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# memorandum

date July 8, 2015

to Kurt Nelson, Tulalip Tribes

from Steve Winter

subject Qwuloolt Estuary Restoration Site
As-Constructed analysis City Review Draft

This memorandum documents our observations of the current state of the internal portions of the Qwuloolt Estuary Restoration Site and actions that we recommend prior to breaching the existing levee. The internal portion of the site has been prepared for restoration in a number of phases from 2007 to the present. ESA has provided designs for construction that detailed specific features including channel excavation, ditch fills, and wave attenuation berms. The primary construction set referenced here is the August 2012 construction set which was largely implemented in 2012, 2013, and 2014. This memorandum was reviewed by Bob Battalio, PE and Ryan Bartelheimer, PE, both of ESA.

The purposes of this memorandum are to summarize our observations of the constructed (as of April 2015) features, compare our observations to the construction plan set, and recommend additional actions that are important to complete prior to breaching the levee.

Please note that these recommendations are only focused on overall site drainage including channels and ditch fills, and wave attenuation berms. There are several other project elements that are not addressed here that we will continue to coordinate with you to address.

## Data

For this analysis, we relied primarily upon the following data sources, provided by others, to document the post-construction conditions:

1. Various surveys provided by Downing Surveyors. These included as-built surveys of the Allen/Jones channel work, and some tributary channel excavations.
2. A 2014 aerial provided by the tribe that shows many of the constructed elements.
3. A recent (likely 2014) aerial on Bing Maps that has the clearest view of constructed elements. During preparation a newer (May 2015) photo was added to Google Earth.
4. A sketch of constructed elements provided by the Tulalip Tribes.

ESA was not onsite during construction, so our own observations are based on post-construction conditions as seen in April 2015. Our observations included a survey of particular points of interest as described here:

1. RTK GPS points, primarily on the wave attenuation berms, by Steve Winter on March 25 and 26, 2015. These points were collected with a rented survey grade GPS, and provide elevations that are likely accurate to within 0.1 feet, based on comparison to available survey control[1].

## Observations

Our review of the site indicates that many of the features included in the restoration design are in place and consistent with the design intent. There are, however, a number of elements that have not been constructed or have been constructed in ways that deviate from our design. Our observations of the differences between as-built and designed conditions are summarized in Figure 1. To provide more detail, the construction drawings were similarly marked up and are included as Attachment 1 to this memorandum. The extent of wave attenuation berm construction is less than shown in the construction plans. Additional investment of time and materials are necessary to provide the necessary protections from wave action.

### *Drainage and Channel System*

The overall goal for drainage from the site is to allow full tidal inundation of the site via a new breach location near the middle of the site. Drainage needs to convey both Allen and Jones Creeks to this new outlet, meaning that the lower portion of existing Jones Creek will become the lower reach of Allen Creek and flow 'backward' compared to the current condition. The remainder of drainage from the site is intended to be captured in smaller tributary channels and conveyed to the main creek channels. These tributary channels are intended to help establish more natural drainage patterns, facilitate tidal flux throughout the site, provide some habitats below elevation 4 feet, replace the linear ditch system, and provide site drainage: The increased site drainage is expected to facilitate vegetation establishment directly, and also by reducing the wave climate that tends to disturb pioneer vegetation establishment.

Currently, both creeks have been moved into their new meandering alignments. Many tributary channels have been excavated and appear to connect into appropriate drainage points around the perimeter of the site. Figure 1 depicts the layout of the excavated channels based on our observations and recent aerial photographs. We do not have detailed survey to show the actual as-built plan-form or cross-sections at this time.

Allen Creek flows through a relict portion of its former channel. Currently vegetation and beaver activity result in ponding within the relict channel and upstream of it. Post-breach, we expect that the additional tidal flux through this area will scour out the vegetation, which will result in the intended full tidal exchange.

Key observations:

1. Not all ditches have been filled on the site, apparently because the ditches required more fill material than anticipated, which also affected the availability of material for berms. At this point, it is likely that

[1] Surveying Practice: ESA performs land surveys and collects hydrographic data to augment traditional surveying services for the purposes of geomorphic interpretation, monitoring of project performance, and other specific uses consistent with Geologic and Landscape Surveys as defined in the Policy on Incidental Surveying Practice (Washington Board of Registration for Professional Engineers and Land Surveyors, Board Journal). ESA does not provide traditional land survey services such as property boundaries and maps for general use by others. ESA recommends that these traditional surveying services be accomplished by a licensed, professional land surveyor either under direct contract with the client or as a sub-consultant to ESA.

at least some of the linear drainage network will be active post-breach, particularly near the edges of the site. These ditches appear to be connected to the overall site channel network, so should avoid stagnant water for most of their length.

2. Minor revisions were noted compared to the proposed drainage network, apparently to better connect into the perimeter ditches that were left intact.

3. There are a number of closed depressions within the fields that are likely to pond water during low tide. Ponding deeper water in portions of the site may also allow for greater channel development; one of the goals of the project.

### *Wave Attenuation Berms*

Wave attenuation berms were included in the design to reduce the potential for wave runup and erosion around the perimeter of the site, particularly where built assets exist. These berms are also intended to allow for faster vegetation establishment and encourage sediment deposition and faster aggradation of the overall subsided site. Vegetation establishment on the berms is important to limit wave erosion and help these features persist over time, as well as providing ecological and aesthetic benefits.

After the breach is complete, most high tides will inundate the entire site for several hours each day. Depths over the typically site grade will be up to about 5 feet from the lower site elevations (4 feet NAVD 88) to MHHW (9.2 ft NAVD 88). The distance from the Ebey Slough levee to the northern perimeter is over 3,500 feet in many places, and the Corps analysis determined that waves can re-generate within the site when strong winds are from the south. Our design included two types of wave attenuation berms : (1) a wetland berm built to a top elevation around Mean Higher High Water (MHHW) at 9.2 ft NAVD 88 along channel edges, and (2) a riparian berm, built to around 11.2 feet NAVD 88 along the project perimeter and some channel edges, which would be planted with native shrubs.

A total of 10 riparian berms were built of the 17 planned and 4 of the 12 wetland berms were fully constructed. Of the constructed berms four were shorter than designed and three were longer than designed, one wetland berm was built to the dimensions of a riparian berm, and one wetland berm was added at a new location (other than designed). The Tribe assessed the construction as follows: The amount of constructed berm length was based on material availability, site conditions, and changes to project area and plans. These revisions were adopted by the Tribe without revision of the construction documents by the engineer-in-charge.

**TABLE 1. WAVE ATTENUATION BERM SUMMARY TABLE. BERM STATUS DETERMINED BY ESA BASED ON TWO DAY SITE REVIEW AND SURVEY AND AUGMENTED WITH OBSERVATIONS PROVIDED BY TULALIP TRIBES BERM NUMBERS BASED ON SHEET 3 FROM THE FINAL PLANS**

| Berm (W/R) | Built (Y/N)? | Notes |
|---|---|---|
| 1 w | Y | Designed as wetland berm, built as riparian berm and extended |
| 2 R | Y | Modified with gap to allow local drainage |
| 3 R | Y | Modified to avoid overlap with setback levee, shorter length provided |
| 4R | Y | |
| 5R | N | Not built as designed due to site conditions |
| 6R | N | |
| 7R | Y | |
| 8R | N | Not built to allow drainage |
| 9R | N | Site conditions too wet to access |
| 10R | N | Site conditions too wet to access |
| 11R | Y | Partial construction |
| 12W | N | Some sidecast materials placed in 2009 |
| 13W | N | Not built earlier because of distance to material sources |

| | | |
|---|---|---|
| 14W | N | Not built earlier because of distance to material sources |
| 15R | N | On City's Advance Mitigation Site |
| 16R | Y | Extended |
| 17R | Y | Extended |
| 18R | N | Not built, neighboring berm extended, channel present |
| 19R | Y | |
| 20R | Y | |
| 21W | Y | Shape modified to allow drainage - built as two berms |
| 22W | N | Some material sidecast when channel built; below design height |
| 23W | N | Not build |
| 24W | N | Some material sidecast when channel built; below design height |
| 25W | N | |
| 26W | N | New berm built south of tributary channel |
| 27W | Y | Partially built |
| 28W | Y | Partially built |
| 29W | Y | Partially built |

The ESA survey indicates that the crest elevations of the constructed berms are below the designed elevations, typically by 0.5 to 1.0 feet. The side slopes of the berms generally met the design specifications of 3H:1V to 5H:1V, and the widths of the berms at MHHW are near the design specification of 20 ft at MHHW. We interpret this to mean that several of the berms, particularly in the southeastern corner of the site, may have settled after placement, either through consolidation of loose fill materials or compression of soft subsoil materials. Some erosion of soil from the tops of the berms may also contribute to the reduced elevations of the berm crests. We did not observe construction or measure the berms directly after construction so it is not possible for us to determine if they were originally built to the designed elevation and geometry.

To depict how the number and locations of constructed berms may affect the wave attenuation function around the perimeter of the site, Figure 2 shows the constructed berms along with exposure gaps where berms are lacking. Figure 2 also shows where additional wave attenuation berms are still needed to provide protection to steeper portions of the site. It should be noted that the berms are not engineered structures, but rely on vegetation establishment to limit erosion and enhance wave dissipation. Also, the berms are not complete barriers to waves, which can propagate past the berms by diffraction and refraction around them, and waves will migrate over the top of the berms depending on the water depths and dissipation. Hence, the design also required perimeter planting, monitoring and adaptive management to provide additional protections if needed.

The Corps wave analysis from 2007 (CENWS-EC-DB-CS Memorandum) indicated that, even with small mounds (1.5 ft minimum above existing grade with 1:10 slopes) around the site, wave heights would likely be limited to provide sufficient protection for the slopes surrounding the site. The Corps recommended that these low mounds be distributed throughout the site to limit the overall wave climate. Through the design process, ESA included higher berms with elongated geometry and berm redundancy with more than one row of berms along wave travel paths to limit open wave generation fetch as well as dissipate wave energy via breaking on the berm and drag caused by vegetation.

Based on what has been constructed to date, project timing, material availability, site constraints and funding availability we recommend focusing on constructing the berms depicted in Figure 2 at a minimum. We understand that perimeter planting treatments are occurring and are ongoing which will limit erosion potential. Perimeter Monitoring will be required to ascertain whether wave action induces erosion around the perimeter of the site and if so remedial actions along the site perimeter may be required. We therefore expect that the impact of reduced berm construction can be mitigated by perimeter treatments when and where such treatments are needed.

## Summary and Recommendations

1. Observation: Fewer wave attenuation berms were constructed than designed.

   Recommendation: We recommend that, if full berm installation is not feasible for the project, at least six additional berms be constructed in the locations depicted on Figure 2 to close the primary gaps. Four of the proposed berms would be riparian, and two would be wetland berms.

   Additional channels could be excavated, or existing channels expanded, to provide material for these berms. Spoils from the stormwater pond excavation and other sources can also be used to supply fill. We also recommend eliminating the 5H:1V backslope and having 3H:1V sideslopes on both sides to reduce the amount of fill material necessary per linear foot. The berm footprints can also be adjusted slightly to take advantage of locally higher areas in the floodplain.

   Monitoring and adaptive management was always part of the overall approach to addressing potential erosion around the perimeter. Since the built berm system has been modified from the original design, we recommend that additional focus be placed on monitoring and adaptive management of the perimeter side slopes. When high tides or river levels coincide with strong winds, observations should be made along the perimeter shoreline. Wave energy that reaches the perimeter will be mitigated via plantings, but some biotechnical approaches or other spot fixes may be necessary in some locations.

2. Observation: Some of the riparian wave attenuation berms have settled and are below the target elevation.

   Recommendation: The riparian berms that we checked do exceed MHHW elevation, and will likely support plantings, so no modifications are proposed to the previously constructed berms, with one exception at the southern half of Berm 20. This location is in front of one of the steepest, most exposed sections of the perimeter shoreline.

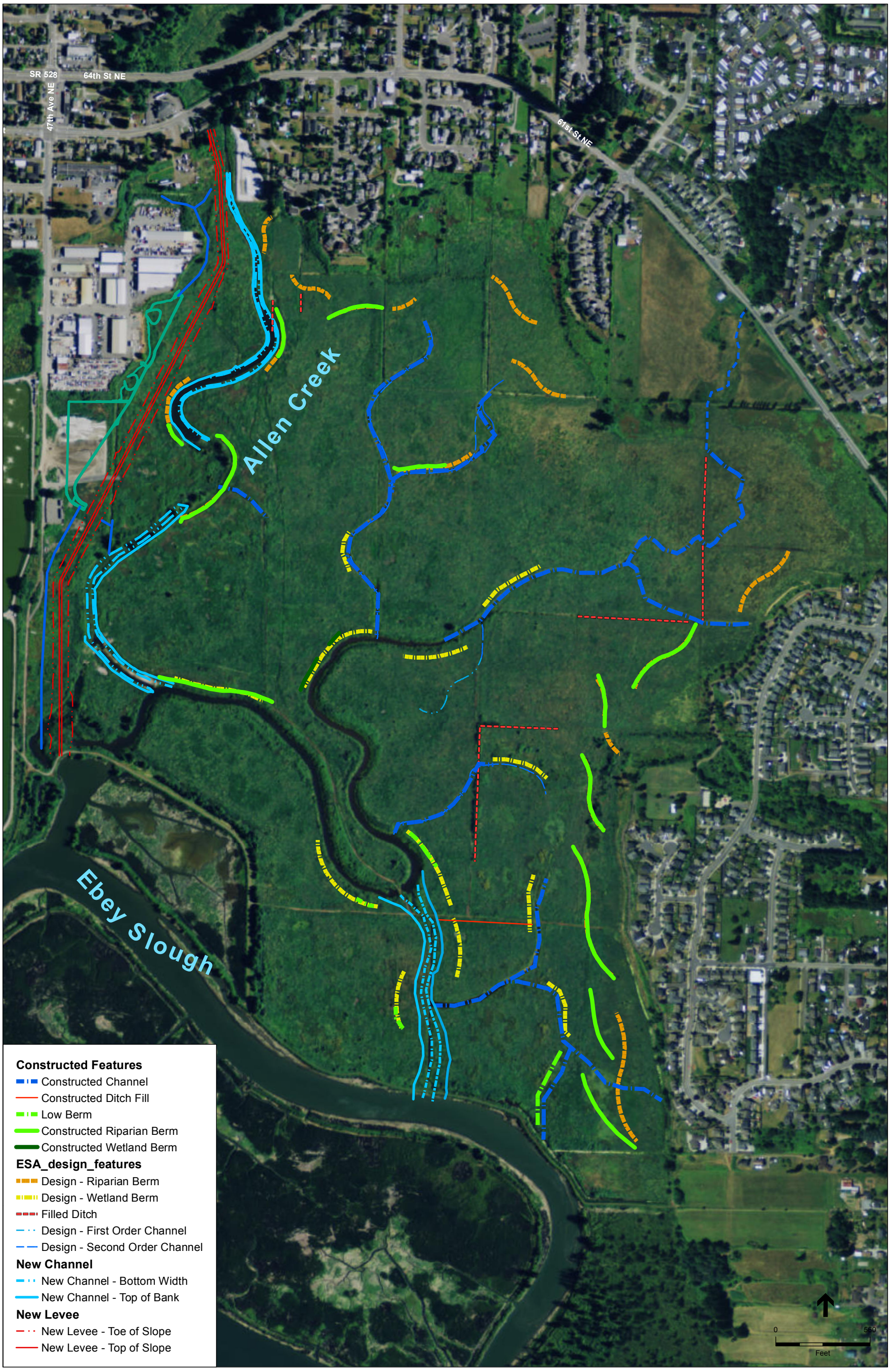
   This berm should be regraded to widen and increase the elevation of the crest while allowing a steeper the backslope (Figure 3).

3. Observation: New channels have been excavated throughout the site.

   Recommendation: No changes needed. Post-breach site drainage will include some linear drainage features, but drainage appears to be sufficiently linked to perimeter drainage points to achieve the goals of providing tidal flux throughout the site and not impeding drainage coming from off-site.

4. Observation: Not all ditches have been filled.

Recommendation: No changes needed. The ditches apparently required substantially greater volumes of material to fill than anticipated, so the extent of ditches filled is less than originally envisioned. It appears that a sufficient length of the linear drainage system has been filled to focus the majority of tidal flux within the restored channel system. While we think that there would be benefits to filling more of the ditches, we do not feel that filling more of the ditches is necessary to achieve the project goals. Also, berm construction is a higher priority than ditch fill.




SOURCE: ESRI Online aerial, Corps Design Plans, ESA Design Plans, ESA Field GPS

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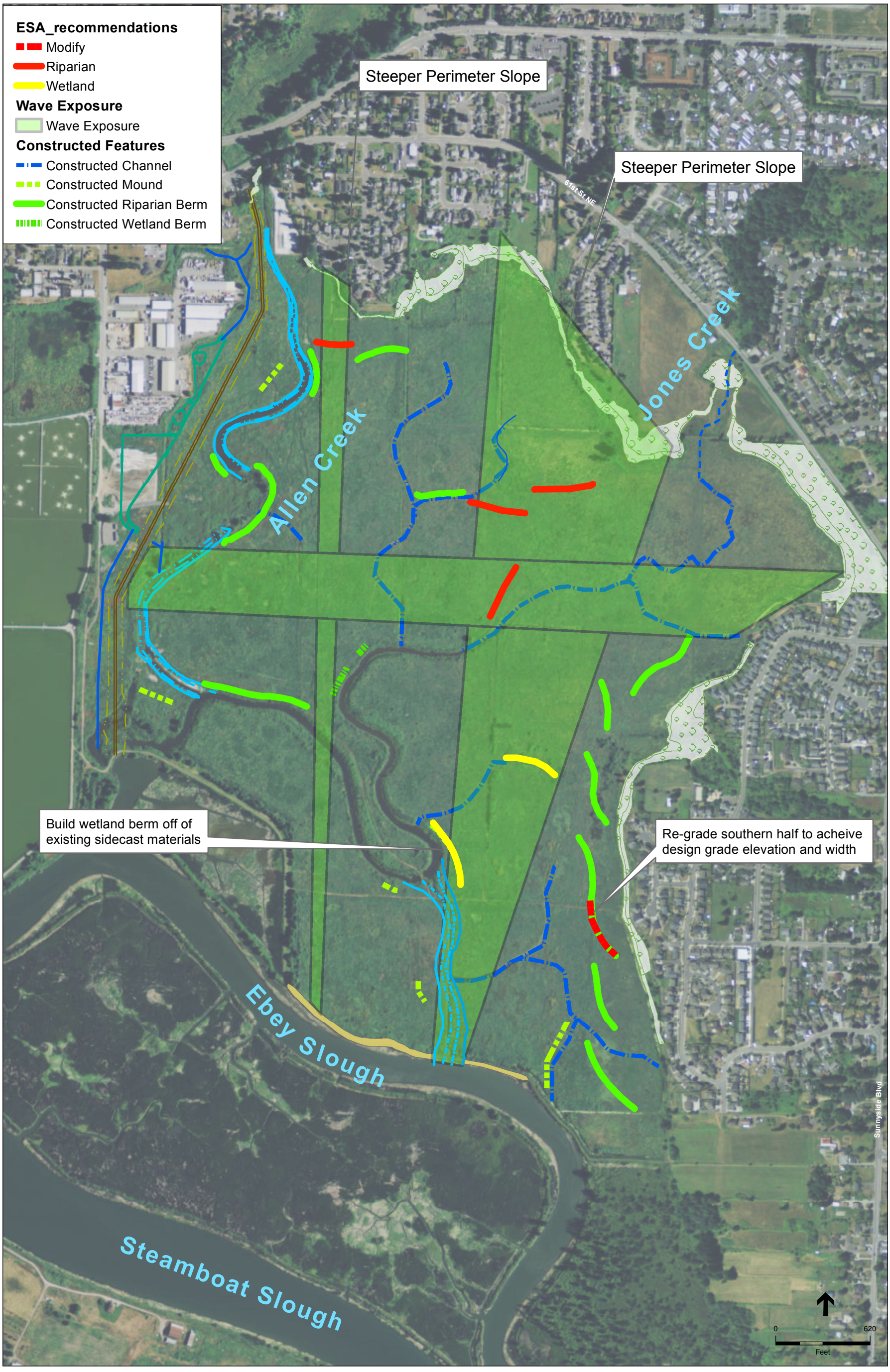
**Figure 1**

Comparison of Design and Constructed Elements




SOURCE: ESRI Online; ESA data

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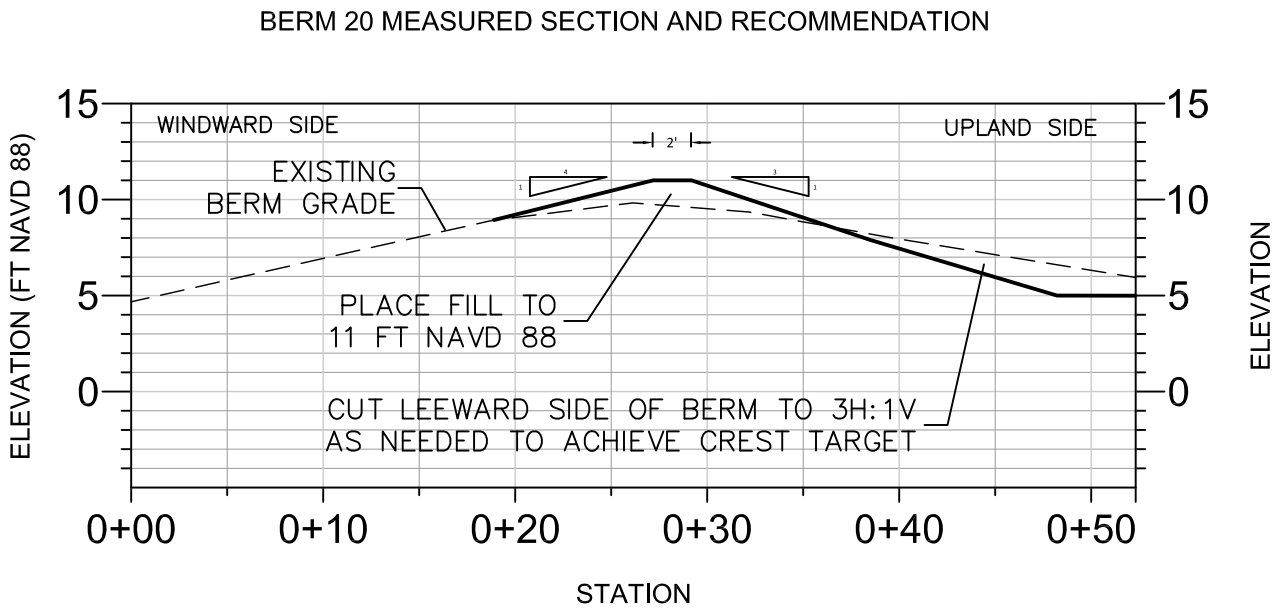
**Figure 2**
Recommendations
for Berm Construction




SOURCE:ESA Survey 2015

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**Figure 3**

Berm 20 proposed regrading
Marysville, Washington