Saint George Harbor

Feasibility Study

Appendix B – Geotechnical Feasibility Report

Saint George, Alaska

Tentatively Selected Plan

August 17, 2018

U.S. Army Corps of Engineers

Alaska District

CEPOA-EC-G 19 July 2018

MEMORANDUM FOR CEPOA-PM-C (Attn: Ms. Reese Phillips)

SUBJECT: Geotechnical Feasibility Report, St. George Small Boat Harbor Navigation Improvements Feasibility Study, St. George, St. George Island, Alaska

Enclosed is the Geotechnical Feasibility Report for the St. George Small Boat Harbor Navigation Improvements Feasibility Study. Included with this report is a Geotechnical Data Report written for the Zapadni Bay St. George Harbor and Breakwater Improvements project.

Please address any questions you may have to Ken McInally at 907-753-5691 or John Rajek at 907-753-5695.

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I. INTRODUCTION

The purpose of this report is to summarize results of existing geotechnical information at the St. George Harbor located in Zapadni Bay and document anticipated geotechnical conditions as they pertain to the current proposed Tentatively Selected Plan (TSP) known as the North Anchorage Harbor site on St. George Island, referenced as Alternative N-3 in the Feasibility Report. This report also recommends geotechnical design criteria for proposed rubble-mound breakwater construction and dredging at the North Anchorage Harbor site. Information and assumptions in this report were developed through a desk study of existing geotechnical information and it is intended for use by design engineers and planners to evaluate feasibility alternatives for new harbor improvements on St. George Island. Information in this report is not intended for use in construction contract documents.

II. LOCATION AND PROJECT DESCRIPTION

St. George Island is one of the Pribilof Islands located in the Bering Sea, approximately 225 miles north of Dutch Harbor and 750 miles west of Anchorage, Alaska. The current St. George Harbor is located in Zapadni Bay and the proposed TSP, referenced as Alternative N-3 in the Feasibility Report, is located just northwest of the community of St. George at the North Anchorage site seen in Figure B-1.

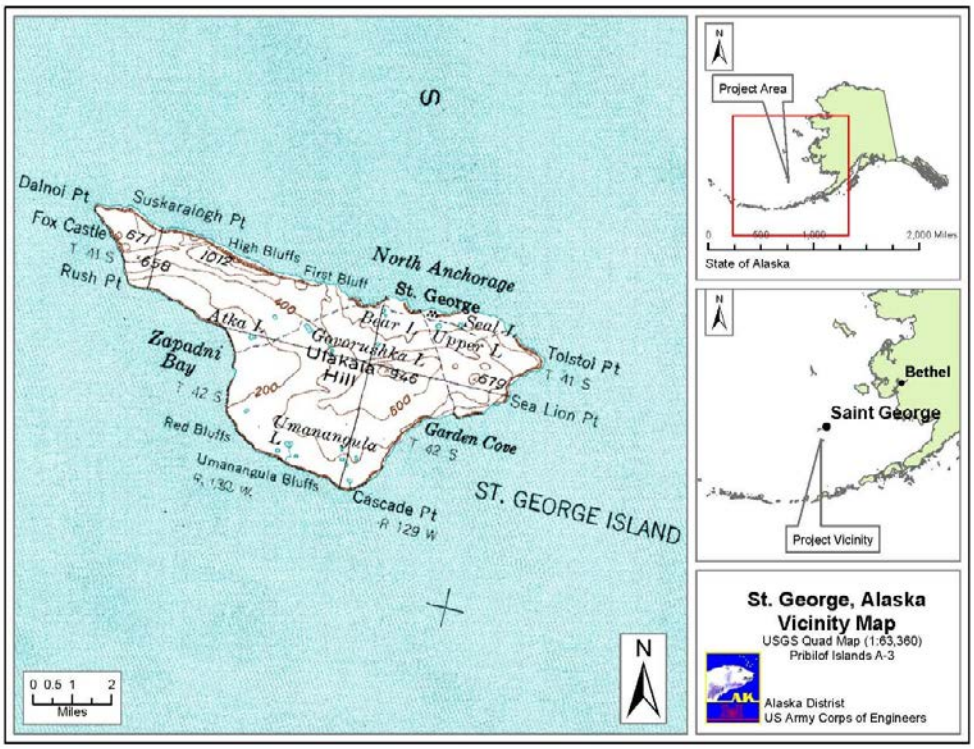

Figure B-1: St. George Island Vicinity Map

The existing St. George Harbor located in Zapadni Bay includes a navigation channel, turning basin, and three rubble mound breakwaters. These breakwaters were constructed from 1984 to 1987 and were designed as berm structures with 8-ton armor stone produced from a local material source on St. George Island. The size of armor stone used in the existing breakwaters has proven to be inadequate as major maintenance has been required to repair breakwater slopes after exposure to fall and winter storms from the Bering Sea. Figure B-2 provides an aerial view of the existing St. George Harbor. Note arrow showing breakwater slope repairs to the east breakwater caused by a December 2015 Bering Sea storm.

Figure B-2: Aerial View of St. George Harbor in Zapadni Bay

The current TSP for harbor improvements on St. George is to construct a new harbor at the North Anchorage site located in a small cove northwest of the community of St. George. Figure B-3 provides an aerial view of the community of St. George and Figure B-4 provides a plan view of the TSP, Alternative N-3, at the North Anchorage site. Figures B-5 and B-6 provide views of the North Anchorage Cove and community of St. George.

Figure B-3: Community of St. George and Adjacent North Anchorage Site

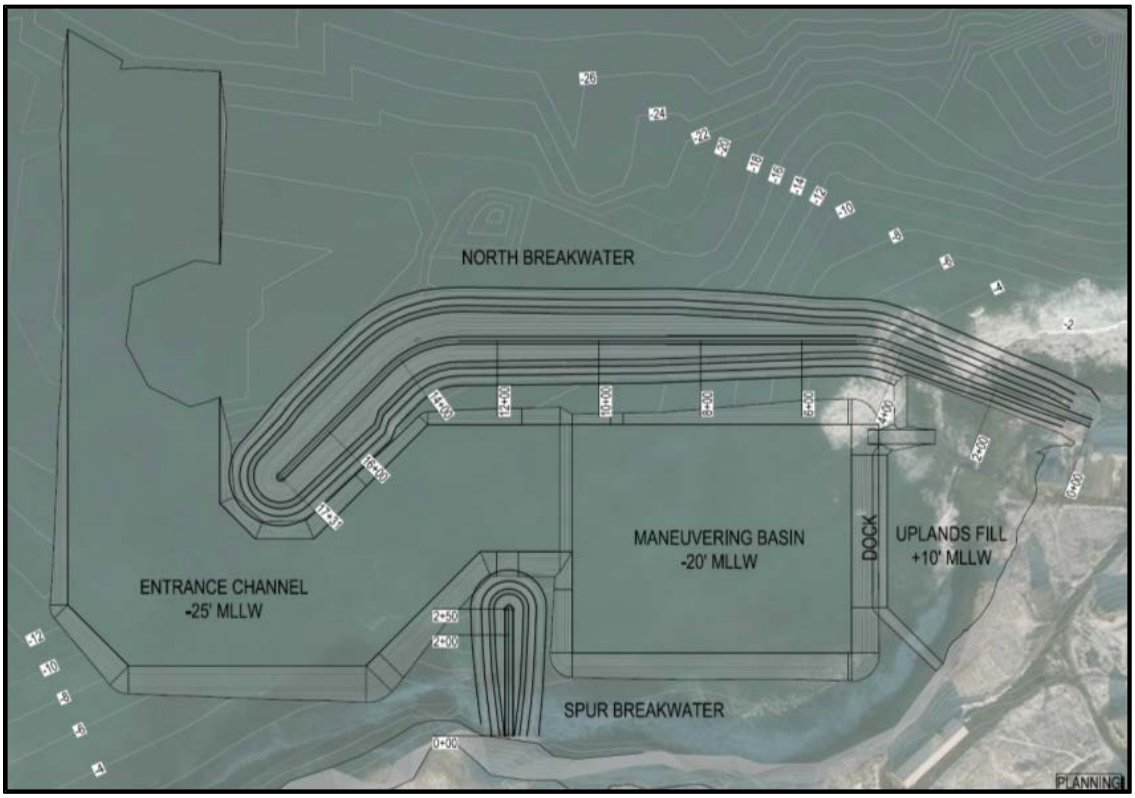

Figure B-4: Alternative N-3 North Anchorage Harbor Site

Figure B-5: North Anchorage Cove

Figure B-6: Community of St. George

Proposed breakwater alternatives for the North Anchorage Harbor site share the same conceptual cross-sectional breakwater design. These breakwaters will be exposed to the open ocean environment and are designed as 3-layer rubble mound breakwaters constructed at slopes of 1.5 and 2 horizontal to 1 vertical with 10-ton armor stones to a crest elevation of +25 feet mean lower low water (MLLW). Figure B-7 provides conceptual breakwater slopes and dimensions that were used for geotechnical evaluation purposes in this report.

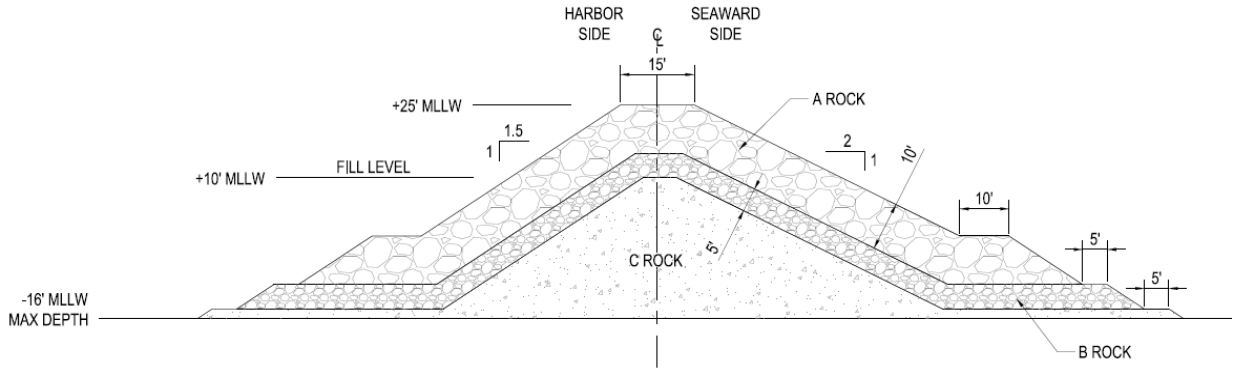

Figure B-7: Conceptual North Anchorage Harbor Breakwater Cross Section

EXISTING GEOTECHNICAL INFORMATION

Shannon & Wilson, Inc. in partnership with The Watson Company performed several geotechnical site investigations which included drilling test borings and geophysical surveys at the St. George Zapadni Bay Harbor in 2014 for the Alaska Department of Transportation. These field exploration efforts are documented in the St. George Harbor and Breakwater Improvements Project Geotechnical Data Report dated March 2015. For reference, this report has been included in Appendix B.1.

A. Geotechnical Exploration

During the Shannon & Wilson geotechnical site investigation, a total of nine test borings were drilled; seven borings were drilled within the Zapadni Bay Harbor and two borings were drilled at the Airport Quarry along with excavating six test pits. Test borings B-1 through B-7 drilled in the vicinity of Zapadni Bay Harbor varied in drill depths from 12 feet to 43 feet below the ground surface. Overburden soils encountered during drilling consisted of medium dense to dense coarse-grained and fine-grained soils with cobbles and boulders. The depth to bedrock varied greatly with ranges from 0.5 feet to 30.5 feet below the ground surface. Below the overburden soils moderately weathered to fresh vesicular basalt bedrock was encountered with reported rock quality designation (RQD) values ranging from 0 to 30. These RQD values indicate poor to very poor rock quality; however in boring B-6, higher RQD values were reported below an approximate elevation of -16.5 feet MLLW.

B. Geophysical Explorations

The offshore geophysical exploration performed in May 2014 by The Watson Company under contract with Shannon & Wilson was used to investigate and identify the thicknesses of sediments over bedrock within the existing harbor basin, entrance channel, and area adjacent to the harbor in Zapadni Bay. The offshore geophysical exploration found sediments varied in thickness from 6 feet close to shore and increased in thickness to approximately 45 feet a distance of 2,800 feet offshore. Onshore geophysical explorations performed by Shannon & Wilson in the Fall of 2014

also identify and correlate the thickness of soil over bedrock. Cross-sections and isopach maps displaying the inferred bedrock elevations are provided in the March 2015 Geotechnical Data Report

C. Rock Quality Testing

Geologic mapping and reconnaissance was also performed in the Airport Quarry to delineate differing rock types, orientation of structural features, and exposed rock faces. Result of rock quality testing from samples collected at the Airport Quarry are summarized in Table B-1. A full discussion of test results are provided in the Shannon & Wilson report provided in Appendix B.1.

Table B-1: Airport Quarry Rock Quality Test Results

Sample	Degradation Value	LA Abrasion (% loss)	Soundness (% loss)	Bulk Specific Gravity	Absorption (%)	Ethylene Glycol (% loss)	Freeze/Thaw (average % loss)
Quarry	91	42	1	2.65	2.6	0	0.08
Quarry	57	64	2	2.60	2.3	0	0.02
Quarry	91	43	1	2.59	0.8	0	0.22

Rock quality test results reported for the Airport Quarry do not meet typical LA Abrasion U.S. Army Corps of Engineers' rock quality testing requirements for shore protection projects. Typically USACE breakwater stone requires LA Abrasion percent loss values to be 20 percent or less. Further evaluation of the Airport Quarry would be required before consideration could be given to using the material source to produce Armor stone for St. George Harbor improvements.

IV. Geotechnical Engineering Analysis and Recommendations

A. North Anchorage Harbor

Review of existing geotechnical information collected at the St. George Harbor located in Zapadni Bay and aerial photos of the proposed North Anchorage Harbor site indicate very favorable breakwater foundation conditions for all North Anchorage Harbor alternatives.

i. Breakwater Slope Stability and Settlement

For engineering analysis and evaluation purposes, we assumed proposed breakwater foundations located at the North Anchorage Harbor site would most likely consist of relatively thin layers of medium dense to dense sediments consisting of coarse-grained soils with cobbles and boulders. The depth to bedrock may vary greatly, but for evaluation purposes, it was assumed bedrock would be within 10 feet of the seafloor since the proposed breakwater alignments are close to shore. Given the current geotechnical information available on St. George Island, the Corps does not anticipate any changes to the current proposed breakwater cross-sections referenced in Figure B-7.

Breakwater slope stability and settlement analysis were not performed for North Anchorage Harbor alternatives because expected foundation conditions were assumed to be very similar to the existing St. George Harbor in Zapadni Bay.

ii. Seismic Hazards

Shannon & Wilson evaluated seismic conditions and performed seismic analysis of the existing St. George Harbor breakwaters as part of their March 2015 Geotechnical Data Report. Peak ground acceleration (PGA) was predicted to be approximately 0.18g with a corresponding earthquake magnitude of M5.2. Shannon & Wilson suggested that seismically induced liquefaction or slope failures associated with Harbor infrastructure were not likely to occur with the predicted low magnitude and low acceleration earthquakes associated with the Pribilof Island area. Given the current geotechnical information available, the Corps does not anticipate additional design considerations or special foundations requirements to address seismic hazards for breakwater or navigation channel construction.

iii. Dredging

Currently the proposed North Anchorage Harbor entrance channel and maneuvering basin is planned to be dredged to a depth of -25 feet and -20 feet MLLW. The thickness of sediment and depth to bedrock is unknown within the proposed harbor entrance channel and maneuvering basin. For estimating purposes, we anticipate bedrock will be encountered very near the surface, three feet or less, within the south side of the entrance channel and maneuvering basin. The thickness of surface sediment may gradually get thicker as the entrance channel moves north away for the shoreline. Drilling and controlled blasting of bedrock will be required within the navigation channel and harbor basin before material can be mechanically dredged by clamshell or long-reach excavator. Dredge cuts in the surface sediment can be assumed to be stable at slopes of 1.5 horizontal to 1 vertical. Dredge cuts in bedrock may be cut at slopes of 0.25 horizontal to 1 vertical.

iv. Future Geotechnical Site Investigation Recommendations

The main goal with conducting a geotechnical site investigation at the North Anchorage Harbor site would be to properly characterize proposed dredge material, allow evaluation and recommendations of the suitability of breakwater foundation material, and identify any geological conditions that would require special considerations during preconstruction engineering and design of the harbor. Geotechnical information will also be used to establish the basis for accurate dredging cost estimates. The following geotechnical investigations are recommended for the North Anchorage Harbor site if this alternative is selected for the next phase of design:

- Conduct an offshore geotechnical site investigation consisting of drilling between 15 and 20 test borings below the proposed rubble mound

breakwaters, entrance channel, and maneuvering basin. The preferred drilling method would consist of using a sonic drill rig that would be able to penetrate dense coarse-grained sediments with cobbles and boulders and also able to advance into the bedrock to depths below the proposed bottom of the navigation channel.

- Conduct an offshore marine geophysical investigation to further define sub-seafloor conditions and complement the geotechnical drilling by providing a broader understanding of subsurface stratigraphy and the depth to the top of bedrock within the dredging areas. The geophysical investigation should consist of survey track lines collected at a nominal spacing of 25-feet parallel and perpendicular to the proposed breakwater alignments, navigation channel, and maneuvering basin.

V. Reference

Shannon & Wilson, Inc. March 2015. “St. George Harbor and Breakwater Improvements Project, Geotechnical Data Report”.