years, during which the hydrology and natural vegetation recruitment can be evaluated and further rehabilitation activities can be determined. Rehabilitation of emergent, forested, and scrub-shrub wetland plant communities in these areas will involve monitoring hydrologic conditions and natural vegetation recruitment, and developing a planting plan to reestablish site-appropriate native plant communities. A recommended plant palette is presented in Section 6.3.4.

Forested and scrub-shrub wetland plant communities consisting of native plant species will be reestablished in those areas in higher topographic conditions in the unmanaged grass fields where site hydrology is drier. The recommended plant palette presented in Section 6.3.4 identifies a range of native species suitable for drier to wetter wetland areas. The final planting plan will be influenced by the supporting hydrology and microtopography of the site and will attempt to establish a mosaic of habitat types similar to the areas adjacent to the fields.

BUFFERS

Based on the Ecology, USACE Seattle District, and EPA, Region 10 Joint Guidance on *Wetland Mitigation in Washington State* (Ecology, et al. 2006), it is likely that Mitigation Site 1 will require at least a 110-foot buffer. This width is based on the buffer required to protect a Category II wetland exposed to a moderate level of impact from adjacent land uses. The actual width and acreage of buffer area will depend upon the final configuration of the mitigation site; however, Mitigation Site 1 has adequate space to incorporate buffers sufficient to protect the site from potential impacts.

A majority of Mitigation Site 1 is on former agricultural land. Assuming the existing land use remains the same when the wetland mitigation is implemented, the mitigation site will be surrounded primarily by degraded wetlands and other open space. Existing high-level impacts to water quality from farming activities upstream of the mitigation site will likely continue. However, any wetland buffers will be on Navy land and will not reduce these high-level impacts. Based on these factors, a moderate level of impacts from adjacent land uses was used to estimate the required buffer width. Final buffer widths will be determined through discussions with the regulatory agencies (USACE and Ecology) during the final design and permitting phase of the proposed project.

6.3.1 RESTORED AND REHABILITATED FUNCTIONS

The existing wetland on Mitigation Site 1 is Category III, with a low level of function for hydrology and water quality, and a moderate level of function for habitat (primarily due to size and connectivity). The proposed mitigation will significantly improve hydrology and water quality functions, in addition to improving habitat in both riverine and depressional wetland classes. The outcome will likely be a Category II wetland that will provide both improved local and landscape level functions. Target wetland functions were considered using the *Washington State Rating Form for Eastern and Western Washington* (Hruby 2004a, b) and *The Methods for Assessing Wetland Functions* (Hruby et al. 1999 and 2000). Target functions were assessed for anticipated effects on hydrology, water quality, and habitat.

HYDROLOGIC FUNCTIONS

Restoration of Crescent Harbor Creek will reestablish natural stream conditions and improve hydrologic conditions locally on the site as well as at a landscape level. The current creek channel moves water through the site quickly during and following storm events. The restored creek will have a vegetated, meandering channel with an associated floodplain, resulting in decreased flow velocity and peak flows, and longer water retention onsite. Stream flows will persist for longer durations following storm events and into the dry summer.
The increased hydroperiod will improve hydrologic connectivity between the freshwater stream and the downstream salt marsh. The restored stream will also decrease streambank erosion and sediment delivery into the salt marsh and estuary. Filling the small agricultural ditches and rehabilitation of wetland vegetation in the fields will improve retention of stormwater onsite and support a more diverse assemblage of wetland communities.

WATER QUALITY FUNCTIONS

Crescent Harbor Creek is a 303d listed waterway for fecal coliform and dissolved oxygen. As mentioned above, the restored creek will slow flow velocities and increase the hydroperiod on the site. The water quality in Crescent

Harbor Creek will be improved through increased nutrients and pollutant infiltration into the soil and uptake by vegetation, resulting in improved water quality in the downstream salt marsh and estuary.

HABITAT FUNCTIONS

Rehabilitation of riparian, emergent, forested, and scrub-shrub wetland vegetation communities will improve species richness, structural diversity, and habitat connectivity between adjacent wetland communities.
In combination with the restored stream channel, Mitigation Site 1 will have improved capacity to support a more diverse assemblage of wildlife, birds, amphibians, invertebrates, and fish. The improved hydrologic and water quality conditions in Crescent Harbor Creek will improve habitat conditions in the downstream salt marsh and estuary, which provide important rearing and foraging habitat for salmonids (as described in Section 6.2). The lower reaches of Crescent Harbor Creek will potentially become accessible to and provide rearing and foraging habitat for salmonids.

6.3.2 HYDROLOGIC REGIME

There are three main anthropogenic modifications that are inhibiting the functions of the natural hydrologic regime at Mitigation Site 1: the incised and realigned channel, the dam and pond, and the agricultural drainage ditches, as described in Section 5.2.4. Collectively, these modifications to the site drain surface and subsurface water and adversely affect the hydrologic regime of the site with respect to supporting wetland functions. A key initial phase in the rehabilitation of this site is disconnecting the existing anthropogenic drainage network. Disconnecting this drainage system will reduce drainage of soilwater, and it is hypothesized that this reduced drainage will ultimately increase groundwater levels. Additionally, realigning Crescent Harbor Creek into its historic alignment will raise the channel invert and reduce the hydraulic head differential that is hypothesized to be draining shallow groundwater. The restored creek will also have improved morphology and function, providing better habitat and increasing the creek's ability to improve water quality through natural biological and filtering functions. As noted in section 5.2.4, restoration of the downstream marsh (e.g., actions to increase surface water elevations in the marsh) would probably contribute to increased base-elevations for groundwater, improving hydrologic conditions on the site.

Recovery of the site's hydrologic regime is anticipated to occur over several years. This could take longer depending on normal variations in annual precipitation. Multiple years of hydrologic data collection are required to provide a more-precise estimate of how quickly the hydrologic regime of the site may recover, and insufficient information for this purpose has been collected at this time. Additional information from ongoing monitoring (see Section 6.5) and adaptive management (see Section 6.4) will support final designs, allow for reassessment of anticipated recovery timelines, and allow modification of restoration actions in response to new information.

The entire vegetation assemblage and evapotranspiration balance of the site is heavily altered from pre-Euro-American conditions. Therefore, response of the hydrologic regime may initially be slow, but should increase over time in response to a positive feedback with vegetation establishment (e.g., wetter conditions build organic material, which holds more water, which provides opportunities for increased vegetation, and improved habitat conditions).

6.3.3 GRADING

Mitigation project grading consists of filling the existing Crescent Harbor Creek channel, excavating the new channel alignment, removing the dam and pond, and disconnecting the agricultural drainage channels. The conceptual grading plan (Exhibit 6-3) provides a mostly balanced cut and fill scenario for the site. Approximately 310 cubic yards of excess material will be produced. Some portion of this material would be used to modify the existing agricultural drains, reducing the final amount of spoil. Final-design engineering may achieve a complete balance of material on site. Deposited materials in upland areas may increase topographic diversity at the site and provide a topographic buffer to the mitigation site. Any disposal of excess materials would avoid impacts to existing mature and high value vegetation.

Analysis and engineering design were completed at a conceptual level to establish the feasibility of the mitigation project. The analysis included one-dimensional hydraulic modeling to characterize a stable channel configuration, with low potential for erosion and deposition. Details of the analysis are contained in a report establishing the basis of design (PWA 2008b).

All volume and grade estimates in the conceptual restoration plan are approximate. These estimates would be refined during final design based on design-level surveys of topography and bathymetry. An overview of the mitigation project actions is provided in the following sections.

FILL EXISTING CREEK CHANNEL

The volume of the existing creek channel is approximately 2,330 cubic yards. Material from the adjacent berm will be used to fill this channel, with a minor deficit of approximately 300 cubic yards being covered from other excavations on site—most likely surplus material from excavation of the new channel at the upstream end of the site. Channel fill work will be completed in conjunction with degrading of the adjacent berm using the same equipment. Vegetation on the steep banks of the channel will be cleared and grubbed prior to placement of fill. Valuable native vegetation on the berm or channel banks will be salvaged for replanting along the realigned channel. The final design process will determine compaction specifications and the need for any soil amendments to inhibit preferential groundwater flow into and through the channel—either from general inflow along the entire length of the channel, or specifically from where the realigned channel will cross the existing channel. The final ground surface) will be contoured to blend in with the adjacent existing topography.

The berm along the east side of the existing channel (estimated to be approximately 2,030 cubic yards) will be degraded using heavy equipment (likely a 200- or 300-series excavator) and used to fill the adjacent channel. The final ground surface (Exhibits 6-4 and 6-5) will be contoured to blend in with the channel fill actions and the adjacent existing topography. It is anticipated that all existing vegetation on the berm will be cleared and native vegetation along the eastern toe of the berm will be preserved to the extent that it does not interfere with achieving the final design grade.

CONSTRUCT NEW CREEK CHANNEL TO CONNECT WITH EXISTING HISTORIC CHANNEL

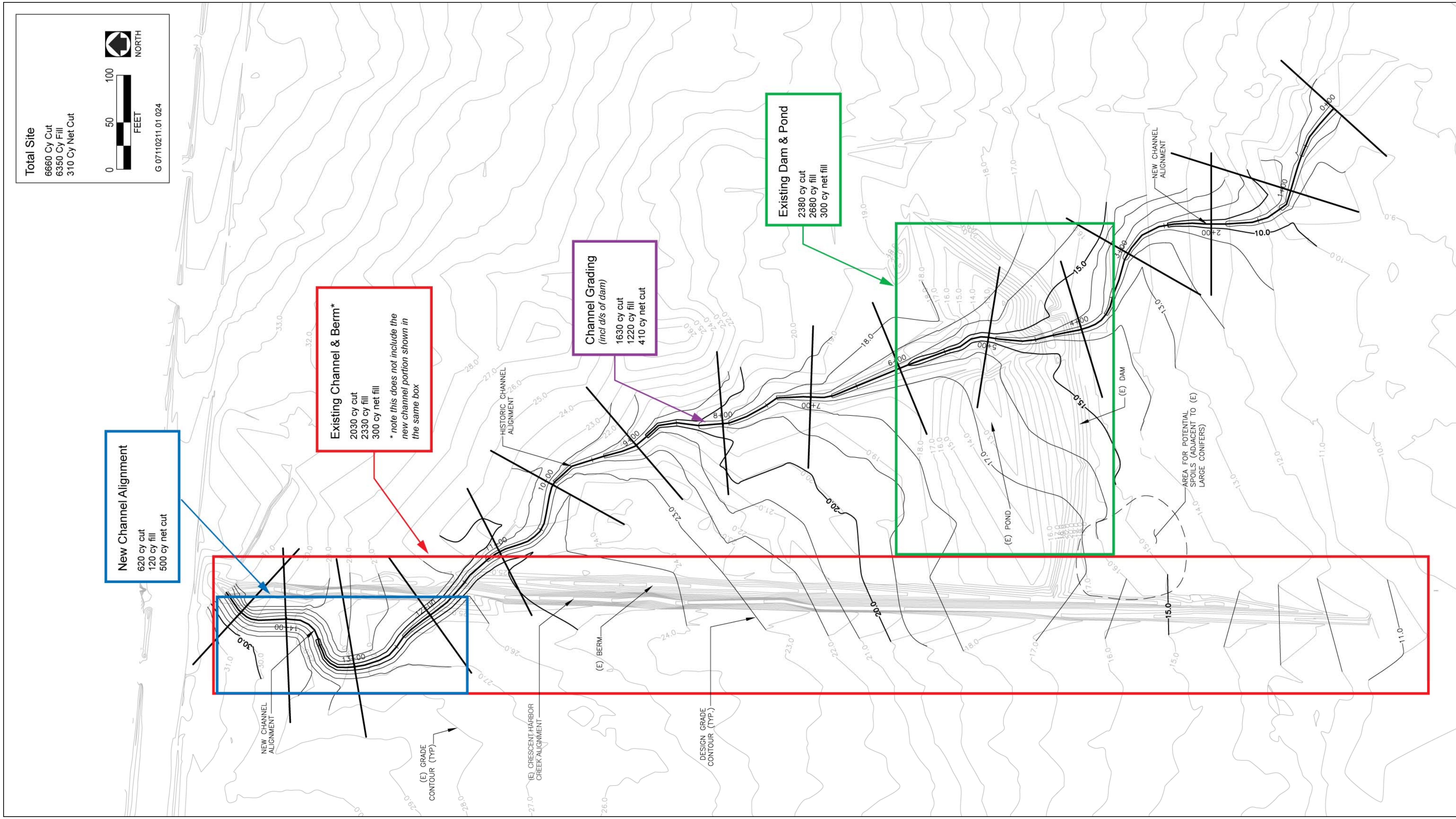
The existing segment of the historic channel presents a substantial restoration opportunity. With the creation of a new channel alignment from the culvert outfall at Crescent Harbor Road, the invert of the stream can be raised from its existing, incised alignment and be reconnected to the historic segment (Exhibits 6-4 and 6-5). In the reach currently occupied by the pond, dam, and leveled field downstream, a new channel will link the creek to the downstream marsh. With the exception of the most upstream section of channel, the combination of these actions will maintain the channel invert at an elevation no more than approximately 2.5 to 3 feet from the adjacent land surface. This will substantially decrease the amount of groundwater hydraulic head and is anticipated to assist in the recharge of groundwater levels at the site.

The restored channel will be comprised of three reaches. The upstream reach (from station 14+76 to approximately station 11+60 in Exhibit 6-4) will be an entirely new channel alignment. The middle reach (from approximately station 11+60 through station 6+00), will follow the historic alignment and require only minimal grading. The downstream reach (from station 6+00 to the marsh at station 0+00) will generally follow a former alignment suggested by historic aerial photographs, although it will require excavation of a shallow, new channel through this leveled field.

Approximate cut and fill volumes for the existing and realigned channel are illustrated in Exhibit 6-3. Despite the constraints imposed by the existing creek entering the site at a different location compared to its historic alignment, the planform characteristics of the conceptual channel design (Table 6-1) are similar to those of the historic channel (assessed through reconnaissance-level interpretation of channel alignments shown on the historic maps in Exhibits 5-9). It is important to note that although the restored channel in the middle reach (where the historic channel still exists) is shown as being less sinuous in the table, it is likely that assessment methods have introduced error, and in actuality the proposed and historic sinuosity values are very similar. The estimated historic sinuosity is based on less-accurate aerial photograph analysis, and in this undisturbed portion of the site it is unlikely that the topography has changed since the time of the photos. Thus, while we only have the historic photographs to assess historic sinuosity, we strongly suspect the proposed channel sinuosity is very similar to the historic analogue.

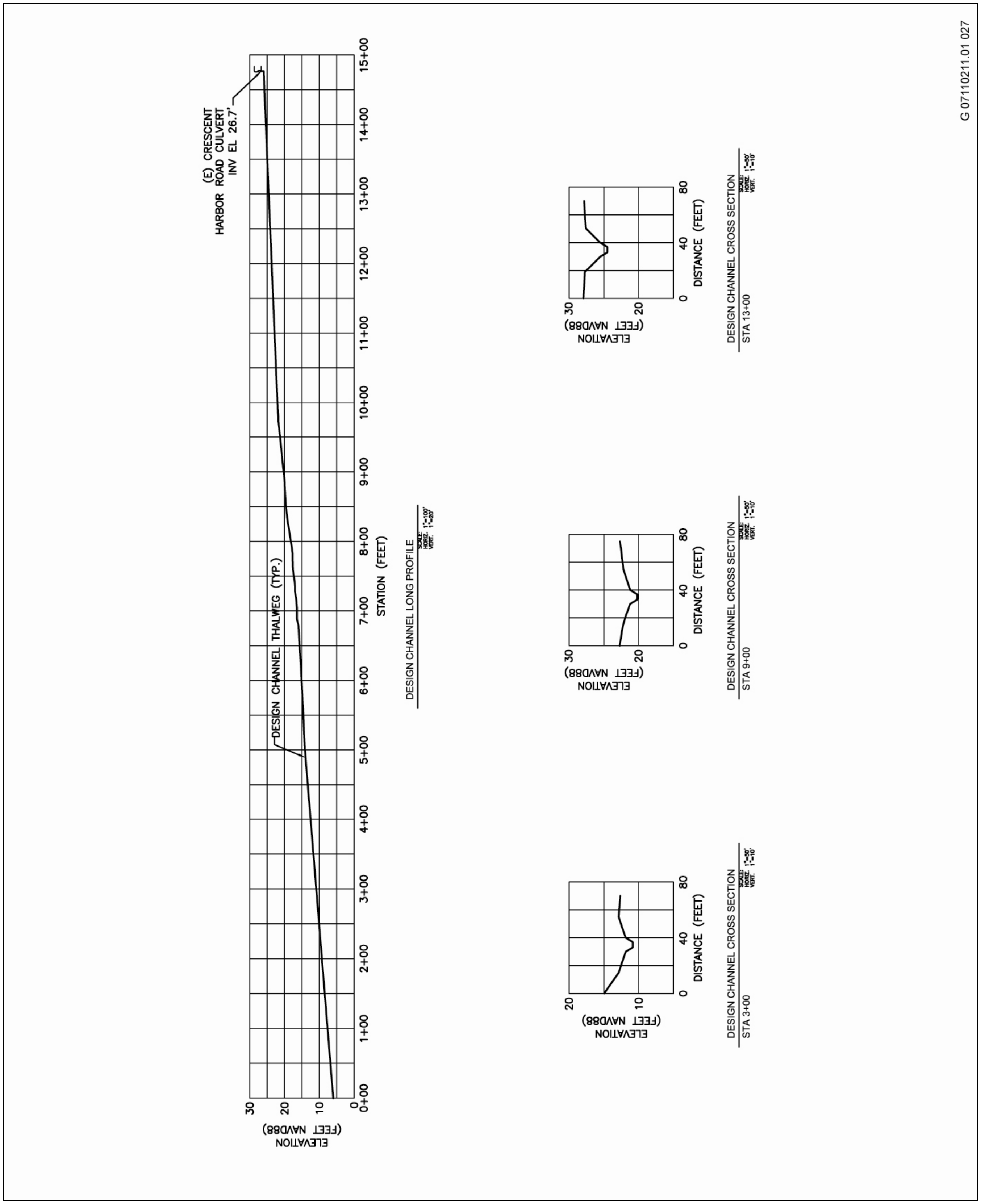
Source: Prepared PWA in 2008

Mitigation Site 1: Conceptual Realigned Crescent Harbor Creek Channel – Plan View **Exhibit 6-3**



Source: Prepared by PWA and EDAW in 2008

Mitigation Site 1: Grading Cut and Fill Summary **Exhibit 6-4**



Source: Prepared by PWA in 2008

Mitigation Site 1: Conceptual Realigned Crescent Harbor Creek Channel – Longitudinal and Cross Sections **Exhibit 6-5**

Table 6-1
Mitigation Site 1: Crescent Harbor Creek Channel Characteristics

Characteristic	Historic Channel	Design Channel
Avg Meander length (ft)	222	136.6
Avg Amplitude (ft)	48.8	24.0
Valley length (ft)	1956	1279
Valley slope	0.013	0.016
Channel length (ft)	2332	1476
Channel slope	0.011	0.014
Sinuosity	1.2	1.2

Source: Prepared by PWA in 2008

From the perspective of optimizing the channel morphology to maximize habitat and ecological processes, the upstream reach is the most challenging because of inherent design constraints. The historic channel alignment entered the site to the west of the existing culvert crossing under Crescent Harbor Road. In order to link the creek from the upstream edge of the project site, which is constrained by the existing location of the culvert crossing, with the closest part of the historic channel alignment (which is immediately east of the existing channel), a new channel must be cut through relatively-high ground to attain an alignment conducive to connecting to the historic channel. The resultant channel geometry is a compromise between excavating the large amounts of material necessary to achieve a configuration similar to the natural, wider, historic analogue cross section (shown in Exhibit 5-15) and the goal of maintaining as much geomorphic function as is feasible. Design refinement during final design may consider narrowing the channel bottom width and decreasing the slope of the banks; however, those modifications will increase cut volume. Given the approximately 300 cubic yard surplus of material that would result with the existing conceptual designs, any modifications to the current channel geometry must be balanced with other modifications to the conceptual mitigation plan.

The conceptual design of the middle and lower reaches of the restored channel (from approximately station 11+60 to station 0+00) incorporates the use of the existing, historic morphology to attain a wider, more-optimal channel geometry that requires less excavation. An important element to be refined during final design is the treatment of soils at approximately station 11+60, which is where the restored channel crosses the existing channel (to be filled). Design of the channel and floodplain in this area must eliminate diversion potential[9] and address the need for measures to reduce seepage of water from the bottom of the proposed channel into the fill of the existing channel.

[9] Diversion potential is a phrase used to describe topographic configurations where flow in a channel has the potential to divert down another alignment.

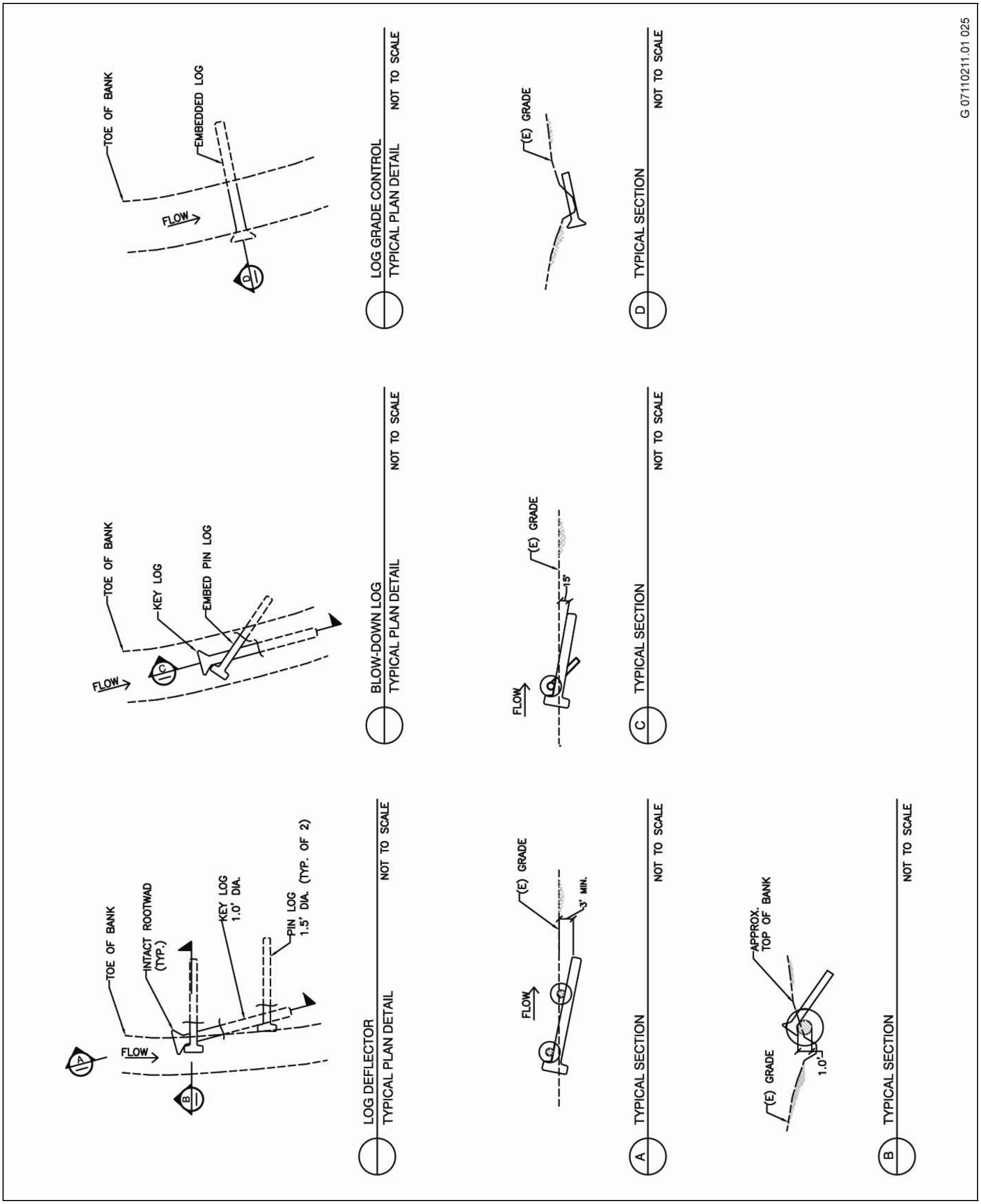
Final design of the channel will include integration of instream features to improve habitat. At this conceptual level of design, the hydraulic modeling that was used to configure the conceptual channel geometry assumed integration of large woody debris (LWD)—specifically 1-foot diameter logs partially embedded into the bed and banks of the channel at intervals of approximately 50 feet. These flow heterogeneity elements were conservatively modeled (i.e., with more channel ineffective flow area than might be found in actual installations) and were found to have relatively little increase (0.2 foot) on modeled 100-year flood water surface elevations. This indicates that final designs (which would also include hydraulic modeling to support designs and assess their likely hydraulic effects) could integrate more and/or larger LWD elements without any adverse effects on flood conveyance. Exhibit 6-6 depicts several typical LWD configurations that may be integrated into the final design to increase habitat value of the channel.

Degrade Existing Dam and Fill Pond

The dam and pond create unnaturally-high and -low topography (respectively) when compared to pre-disturbance conditions. If this topography is not modified, the pond and dam would inhibit reoccupation of Crescent Harbor Creek in its historical channel alignment. Degrading the dam and filling the pond will restructure the land surface in this portion of the site such that a new channel could be constructed to connect the historic channel segment upstream with the downstream marsh. The volume of the dam (2,380 cubic yards) is slightly less than the volume of the pond (2,680 cubic yards), resulting in the need to borrow approximately 310 cubic yards of material from other sources on site—probably from channel excavations downstream of the dam (see Exhibit 6-3 for summary of cut and fill volumes). While this element of the project is described separately from the creation of the new channel alignment, during actual construction the excavation of the dam and fill of the pond will be undertaken such that the channel through this portion of the site will be created as shown in Exhibit 6-4. All vegetation on the dam will be removed; however, it is anticipated that mature, native trees within the pond area could be preserved with careful placement of fill around their trunks. Adjacent to the existing junction of the dam and berm are several large coniferous trees that should be preserved. If material spoil is a necessary component of the mitigation project’s final design, the land area adjacent to these trees is proposed as a potential spoil location (see Exhibit 6-4).

Disconnect Agricultural Drainage Channels

The small agricultural drainage channels (shown in Exhibit 5-13) will be disconnected from the drainage network through relatively small topographic modifications. While the topography of these channels was not surveyed in detail, the total volume of these drains is estimated to be less than the small surplus of material anticipated from conceptual engineering of other mitigation project actions. Work for this element of the project will likely be completed using a small, mini-excavator and hand labor. The final ground surface will be revegetated (see Section 6.3.4) and is not anticipated to require any special erosion control measures.



Source: Prepared by PWA in 2008

Mitigation Site 1: Conceptual Realigned Crescent Harbor Creek Channel – Details **Exhibit 6-6**

Final Design Refinements

The final design process will integrate and account for issues beyond the scope of the current conceptual/feasibility design process. Items to be refined as the design progresses include:

- Development of a Stormwater Pollution Prevention Plan (SWPPP) and water diversion plan.
- Completion of a utility survey to confirm the absence of key infrastructure[10].
- Finalization of channel alignment based on detailed field mapping of vegetation to avoid any specimen trees or other key features.
- Completion of supplemental topographic and bathymetric surveys to better define the existing surface and better estimate excavation volumes. Specific areas include the existing dam, the area downstream of the dam, the connection of the historic channel to the marsh, and the banks of Crescent Harbor Creek at the Crescent Harbor Road culvert outlet.
- Refinement of excavation and fill volumes to account for soils lost due to clearing and grubbing, soil expansion during excavation, and soil compaction requirements during fill placement.
- Design and configuration of LWD structures, including development of criteria for sizing, placement and anchoring of structures.
- Detailed evaluation of soil material properties of the berm to determine its transmissivity when placed as fill into the incised, existing channel; and subsequent assessment of the need for a low- or non-permeable flow cutoff feature at the location where the design channel crosses the existing channel.

6.3.4 Vegetation

This section provides recommendations for enhancing native wetland vegetation following the rehabilitation of the mitigation site's hydrology. A detailed planting plan will be prepared during the final design phase.
The mitigation site includes four planting zones: riparian corridor; a mosaic of forested wetland and scrub-shrub wetland; a mosaic of forested wetland, scrub-shrub wetland and emergent wetland; and upland (Exhibit 6-7). These planting zones were determined based on current and anticipated rehabilitated hydrologic conditions, and observation of vegetation on adjacent unmanaged wetland areas. Within these planting zones, individual species will be selected from the recommended planting palette (Table 6-2) and located according to hydrologic, topographic, and soil conditions. Revegetation will be implemented in two phases. The first phase will revegetate

[10] Staff at NAS Whidbey Island confirmed the absence of utilities in this area of the project; however, a formal, in-the-field utility locate (i.e., Washington's "Call Before You Dig" 1-800-425-5555 Program) was not completed at this stage of design.

Table 6-2
Planting Palette

Scientific Name	Common Name	Wetland Indicator Status	Notes
Emergent Wetland			
Juncus balticus	Baltic rush	OBL	Common in open seepage areas. One of few species mixed in with lower-lying transitional emergent wetlands that are typically dominated by introduced pasture species.
Juncus effusus	Pacific rush	FACW	Common in open wetter emergent wetlands and seepage areas surrounded by drier transitional wetlands that are typically dominated by introduced pasture species.
Carex cusickii	Cusick's sedge	FACW	One of few native species in dominant emergent drier transitional wetlands that are typically dominated by introduced pasture species.
Carex praegracilis	clustered field sedge	FACW	One of few native species in dominant emergent drier transitional wetlands that are typically dominated by introduced pasture species.
Scirpus acutus	hardstem bulrush	FACW	Common in seasonally to permanently flooded areas.
Scirpus maritimus	Pacific bulrush	FACW	Common in seasonally to permanently flooded areas, but only in estuarine, saltwater influenced areas.
Scrub-Shrub Wetland			
Cornus sericeus	red osier dogwood	FACW	Common but abundant only in lowest, wettest scrub-shrub wetlands.
Lonicera involucrata	twinberry	FAC	Common but not particularly abundant.
Symphoricarpos albus	snowberry	FACU	Technically this species is not a "wetland" plant, but it is a common transitional species.
Spiraea douglasii	hardhack	FACW	A native wetland species considered by many ecologists to be a weedy species (can form dense thickets).
Rosa nutkana	Nootka rose	FAC+	Forms dense thickets. A strong associate of snowberry.
Rubus spectablis	salmonberry	FAC+	Common, widespread and locally abundant.
Salix sitchensis	Sitka willow	FACW	Occurs infrequently in wetter transition areas.
Salix hookeriana	Hooker's willow	FACW	Common. Best suited for marshy, ponded areas.
Forested Wetlands			
Salix scouleriana	Scouler's willow	FAC	Most common and abundant willow in mixed and deciduous forested wetlands.
Alnus rubra	red alder	FAC	More common and abundant in mixed forested wetlands than in deciduous forested wetlands.
Salix lucida ssp. *lasiandra*	Pacific willow	FACW+	Common willow around ponded areas and co-dominant with Scouler's willow in deciduous forested wetlands.
Upland Forest			
Alnus rubra	red alder	FAC	More common in mixed forested wetlands than in deciduous forested wetlands.
Picea sitchensis	Sitka spruce	FAC	Typically mixed in upland forest but sometimes in transitional forested wetlands.
Abies grandis	grand fir	FACU	Typically mixed in forested wetland and upland forests.
Acer macrophyllum	bigleaf maple	FACU	Common in upland forests.
Pseudotsuga menziesii	Douglas fir	FACU	Most common and abundant conifer species in upland forests.
Salix scouleriana	Scouler's willow	FAC	Most common and abundant willow in mixed and deciduous forested wetlands.

Source: Prepared by EDAW in 2008
Plant species wetland indicator status is a rating that indicates the probability that a particular plant species will occur in a wetland. Indicator status categories are defined as follows (Reed 1988):
Obligate (OBL) – almost always occurs in wetlands (>99% probability of occurring in wetlands);
Facultative Wetland (FACW) – usually occurs in wetlands (67-99% probability of occurrence in wetlands);
Facultative (FAC) – equally likely to occur in wetlands or non-wetlands (34-66% of occurrence in wetlands);
Facultative Upland (FACU) – usually occurs in non-wetlands, but occasionally occurs in wetlands (1–33% of occurrence in wetlands);
Obligate Upland (UPL) – almost never occurs in wetlands (1% probability of occurrence in wetlands); and
No Indicator (NI) – no status assigned because information is lacking.
A positive (+) or negative (-) sign in the regional plant indicator status list is used to define the regional frequency of occurrence in wetlands. The positive sign indicates that a facultative plant is more frequently found in wetlands (FAC+), and a negative sign indicates that a facultative plant is less frequently found in wetlands (FAC-).

areas disturbed by channel restoration activities and the filling of the agricultural drainage ditches. First phase planting will be conducted in the fall, immediately following the completion of grading activities. The second phase will enhance vegetation over the entire Mitigation Site 1. The second phase planting will be conducted in the fall, 3 years after the completion of hydrologic rehabilitation activities. The second phase planting plan will be based on 2½ years of hydrologic monitoring and vegetation monitoring to assess the hydrologic response and natural recruitment at the mitigation site following rehabilitation of the site's hydrology.

PLANTING ZONES

Riparian Corridor. This planting zone consists of the realigned channel, channel banks, and associated floodplain (including off-channel depressions). The width of the riparian corridor will vary from 20 to 100 feet. It is anticipated that the restored hydrology in the riparian corridor will support wetland species tolerant of seasonal inundation. Vegetation in this zone will include a mixture of forested wetland, scrub-shrub wetland, and emergent wetland species. Primary species will include Baltic rush, Pacific rush, red osier dogwood, Nootka rose, salmonberry, red alder, and Scouler's willow.

Forested Wetland /Scrub-shrub Wetland Mosaic. This planting zone consists of the higher topographic areas on the mitigation site. It is anticipated that this planting zone will receive a minor improvement in hydrologic conditions as a result of the rehabilitation of the mitigation site's hydrology; therefore, it will support wetland species tolerant of extended dry periods. Vegetation in this zone will include a mixture of forested wetland and scrub-shrub wetland species. Primary species will include Nootka rose, twinberry, snowberry, Scouler's willow, Sitka spruce, grand fir, and Douglas fir.

Forested Wetland /Scrub-shrub Wetland /Emergent Wetland Mosaic. This planting zone consists of the lower topographic areas on the mitigation site. It is anticipated that this planting zone will receive a significant improvement in hydrologic conditions as a result of the rehabilitation of the mitigation site's hydrology; therefore, it will support wetland species tolerant of extended wet periods. Vegetation in this zone will include a mixture of forested wetland, scrub-shrub wetland, and emergent wetland species. Primary species will include Baltic rush, clustered field sedge, Nootka rose, salmonberry, Sitka willow, Scouler's willow, and red alder.

Upland. This planting zone consists of the highest topographic areas on the mitigation site. It is anticipated that this planting zone will not be affected by the rehabilitation of the mitigation site's hydrology and will support species tolerant of dry conditions. Vegetation in this zone will include a mixture of facultative upland forest and scrub-shrub species. Primary species will include Nootka rose, grand fir, bigleaf maple, and Douglas fir.

IRRIGATION

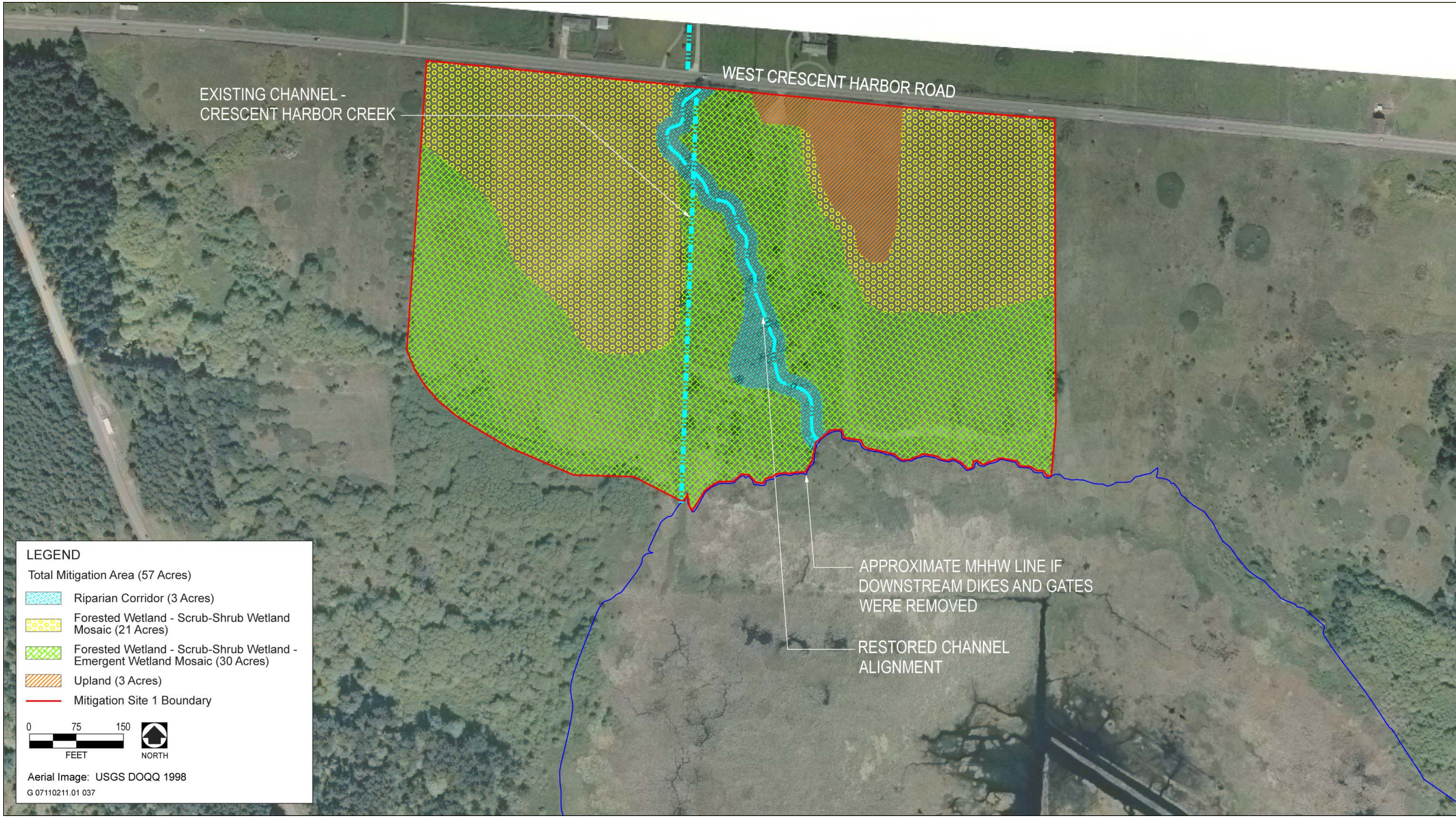
As described in Section 5.2.3 “Climate,” Whidbey Island is in the rainshadow of the Olympic Mountains. Most of the precipitation at the mitigation site occurs from October through May, and long dry summers are typical. A soil moisture deficit generally occurs in July and August (Dinicola 1990), necessitating the need for supplemental irrigation during the vegetation establishment period (i.e., 2–5 years). An irrigation plan will be developed during final design phase, and will include identification of a water source, irrigation system type (e.g., drip, flood, sprinkler), irrigation system layout/design, watering time and frequency, and irrigation system maintenance and monitoring plan.

INVASIVE PLANT MANAGEMENT

An invasive plant management plan will be developed during the final design phase. The plan will detail the protocol for monitoring and managing nonnative invasive plants during and following project implementation. There are two nonnative invasive plant species that are of primary concern at the mitigation site: Himalayan blackberry and Reed canary grass. Both species are highly competitive and can negatively impact native vegetation if left unmanaged. Grading associated with the restoration of Crescent Harbor Creek provides the opportunity to remove existing Himalayan blackberry and Reed canary grass at the mitigation site. Individual Himalayan blackberry plants not destroyed by the grading activities will be manually removed. Reed canary grass not destroyed by the grading activities will be cut (or can be burned) prior to mitigation planting and during the vegetation establishment period (i.e., until native vegetation can shade out the Reed canary grass). The mitigation site will be monitored following mitigation planting, and nonnative invasive plants will be managed according to the invasive plant management plan. Annual pasture grasses are expected to persist at the mitigation site, but their abundance is expected to decline as the hydrologic conditions on the site change and native wetland vegetation becomes established.

6.4 MONITORING

Monitoring the mitigation project after planting is required by the permitting agencies and is a valuable tool for evaluating the success of the mitigation project and making adjustments if needed. A monitoring plan will be developed as part of the final mitigation plan according to agency guidelines (Ecology, et al. 2006). The monitoring plan will include methods, duration, and frequency for data collection and reporting. The goals, objectives, and performance standards developed as part of the final mitigation plan will provide the basis for measuring project success and permit compliance. Monitoring the hydrologic and vegetation conditions will contribute to refinements in site management and will be critical to the success of the mitigation project. Monitoring will be conducted for a minimum of 5 years; however, the establishment of forested wetland species may require monitoring for up to 10 years.



Source: Prepared by EDAW in 2008

Mitigation Site 1: Conceptual Planting Zones **Exhibit 6-7**

As discussed in Section 6.3.4 “Vegetation,” monitoring the project’s effect on hydrologic conditions on the site will be critical for the development of the second phase planting plan. The initial 2½ years of hydrologic monitoring data will be analyzed and used to refine planting zones for the second phase planting plan. Additionally, data on natural vegetation recruitment on the site and the success of the first phase planting will contribute to refinements of the second phase planting plan.

6.5 ADAPTIVE MANAGEMENT

It will be important to employ an adaptive management strategy during the implementation, maintenance, and monitoring of the mitigation project. The final mitigation plan will be developed using the best information available; however, unforeseen circumstances may arise during project implementation that will require design modifications or changes to the final mitigation plan. Project monitoring will provide information that can be used to refine site maintenance activities or reveal the need for additional monitoring. Adaptive management decisions will be made in discussion with the appropriate agencies.

7.0 MITIGATION BANKING

The final design and permitting for the proposed project will determine the required amount of mitigation. Developing Mitigation Site 1 as a mitigation bank would provide the flexibility for the site to accommodate additional wetland impacts resulting from changes to the proposed project. If all of the acreage on Mitigation Site 1 is not needed to meet the requirements for the proposed project, it could be used to meet wetland mitigation requirements for future projects occurring on NAS Whidbey Island.

7.1 WHAT IS MITIGATION BANKING?

Wetland mitigation banks typically involve the consolidation of many small wetland mitigation projects into a larger, potentially more ecologically valuable site. Bank projects are implemented prior to allowing unavoidable impacts by a project, and credits are generated by this up-front activity. The mitigation bank credits can then be used by the bank sponsor for unavoidable impacts to wetlands by a project or projects, or sold to another party to offset impacts to wetlands that occur in other locations. Avoidance and minimization of wetland impacts by a project is still required prior to using credits from a mitigation bank, and the bank sponsor is required to monitor and maintain the site to ensure continued success after construction is complete.

7.2 REGULATORY ENVIRONMENT

The U.S. Environmental Protection Agency (EPA) and USACE issued a new Wetlands Compensatory Mitigation Rule on March 31, 2008 (40 CFR Part 30: Compensatory Mitigation for Losses of Aquatic Resources; Final Rule). The new rule identifies mitigation bank credits and the most preferred option for compensatory wetland mitigation, since they are usually in place before an activity impacting wetlands is permitted.

Washington State passed a Wetland Mitigation Banking law (Chapter 90.84.RCW) in 1998 supporting the establishment of mitigation banks, and giving Ecology regulatory authority to adopt rules for the certification, operation, and monitoring of wetland mitigation banks. Ecology, in collaboration with local, state, and federal agencies, and non-governmental interests, has developed a draft rule (WAC 173-700) focusing on the process of implementing wetland mitigations banks and the procedures for certifying banks, and anticipates adopting a final rule in 2009. Mitigation banks certified under the draft rule must be consistent with existing federal, state, and local laws and rules, and bank proponents must obtain any applicable permits or approvals.

Under both the federal guidance on mitigation banks and the state's draft rule, wetland bank proposals are reviewed, evaluated, and negotiated by an interagency team called the Mitigation Bank Review Team (MBRT). The MBRT works with applicants to develop a mitigation bank instrument, which outlines the terms and conditions of bank approval or certification, and to oversee the establishment, use, and operation of the bank.

7.3 BENEFITS

7.3.1 ECONOMIC

Wetland mitigation banks provide an economic incentive for restoring, creating, enhancing and/or preserving wetlands. Entities having many projects that affect wetlands, or that have large or ongoing wetland impacts, may create wetland mitigation banks rather than mitigating in a piecemeal fashion. The use of wetland mitigation bank credits to compensate for unavoidable wetland impacts by a project may simplify the permit process, since compensatory mitigation is already constructed and functioning.

7.3.2 ECOLOGICAL

Wetland mitigation banks ensure a greater likelihood of success for compensatory wetland mitigation, since bank projects are implemented up front. They provide the potential to consolidate piecemeal mitigation projects into one contiguous, unified ecosystem, ensuring greater diversity of habitat and function, and creating a more sustainable system.

8.0 POTENTIAL FUNDING MECHANISMS

If the proposed project does not require wetland mitigation, the Navy may want to restore Crescent Harbor Creek and rehabilitate wetlands at Mitigation Site 1 as a natural resources project. A number of federal, state and local governmental programs provide assistance for restoration of aquatic habitats, including riparian and wetland habitats. The nature of riparian and palustrine wetland habitat restoration and rehabilitation opportunities at Crescent Harbor could make a restoration project eligible for a variety of governmental assistance programs. Grant programs might include those that focus on:

- watershed restoration;
- aquatic lands restoration;
- creek restoration;
- resident and anadromous fish habitat restoration;
- fish passage restoration;
- estuarine and nearshore habitat restoration;
- wetlands restoration; and
- water quality.

8.1 GRANT PROGRAMS

8.1.1 THE PUGET SOUND NEARSHORE PARTNERSHIP

The Puget Sound Nearshore Partnership is a large-scale initiative to identify and implement habitat restoration needs in Washington State's Puget Sound basin. Nearshore Project goals are to identify significant ecosystem problems, evaluate potential solutions, and restore and preserve critical nearshore habitat. The Puget Sound Nearshore Partnership represents a partnership of the USACE; state, local, and federal government organizations; tribes; industries; and environmental organizations.

ESTUARY AND SALMON RESTORATION PROGRAM (ESRP)

In the 2007–09 biennial budget, the Legislature appropriated 13 million dollars to Washington Department of Fish and Wildlife (as the local sponsor) to fund additional nearshore restoration and protection projects through a competitive award process. To be eligible to apply for ESRP grant funds, a project must first be included in the Nearshore Project Database. The Nearshore Project Database is a catalog of potential nearshore projects within the Puget Sound region.

8.1.2 WASHINGTON RECREATION AND CONSERVATION FUNDING BOARDS

The State of Washington Recreation and Conservation Funding Boards administer a variety of grants, some of which might apply to restoration activities at Crescent Harbor. Provided below is a list of such potentially applicable grants.

THE AQUATIC LANDS ENHANCEMENT ACCOUNT (ALEA) GRANT PROGRAM

The Aquatic Lands Enhancement Account (ALEA) Grant Program provides grant-in-aid support for the purchase, improvement, or protection of aquatic lands for public purposes, and for providing and improving access to such lands. It is guided by concepts originally developed by the Washington Department of Natural Resources, including reestablishment of naturally self-sustaining ecological functions related to aquatic lands, providing or restoring public access to the water, and increasing public awareness of aquatic lands as a finite natural resource and irreplaceable public heritage. All divisions of local or state government, including Native American Tribes, are eligible to apply if legally authorized to acquire and develop public open space, habitat, or recreation facilities. Federal agencies, nonprofit organizations, and private entities are not eligible, but are encouraged to seek a partnership with an eligible entity in order to pursue the public benefits the ALEA Grant Program supports. ALEA Grant Program funds may be used for the acquisition (purchase), restoration, or improvement of aquatic lands for public purposes, and for providing and improving public access to aquatic lands and associated waters. All projects must be consistent with the local shoreline master program and must be located on lands adjoining a water body that meets the definition of “navigable.” Projects intended primarily to protect or restore salmonid habitat must be consistent with the appropriate lead entity strategy or regional salmon recovery plan.

THE WASHINGTON WILDLIFE AND RECREATION PROGRAM (WWRP)

The Washington Wildlife and Recreation Program (WWRP) provides funding for parks, water access sites, trails, wildlife habitat, and farmland preservation. Eligible grant recipients are: municipal subdivisions (cities; towns; counties; port districts; park and recreation districts; and school districts), tribal governments, and state agencies. Local and tribal governments must provide at least 50 percent matching funds in either cash or in-kind contributions.

8.1.3 SALMON RECOVERY GRANT PROGRAM

The Salmon Recovery Grant Program provides funding for the protection and restoration of salmon habitat. The program also supports feasibility assessments for future projects and other activities. Eligible Grant Recipients are municipal subdivisions (cities, towns, counties, and special districts such as port, park and recreation, conservation, and school), tribal governments, private landowners, State agencies, and nonprofit organizations. Applicants must provide at least 15 percent matching funds in either cash or in-kind contributions.

8.1.4 U.S. Fish and Wildlife Service National Fish Passage Program

The U.S. Fish and Wildlife Service's National Fish Passage Program provides funding and technical assistance toward removing or bypassing barriers to fish movement. A fish passage project can be any activity that directly improves the ability of fish or other aquatic species to move by reconnecting habitat that has been fragmented by barriers. Fish passage project proposals may be initiated by any individual, organization, or agency, in cooperation with the Service's Fish and Wildlife Management Assistance Offices. By August of each year, project proposals must be provided to the local Fish and Wildlife Management Assistance Office for submission to an internal database. Projects will be reviewed and prioritized on a Regional basis. Funding is administered through the Fish and Wildlife Service office that is coordinating the project with partners. The Program has flexibility from project to project but strives to achieve a 50% match, including in-kind contributions.

8.1.5 NOAA Community-based Restoration Program

Through the Community-based Restoration Program, NOAA awards millions of dollars to national and regional partners and local grassroots organizations every year. Under a competitive process, projects are selected for funding based on technical merit, level of community involvement, cost-effectiveness, and ecological benefit. Individual project grants allow groups to apply directly to NOAA for funds to support habitat restoration, marine debris removal, and river restoration projects to remove dams and other barriers. Proposals are due in the fall of each year. Awards range from $30,000 to more than $500,000.

9.0 REGULATORY ISSUES

Implementation of a wetland mitigation plan at Mitigation Site 1 would require permits and authorizations from state and federal agencies. The following environmental regulations would likely be triggered by implementation of a wetland mitigation plan at Mitigation Site 1, and should be considered during the draft and final mitigation planning phases.

9.1 SECTION 404 OF THE CLEAN WATER ACT

The Regulatory Branch of USACE evaluates applications for permits for work in waters of the United States. [33 CFR Parts 320 through 330; 40 CFR Part 230]. The USACE regulatory program is based on its authorities pursuant to the Rivers and Harbors Act of 1899; the Federal Water Pollution Control Act, as amended (Clean Water Act [CWA]); and the Marine Protection, Research, and Sanctuaries Act of 1972 (Ocean Dumping Act). At the conclusion of the evaluation process, USACE decides to either issue or deny the permit for the proposed work. The Federal Clean Water Act (Section 404) regulates filling of wetlands. USACE administers the permitting program for this law. A Department of the Army permit, issued by USACE is required for certain activities in, over, under or near waters of the United States or special aquatic sites, including wetlands. Section 404 of the Clean Water Act requires approval prior to discharging dredged or fill material into the waters of the United States, including special aquatic sites such as wetlands.

The proposed compensatory wetland mitigation involves work in waters of the United States, including Crescent Harbor Creek and adjacent wetlands. The existing channelized creek channel would be filled and the creek realigned. Creek restoration and related wetland mitigation activities would involve temporary impacts to wetlands. These activities would require a USACE permit.

A nationwide permit is a form of general permit which authorizes a category of activities throughout the nation. These permits are valid only if the conditions applicable to the permits are met. If the conditions cannot be met, a regional or individual permit will be required. It is anticipated that activities required to complete the proposed compensatory wetland mitigation would be authorized by USACE' NWP 27 for Aquatic Habitat Restoration, Establishment, and Enhancement Activities. This NWP can be used to authorize compensatory mitigation projects, including mitigation banks and in-lieu fee programs.

9.2 SECTION 401 OF THE CLEAN WATER ACT

Section 401 of the Clean Water Act requires that activities permitted under Section 404 meet state water quality standards. Ecology is designated by statute as the state agency responsible for issuing this water quality certification in Washington, and the agency is required to review and certify that proposed projects meet state standards. The Federal permit is not valid unless it has been certified by Ecology. This certification is required on all USACE General Permits as well as all Individual Permits.

State 401 Certification. An individual 401 review is required for projects or activities authorized under NWP 27 if the project or activity involves fill in tidal waters, or the project or activity has impacts to wetlands.
The proposed compensatory mitigation would involve temporary impacts to existing wetlands and would therefore require State 401 Certification.

9.3 SHORELINE MANAGEMENT ACT (SMA)

The Shoreline Management Act (SMA) was enacted in 1971 and regulates only a portion of the wetlands in the state. The SMA regulates only wetlands within 200 feet of shoreline water bodies, and wetlands “associated” with these water bodies. The proposed mitigation project is located within 200 feet of the salt marsh associated with Crescent Harbor, and would therefore be under jurisdiction of the SMA.

9.4 COASTAL ZONE MANAGEMENT ACT (CZM) CONSISTENCY RESPONSE

NAS Whidbey Island is located within the state of Washington’s coastal zone. The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. 1451 et seq., as amended) encourages states to develop management plans for coastal zones in order to protect natural resources and shoreline-related commercial land uses of the nation’s shorelines. Section 307 of the CZMA stipulates that where a federal project initiates reasonably foreseeable effects on any coastal use or resource (land or water use or natural resource), the action must be consistent to the “maximum extent practicable with the enforceable policies of approved State management programs” (16 U.S.C. 1456 19 (c)(1)(A)).

The state of Washington developed and implemented a federally approved Coastal Management Program describing current coastal legislation and enforceable policies. The Washington Coastal Zone Management Program provides management of the coastal zone within the 15 counties containing the state’s coastal resources. It is implemented by the Washington State Department of Ecology through the Shorelands and Environmental Assistance Program. Under the program, activities that impact any land use, water use, or natural resource of the coastal zone must comply with six laws, or “enforceable policies.” These include the Shoreline Management Act (SMA); the State Environmental Policy Act (SEPA); the Clean Air Act (CAA), the CWA; the Energy Facility Site Evaluation Council (EFSEC), and the Ocean Resource Management Act (ORMA).

Federal lands such as NAS Whidbey Island, which are “lands the use of which is by law subject solely to the discretion of the Federal Government, its officers, or agency,” are statutorily excluded from the CZMA’s definition of the “coastal zone” (16 U.S.C. Section 1453(1)). If, however, the proposed federal activity affects coastal uses or resources beyond the boundaries of the federal property (i.e., has spillover effects), the CZMA Section 307 federal consistency requirement applies.

The proposed compensatory mitigation site is located within the State of Washington's coastal zone. For those projects within SMA jurisdiction, compliance with Shoreline Management Act provisions is sufficient to meet CZMA consistency requirements. When a project is outside of SMA jurisdiction but still within the coastal zone, Ecology must issue a separate notice of consistency.

Where individual 401 review is triggered, an individual CZM Consistency Response must be obtained for projects located within the 15 coastal counties. A "Certification of Consistency" form must be submitted in accordance with State General Condition 3 (Notification).

9.5 ENDANGERED SPECIES ACTS (ESA)

USACE (Section 404) permit decision is considered a federal action that must comply with the Endangered Species Act (ESA). The ESA is administered by NMFS and USFWS. NMFS has ESA jurisdiction over salmon, other marine fish, marine mammals, and marine reptiles. USFWS has ESA jurisdiction over birds, terrestrial animals, plants, amphibians, and most freshwater fish. Under Section 7 of the ESA, the Seattle District Corps must consult with the NMFS and the USFWS on its permit program on any permit application for proposed work which may affect threatened or endangered species, or their designated critical habitat.

Under the USACE federal permit program, permit applications must be reviewed for the potential impact on threatened and endangered species pursuant to Section 7 of the ESA. USACE, through informal and formal consultation procedures with the NMFS and USFWS, must evaluate information on the presence of listed species (including timing and life stages), habitat for such species and their prey sources, and other parameters.
The information required for ESA evaluation must be prepared in the form of a Biological Assessment (BA), which is used to assess project impacts to listed and/or proposed species and designated and/or proposed critical habitat. If USACE determines that work proposed in the permit application would have no effect on all threatened or endangered species, no further consultation with NMFS and USFWS is required. USACE has developed guidelines for "no effect" situations, for both freshwater and marine environments. If USACE determines that the work proposed in a permit application may affect any threatened or endangered species, some type of consultation with NMFS and USFWS will be required, and the consultation will be either informal or formal.

Informal Consultation. If the effects of the proposed work on listed species would be beneficial, or the potential adverse impacts are insignificant and discountable, then USACE determines that the project may affect, but is not likely to adversely affect the species or critical habitat. USACE would then forward the BA to NMFS and USFWS (based on the affected species) and request that they concur with the "not likely to adversely affect" determination. Once concurrence is granted, the consultation process ends. If NMFS or USFWS finds that the project will have significant adverse effects on listed species or critical habitat and cannot concur with the “not likely to adversely affect” determination, a formal consultation commences.

Formal Consultation. If the proposed work may have more than insignificant and discountable adverse impacts to listed species or critical habitat, then USACE determines that the project may affect, or is likely to adversely affect the species or critical habitat. USACE then refers the BA to NMFS and USFWS (based on the affected species) to initiate formal consultation. NMFS and USFWS prepare a biological opinion (BO) that documents whether the project will jeopardize the continued existence of the species, or destroy or adversely modify critical habitat. If the BO finds that the project will jeopardize the species, then USACE will generally deny the permit. Projects that will not jeopardize the species must comply with the terms and conditions of the BO. Formal consultation ends with receipt of the BO.

9.6 NATIONAL HISTORIC PRESERVATION ACT

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of their actions, including actions they permit, fund, or license, on properties that may be listed on or eligible for listing on the National Register of Historic Places (NRHP). To determine if an undertaking could affect NRHP-listed or eligible properties, all cultural resources within the APE that could be affected are inventoried and evaluated for eligibility to the NRHP. Those that are eligible for inclusion in the NRHP are considered “historic properties” under Section 106.

The significance of cultural resources relative to the criteria for listing on the NRHP (36 Code of Federal Regulations [CFR] 60.4) is essential to determining whether the proposed undertaking would adversely affect an historic property. Public agencies are encouraged to avoid significant effects to historic properties, and to avoid potentially adverse effects, when possible. When avoidance is not feasible, the lead federal agency is expected to identify measures to reduce or otherwise resolve adverse effects in consultation with the State Historic Preservation Officer (SHPO), the Advisory Council on Historic Preservation (ACHP), and/or other interested parties prior to approving the proposed undertaking.

ASSESSING RESOURCE SIGNIFICANCE UNDER SECTION 106

Determining the NRHP eligibility of cultural resources requiring discretionary federal action is guided by the specific legal context of the site’s significance as set out in Section 106 of the NHPA (16 United States Code [USC] 470), as amended. Section 106 authorizes the Secretary of the Interior to expand and maintain a National Register of districts, sites, buildings, structures and objects of significance in American history, architecture, archaeology, engineering and culture. A property may be listed in the NRHP if it meets criteria defined in 36 CFR 60.4:

The quality of significance in American history, architecture, archaeology, engineering and culture is present in districts, sites, buildings, structures and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and that which:

a) are associated with events that have made a significant contribution to the broad patterns of our history; or

b) are associated with the lives of persons significant in our past; or

c) embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess a artistic value, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d) have yielded, or may be likely to yield, information important in prehistory or history.

Most prehistoric archaeological sites are evaluated with regard to criterion "d" of the NRHP which refers to site data potential. Such sites typically lack historical documentation that might otherwise adequately describe their important characteristics. Archaeological methods and techniques are applied to gain an understanding of the types of information that might be recovered from the deposits. Data sought are those recognized to be applicable to scientific research questions or to other cultural values. For example, shellfish remains from an archaeological deposit can provide information about the nature of prehistoric peoples' diet, foraging range, exploited environments, environmental conditions and seasons during which various shellfish species were taken. These are data of importance to scientific research that can lead to the reconstruction of prehistoric ways of life. Some archaeological sites may be of traditional or spiritual significance to contemporary Native Americans or other groups, particularly those sites which are known to contain human burials.

Site integrity is also a consideration for the NRHP eligibility of an archaeological locale, and is generally assessed with regard to location, setting design, workmanship, feeling, and association. These may be compromised to some extent by cultural and post-depositional factors (e.g., highway construction, erosion, bioturbation, etc.), yet the resource may still retain its integrity for satisfying Criterion d if the important information residing in the site survives. Conversely, archaeological materials such as shell may not be present in sufficient quantity or may not have adequate preservation for accurate identification. Thus, their potential as data to address important research questions is significantly reduced. Assessment of these qualities is particularly important for archaeological properties where the spatial relationships of artifacts and features are necessary to determine the patterns of past human behavior.

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APPENDIX A

Geologic Unit Descriptions Corresponding to Exhibit 5-10 Geologic Map

APPENDIX A
GEOLOGIC UNIT DESCRIPTIONS CORRESPONDING TO EXHIBIT 5-10 GEOLOGIC MAP
SOURCE: (DRAGOVICH, ET AL., 2005)

$Qgdm_{ed}$ – **Glaciomarine drift.** Clast-rich diamicton with abundant dropstones (unit Qgdmed, >5% dropstones) and mud with few or no dropstones (unit Qgdmec, <5% dropstones); locally contains very thin to very thick interbeds of shallow marine sand and (or) gravel outwash; locally has desiccation joints or cracks. Glaciomarine drift is generally brown and stiff when dry, and grayish blue and soft when moist or wet. Diamicton unit consists of silty sandy gravelly clay to clayey gravel and is typically massive or forms several-meters-thick, structureless or crudely stratified beds with varied gravel dropstone content. Mud unit is structureless, varved, or laminated. Marine shell 14C ages reported include 12,300 ±180 yr B.P. (14C site 24, Easterbrook, 1969) and 13,595 ±145 and 13,650 ±350 yr B.P. (14C sites 25 and 26, Dethier and others, 1995). (Easterbrook, 1966; Dragovich and others, 1998, 1999, 2000c, 2002c, unpub. data; Dethier and others, 1995)

$Qgos_e$ **Glaciomarine sand deposits.** Sand, pebbly sand, and silty fine sand with local thin interbeds of silt and rare cobbly sand; mostly structureless to locally plane bedded, laminated, or rarely cross-bedded; locally complexly interlayered with glaciomarine drift; includes minor glaciofluvial deposits. Facies relations, including fining trends, and sedimentary structures suggest deposition in a shallow glaciomarine setting as foreshore deposits or submarine fan turbidites. (Johnson and others, 2001, 2004; Domack, 1982; Dethier and others, 1995)

Qgt_v **Till**—Dark yellowish brown to bluish gray diamicton consisting of clay, silt, sand, and gravel in various proportions, with scattered pebbles, cobbles, and boulders and local thin to thick lenses of sand, gravel, or rarely silt; structureless and nonstratified; commonly has a friable (shear) fabric and a silty sand matrix; locally contains subglacial ice-shear structures, such as aligned, striated clasts and shearfolded sand and gravel interbeds (critical site 11). Till mantles topography and rests uncomfortably on a wide variety of older deposits. Mantling is well displayed where till descends from the uplands to below sea level (critical site 11). Bedrock glacial striae, ice-shear structures, and fluted till shapes indicate a late WSW ice-shear direction formed in zone a few miles wide behind the retreating ice margin. This direction strongly overprints the regional north–south fluting trend observed along the axis of the Puget Lowland and may be the result of a late ice surge toward the ice-free Juan de Fuca glaciomarine embayment. Regional 14C dates indicate lodgment till deposition in the study area between about 15,200 and 13,600 14C yr B.P. (Booth and Hallet, 1993; Dragovich and others, 2000c, 2002d; WDOE, 1979; Porter and Swanson, 1998; Pessl and others, 1989)

Qp **Peat (Holocene).** Fibrous to woody peat and organic sediments of fresh-water bogs and swamps; occurs in kettles and other depressions, including depressions possibly formed by active faulting; poorly stratified to unstratified. From limited data, peat and saltwater marsh deposits (unit Qm) are distinguished on the basis of saltwater versus fresh-water plant species content (for example, tree stumps). Williams and Hutchinson (2000) note that Swantown Marsh peats were deposited in a low-salinity marsh near high tide limits. They report 14C ages of 1,330 ±50, 1,630 ±50 (14C site 19-20), 1,970 ±50, and 2,010 ±50 yr B.P. (14C site 21-22) from marine-microfossil-bearing “sand sheets” in the peats, which they interpret as tsunami deposits. Near Rocky Point, Johnson and others (2001) obtained a 14C age of 1,750 ±50 from a tree branch in a woody peat exposed at very low tide (14C site 23). Considering the terrestrial nature of this peat deposit, we interpret the current marine setting as evidence for local late Holocene down-dropping of the beach south of Strawberry Point fault no. 1.

Qm **Saltwater marsh deposits (Holocene).** Organic-rich silt and mud, commonly with lenses and layers of peat at or above highest high tide, covered with salttolerant vegetation. Saltwater marsh, nearshore (unit Qn), and beach deposits (unit Qb) in active fault zones may have been uplifted to their present elevations. (Pessl and others, 1989; WDOE, 1979)