Environmental and Permitting Considerations

The rock revetment in the alignment shown in Figure 2 would likely have to be placed below the ordinary high water level of the river (approximately mean higher-high water). Construction work below the ordinary high water level is regulated by the US Army Corps of Engineers (USACE) due to the detrimental impacts such activities can have on aquatic life, including salmon. If this is the case, a USACE permit will be required to place the rock. Although the purposes of the project will likely justify a permit, the permit process will extend the project schedule and may require mitigation to offset environmental impacts. The alignment can be adjusted slightly landward to avoid in-water work. However, if rock is placed in an upland location, it will need to be keyed into the substrate to expected erosion depths as described above. This will require excavation of native peat material and replacement with rock. This excavation would greatly expand the project footprint for the rock revetment.

The sheet pile alternative would have a much smaller footprint than a rock revetment would have and could easily be placed outside of the ordinary high water level of the river. As mentioned above, the wall could be placed in marginally upland areas, such that the peat on the waterward side of the wall is sacrificial. As a result, this alternative is expected to have an easier permit pathway and fewer impacts to aquatic life, including salmon. With that said, placement of a rock as a scour countermeasure would likely necessitate a USACE permit and would have some, but not all, of the environmental impacts of the rock revetment.

Scour Analysis

Scour analysis in estuarine settings is complicated because most guidance on estimation of scour focuses either on purely river (alluvial) settings or open coasts. There is no federally sanctioned guidance for scour analysis in estuarine revetments. Therefore, the analysis presented here adopts a hybrid approach, using guidance developed for coastal revetments (e.g., Brown and Clyde 1989, Fowler 1992, US Army Corps of Engineers 2008), while accounting for total scour in a manner typical in an alluvial setting (i.e., additive for each type of scour anticipated at the site: Federal Highway Administration 2012).

For a sheet pile wall, the depth of local scour (scour associated with the wall itself) has been shown to be approximately the deepwater wave height of incident waves (Fowler 1992). At Dillingham, this is approximately 5 feet deep. However, local scour is not the only source of potential scour at this location. As described above, there is general scour at the site associated with the migration of the Nushagak River channel. The amount of general scour is unclear, but it has the potential to be relatively large (in excess of 10 feet deep) over long time periods, as the thalweg of the river approaches the north bank. However, in considering the design life of the facility rather than a longer period of time in which river channel migration may persist, general scour can be estimated to be approximately the migration length multiplied by the bank slope. Although the bank slope is complicated in the area by an offshore shoal, we estimate the overall bank slope to be approximately 2 percent. With a migration rate of 15 feet per year, this equates to 0.3 foot of scour depth per year, or 9 feet over the design life of 30 years. Applying the additive methodology recommended by the Federal Highway Administration (2012), this equates to a total scour depth of 14 feet in 30 years. As a result, scour countermeasures, such as the toe rock shown in Figure 4, are recommended to minimize scour that could compromise integrity of the sheet pile wall.

For a rock revetment, Brown and Clyde (1989) provides guidance for riprap sizing. They estimate the riprap size should be approximately 0.57 times the deepwater wave height. At Dillingham, this results in a rock size of slightly less than 3 feet. Local scour at the toe of a revetment would be less than at the base of a sheet pile wall and, as mentioned by Brown and Clyde (1989), is difficult to determine since the primary mode of failure of a rock revetment is self-burial, not removal by erosion. Underlying geotextiles can mitigate this risk as noted previously (Lagasse et al. 2006), but some erosion of the toe should be expected from both local and channel-scale processes. Therefore, if a rock revetment is constructed to protect the facility from riverbank erosion it is recommended that a launchable toe be constructed at least 5 feet deep and 5 feet seaward of the toe to mitigate toe erosion.

SUMMARY

Either of the shoreline protection alternatives described in this report appear to be feasible for the intended purpose of providing long-term protection of the facility. Their longevity is also expected to be comparable. The rock revetment, due to its larger footprint, has a larger environmental impact and may have more permit hurdles to complete.

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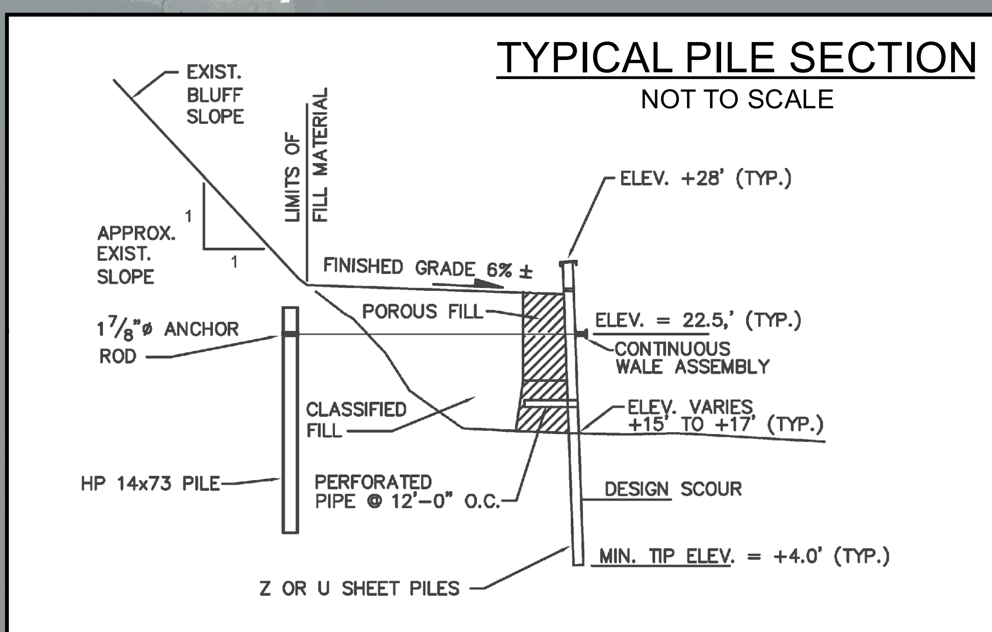
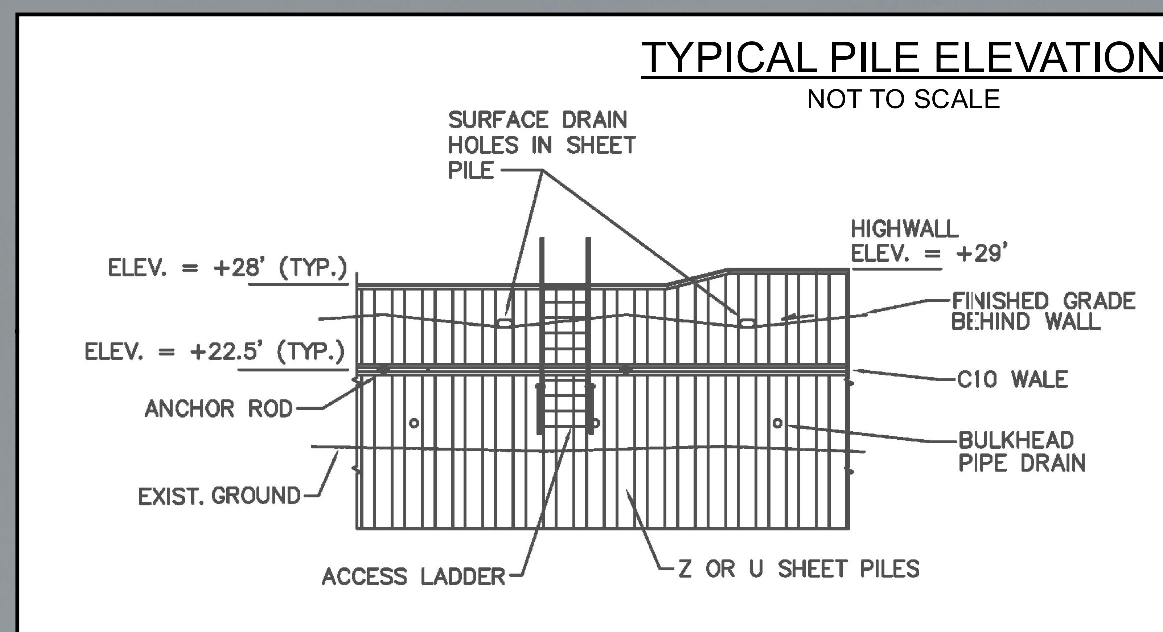
TYPICAL PILE SECTION

NOT TO SCALE



TYPICAL PILE ELEVATION

NOT TO SCALE



DILLINGHAM BANK PROTECTION

DILLINGHAM, ALASKA

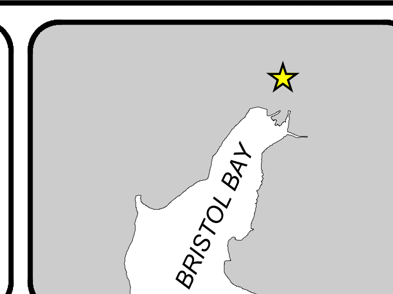
US Army Corps of Engineers Alaska District

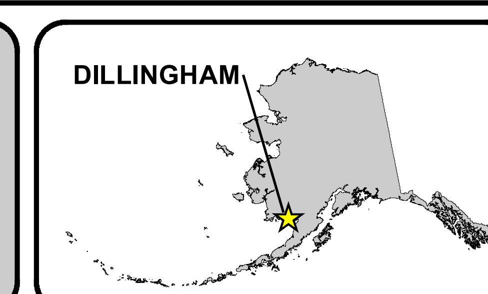
NOTES:

1. THIS LOCALITY IS SHOWN ON USGS QUAD SHEET DILLINGHAM A-7
2. CURRENT SURVEY INFORMATION FOR THIS PROJECT AT
www.poa.usace.army.mil/About/Offices/ConstructionOperations/RiversandHarbors.aspx

MAP DATE: 2016SEP IMAGERY DATE: 2016AUG27

Imagery Credits: National Geographic, ESRI, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, METI, NRCAN, GEBCO, NOAA, IPC, DigitalGlobe, GeoEye, Earthstar Geographics, SIO





Dillingham
Bank Stabilization

Condition of Improvements
30 December 2015
Dillingham Bank Stabilization, Alaska
(CWIS No. 075441)

Authorization **(1)** Public Law 99-190, under Section 114, dated 19 December 1985, as adopted, provides for the installation of 1,600 linear feet of steel sheet pile bulkhead along the toe of the bluff from the Dillingham city cargo dock to Snag Point. **(2)** Public Law 106-377, Section 1(a)(2), and Conference Report 106-988, provides for the extension of the sheet pile wall on the west side of the entrance channel to the small boat harbor, and the replacement of the existing wooden bulkhead at the city dock.

Table 1

Existing Project	**Length ft.**
Sheet pile bulkhead (City Dock to Snag Point)	1,625
Sheet pile with rip rap (east side of entrance channel)	600

Project Usage The project is located at the head of Nushagak Bay, an arm of Bristol Bay, on the right bank of the Nushagak River, just below its confluence with the Wood River about 330 air miles southwest of Anchorage.

Progress of Work

1986	Initial contact is made with the local sponsor.
1988	City seeks additional state funding.
1995	Local interests relocate the water and sewer lines near Snag Point and are reimbursed by the government.
1997	Plans and specifications are completed for the City Dock to Snag Point project.
1998	The Project Cooperation Agreement is signed in January, and a construction contract is awarded in September.
1999	The original contract is modified to accommodate increased costs.
2000	600 feet of additional sheet pile with rip rap protection are constructed on the east side of the entrance channel.
2001	Extension of the project to include the west side of the harbor entrance is directed in the 2001 Appropriation Conference Report. Plans and specifications are being developed and a Project Cooperation Agreement is being negotiated.

Progress of Work

2004	The scope and cost of the project on the west side of the entrance channel are under consideration.
2005	Storms erode behind sheet piling on east side of entrance channel. Letter reports underway for improvements at the west side of the entrance channel, and for protection of the critical areas of the east side.
2009	The project is inspected in September. Scour measurements were taken from mud-line to top of lower wale channel. Scour at toe in some locations exceeds design scour allowance. A comparison of the design and as-built drawing revealed a conflict regarding the tie-rod spacing. Several access ladders are extensively damaged and non-functional. Overall, the project was found to be in good condition with no visual signs of distress.
2010	A site survey was completed in May to determine if historic or archaeological resources were extant within the project area and consequently would be adversely affected by the placement of additional rock revetment along the southwestern shoreline.
2011	The City of Dillingham installed a scour blanket from STA 20+10 to STA 21+60 in front of the Snag Point Bulkhead to reduce future scour.
2012	The project was inspected and scour at the toe of the Snag Point Bulkhead was noted as a continuing problem; numerous actions were recommended.
2013	The project was inspected and scour at the toe of the Snag Point Bulkhead was noted as a continuing problem; numerous actions were recommended.
2014	The project was inspected and scour at the toe of the Snag Point Bulkhead was noted as a continuing problem; numerous actions were recommended.
2015	The project was inspected in June and scour at the toe of the Snag Point Bulkhead was noted as a continuing problem; numerous actions were recommended. A survey of the beach at the toe of the sheet pile was conducted. Analysis of new and historic survey data indicates the thalwag of the Nushagak River is migrating towards the sheet pile wall. Riprap was placed along the toe of the wall from STA 21+60 to STA 25+40 to tie in with the upstream rock revetment.
2016	The project was inspected in May and scour at the toe of the Snag Point Bulkhead was noted as a continuing problem; numerous actions were recommended. Riprap was placed along the toe of the wall from STA 14+00 to STA 15+90 and from STA 17+24 to STA 20+10 to tie in with the downstream rock revetment apron placed in 2011. With this placement, riprap scour aprons had been placed along all critical sections of the wall noted in inspection reports.
2017	The project was inspected and scour at the toe of the Snag Point Bulkhead was noted as a continuing problem though the scour apron appeared to be slowing the rate of scour at the toe of the wall. Numerous actions were recommended including adding rock to the remaining portions of the wall.

Table 2 Cost to Date

Project	Description	Cost $
075441	CG Appropriation	8,482,556
	CG Costs	8,217,308

Table 3 Range of Tides in feet

Tide Station	Mean Range	Diurnal Range	Extreme Range
946 5374 Snag Point AK	16.58	20.64	-