Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Geology and Soils Characterization Study
Study Plan Section 4.5

Final Study Plan

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

July 2013

4.5. Geology and Soils Characterization Study

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Included within the RSP was the Geology and Soils Characterization Study, Section 4.5. RSP Section 4.5 focuses on the methods for evaluating the geology and soils and defining the existing geological conditions at the dam site, reservoir, and access and T-line corridors. This is necessary for developing design criteria to ensure that the proposed Project facilities and structures will be safe and adequate to fulfill their stated functions. RSP 4.5 provided goals, objectives, and proposed methods for data collection regarding this study.

On February 1, 2013, FERC staff issued its study plan determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. RSP Section 4.5 was one of the 31 approved with no modifications. As such, in finalizing and issuancing Final Study Plan Section 4.5, AEA has made no modifications to to this study from its Revised Study Plan.

4.5.1. General Description of the Proposed Study

The overall goals of this study are to conduct a geology and soils evaluation to define the existing geological conditions at the dam site, reservoir, and access and T-line corridors, and to develop design criteria to ensure that the proposed Project facilities and structures will be safe and adequate to fulfill their stated functions. The general objectives of the study plan are as follows:

- Identify the existing soil and geology at the proposed construction site, reservoir area, and access and T-line corridors.
- Determine the potential effects of Project construction, operation, and maintenance activities on the geology and soil resources (including mineral resources) in the Project area including identification and potential applicability of protection, mitigation, and enhancement (PM&E) measures.
- Identify known mineral resources and mineral potential of the Project area.
- Acquire soils and geologic information for the Project area for use in the preparation of a supporting design report that demonstrates that the proposed structures are safe and adequate to fulfill their stated functions.

The field investigation activities for each season will be coordinated with resource agencies and ANCSA Corporation landowners. Geotechnical Exploration Program Work Plans (Work Plans) will be developed that outline the field programs and information needed for submitting applications and obtaining land access permits from applicable agencies and ANCSA Corporation landowners. The Work Plans will identify known impacts to geology and soil resources in the Project area, including the dam, reservoir, and access and T-line corridors. FERC regulations require “evaluation of unconsolidated deposits, and mineral resources at the project site” (18 CFR 5.6(d)(3)(ii)(A)). For the Exhibit E, AEA must provide a report on the geological and soil resources in the proposed Project area and other lands that would be directly or indirectly affected by the proposed action and the impacts of the proposed Project on those resources. This study report will provide the basis of the information needed for the Exhibit E.

4.5.2. Existing Information and Need for Additional Information

Extensive field investigations and studies were undertaken during the 1970s and 1980s for the Watana Dam Site to characterize the geologic, seismic, and foundation conditions for a different type of dam (earthfill embankment) with a much larger footprint and a higher normal mean reservoir operating level.

These studies included the following:

- Regional mapping of surficial deposits (rock and soil) using aerial photography and geologic reconnaissance (Acres 1982b).
- Studies of reservoir slope stability (Acres 1982a, 1982b).
- Subsurface explorations through geophysical surveys, borings, test pits, and trenches (USACE 1975, 1979; Acres 1982b, 1982c; Harza-Ebasco 1983, 1984).
- Preliminary evaluations of borrow and quarry sites (USACE 1979; Acres 1982b, 1982c).
- In situ hydraulic testing and downhole geophysical surveys of rock and soil (Acres 1982b, 1982c; Harza-Ebasco 1983, 1984).
- Instrumentation (groundwater and ground temperature observations and monitoring [USACE 1979; Acres 1982b, 1982c; Harza-Ebasco 1983, 1984]).
- Laboratory testing of physical properties of rock and soil (USACE 1979; Acres 1982b, 1982c; Harza-Ebasco 1983, 1984).
- Site-specific seismic hazard evaluations, including lineament, fault and ground motion evaluations; monitoring of local seismic events (WCC 1980, 1982).
- Evaluation of reservoir induced seismicity (RIS) (WCC 1982).
- Geology and soil resources (Harza-Ebasco 1985).

In summary, the following geotechnical investigations and testing were performed prior to 1986 and in 2011–2012:

- Geologic interpretation (e.g., terrain unit mapping) and seismic source identification using aerial photography and satellite imagery.
- Geologic mapping of dam site and reservoir areas.
- Drilling at the dam site, construction materials source areas, geologic features (i.e., relict channel near dam site), proposed permanent camp/village, access road corridor, etc.
- Instrumentation monitoring (groundwater and ground temperature).
- Seismic refraction surveys, wih some electrical resistivity and ground-penetrating radar (GPR) surveys.
- Test trenches and pits (Borrow Areas D, E, I, J).
- Site-specific seismic hazard investigations and evaluations.
- Trenching of lineaments and faults.

For this study, the existing information, coupled with new field investigations and studies, geologic mapping, and Light Detection and Ranging (LiDAR) and Interferometric Synthetic Aperture Radar (InSAR) imagery data, will provide specific information on the properties of Project-site-specific rock and soil units that would be affected by the newly proposed Project.

4.5.3. Study Area

The study area will include the dam site area, reservoir area, construction material sources, tailwater downstream of the dam, access road and transmission line corridors, airport facilities, and construction camp and permanent village sites (Figure 1.2-1).

4.5.4. Study Methods

The study of geology and soils resources for supporting licensing and detailed design will include a number of components:

- Develop an understanding of geologic and foundation conditions for the dam site area and specifically for each of the surface and underground components of the Project.
- Evaluate abutment stability.
- Develop an understanding and characterize the geology and soil resources in the Project area (dam and reservoir areas and access and T-line corridors.
- Evaluate the mineral resource potential in the impoundement area, reservoir area up to approximately elevation 2,075 feet, and dam and camp facilities area.
- Evaluate major geologic features, rock structure, weathering/alteration zones, etc. in the dam site and reservoir areas.
- Delineate and characterize construction material sources for the dam and appurtenant structures, access road, transmission line, and construction camp.
- Evaluate the surficial geology, mass wasting features, and potential thawing of localized permafrost on reservoir slope stability.
- Seismic source characterization, site-specific ground motion evaluation, and probabilistic seismic hazard assessment (see Section 16).
- Evaluate reservoir leakage and piping.

Study methods are discussed below.

Review of Project Documentation

The existing documentation from the 1970s and 1980s will be brought into geo-referenced, geotechnical databases to build new information on the earlier studies in digital formats.

Regional Geologic Analysis and Mineral Resources Assessment

Existing published information, air photo interpretation and reconnaissance mapping, and new LiDAR survey data will be used to: (1) update information about the geology at the proposed Project and in the surrounding area, including surficial and bedrock geology, geologic structure, seismicity and tectonics, mass wasting, and mineral resources; (2) determine siting of Project components or structures; (3) identify geologic features of significance; and (4) assess potential impacts and potential mitigation measures to address impacts (e.g., erosion) on geology and soil resources and Project construction. A survey of the mineral resources will be performed to assess proven and probable mineral resources potential and mining activity in the impoundment area using existing data. The impoundment area is the area where access to mineral resources may be affected by the Project. In addition to the impoundment area, the road and transmission corridors will be evaluated for potential quarry and aggregate sites and known mineral deposits to identify if access to mineral resources may be adversely or beneficially affected by the Project.

The survey will entail mapping of known mineral deposits, identification of likely areas of mineral resources, plus field reconnaissance of selected areas of high mineral potential, review of area mining claims, and analysis of mineral potential from borings and other sampling work done for the dam and other facilities ongoing geotechnical investigations. AEA will consult with the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS) on this study plan to determine that appropriate methods and evaluation techniques are used for the mineral resource investigation.

Recently-acquired LiDAR and InSAR data in the region will be used to identify lineaments of faults for evaluation of activity and Project significance. Field reconnaissance, geologic mapping, and subsurface investigations, if necessary, will be performed and the data will be used to update the seismic source characterization, site-specific ground motion evaluations, and probabilistic seismic hazard assessment (PSHA) (see Section 16).

Geologic and Geotechnical Investigation and Testing Program Development

The development of a geologic and geotechnical exploration and testing program Work Plan for completion of geologic field studies for final design and ultimately for construction will be undertaken. Based on review of the existing data including previous geologic mapping, subsurface investigations, and laboratory testing from the 1970s and 1980s, and recent studies (2011–2012), additional investigations and testing will be conducted as described below:

- Delineate and characterize geology and soil resources including geologic features, rock structure, weathering/alteration zones.
- Undertake physical and chemical testing, as well as petrographic analysis, to characterize the geology and soils materials, as appropriate.
- Evaluate lineaments and faults relative level of activity and significance to site-specific ground motion evaluations for the Project.
- Delineate and characterize construction material sources for the dam and appurtenant structures, access road, and construction camp.
- Determine the effects of discontinuous permafrost on the dam foundation and abutments relative to foundation treatment, grouting, and drainage, as well as reservoir slope stability and access road and T-line construction.
- Evaluate the effect of Project features on permafrost and periglacial features (thawing of permafrost), as well as the impact of these features on permanent structures, work camps, temporary construction areas, road corridors, transmission lines, etc.
- Evaluate the need for, and potential sources of, borrow for ancillary facilities including upland structures, access roads, and transmission lines.
- Evaluate potential waste stockpiles and storage sites including plans to help reduce the impact of these facilities on adjacent areas.
- Evaluate plans and methods for the reclamation of borrow area and quarry sites.
- Evaluate the Project's impact on access to geologic resources (mineral resources) by reviewing existing state and federal databases, as well as readily available geologic maps and surveys.
- Conduct a preliminary evaluation of the effect of soils composition in the Project area on construction, operation, and maintenance of the proposed Project.
- Evaluate potential reservoir leakage on the right abutment just upstream of the dam site (e.g., relict channel).

- Establish seismic monitoring stations in the Project area to augment the stations in the Alaska Earthquake Information Center network to monitor and detect any local earthquakes.

Field Geologic and Geotechnical Investigations

Geologic and geotechnical field investigations will be carried out in phases (2011–2015) with portions of that work contributing to the report on geology and soils in 2013 and updates in 2014. The geotechnical investigations and testing undertaken as part of the Project feasibility and design effort will include geologic mapping, drilling, sampling and in situ testing, test trenches, pump tests, test adit, laboratory testing, instrumentation monitoring, etc. Initial and limited geologic exploration and testing programs were undertaken in the 2011–2012 seasons to investigate the dam foundation and a new quarry site for concrete aggregate material, installation and monitoring of geotechnical instrumentation, and reconnaissance geologic mapping.

Reservoir-Triggered Seismicity

Seismic evaluations are being undertaken for the Project under a separate study (see Section 16) and will include installation of a long-term earthquake monitoring system. The Geology and Soils and Seismic Characterization Studies would contribute information to that study.

Reservoir Slope Stability Study

An assessment will be made of reservoir rim stability based on the geologic conditions in the reservoir area, particularly in the reservoir drawdown zone. Geologic information from the previous study on reservoir slope stability (Acres 1982a) as well as LiDAR imagery, geologic mapping, field investigations, and instrumentation monitoring will be used to assess the stability concerns of the reservoir rim area. Key factors in this study are the planned reservoir level and anticipated range of drawdown, rock and soil type and conditions, presence of permafrost, topography, and slope aspect and conditions.

Geologic and Engineering Analyses

The analysis will identify and evaluate construction material sources to provide adequate quantities for construction, suitable alignments and foundation design for the access road, construction, permanent camps, and transmission lines; and identify re-use of excavated materials and/or disposal areas. The study will also assess the soil erosion potential along the transmission and road corridors, along with other effects of design and construction on geology and soils, and identify the suitability of measures to reduce and mitigate impacts.

Additionally, a number of geologic, seismic, and engineering analyses will be undertaken to develop the geologic model and to assess foundation design, abutment stability, seepage and piping potential, slope stability, ground motion evaluations, and site-specific probabilistic seismic hazard assessment for the dam site area. The study will also identify impacts and measures to mitigate impacts to geology and soil resources.

4.5.5. Consistency with Generally Accepted Scientific Practice

Studies, field investigations, laboratory testing, engineering analysis, etc. will be performed in accordance with general industry accepted scientific and engineering practices. The methods

and work efforts outlined in this study plan are the same or consistent with analyses used by applicants and licensees and relied upon by FERC in other hydroelectric licensing proceedings.

4.5.6. Schedule

The proposed study includes a limited field investigation program in 2012 for interpretation of digital imagery, reconnaissance geologic mapping, drilling, paleoseismic or lineament analysis, installation of a long-term earthquake monitoring system, assessment of slope stability for the reservoir rim, and reservoir triggered seismicity study. For 2013–2015, comprehensive investigations will focus on the dam site, reservoir area, and access road and transmission line corridors. Initial and Updated Study Reports explaining actions taken and information collected to date will be issued within 1 and 2 years, respectively, of FERC's Study Plan Determination (i.e., February 1, 2013). Updates on the study progress will be provided during Technical Workgroup meetings which will be held quarterly in 2013 and 2014.

The primary activities and planned schedule are shown in Table 4.5-1.

Table 4.5-1. Schedule for implementation of the Geology and Soils Study.

Activity	2012				2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1Q
Geo-Reference 1980s Investigations	——	——	——	——									
Regional Geologic and Mineral Assessment			——	——									
Field Investigations		——	——			——	——	——		——	——	——	
Geology and Soils Mapping				—		——	——						
Reservoir Slope Stability Analysis					——		——	——					
Initial Study Report								—Δ					
Follow-on Investigations as Needed									- - -	- - -	- - -	- - -	- - -
Updated Study Report											——	——	▲

Legend:

——Planned Activity
----- Follow-up activity (as needed)
Δ Initial Study Report
▲ Updated Study Report

4.5.7. Relationship with Other Studies

The Geology and Soils Study will provide information that will be used in several other studies, as shown in Figure 4.5-1. The geology and soils mapping will be important to complete in 2013 to provide the baseline spatial data to the cultural and botanical resources studies. The reservoir slope stability analysis will take place in 2013, which will then feed into the geomorphology study using the initial reconnaissance-level information as input into the geomorphology analysis.

4.5.8. Level of Effort and Cost

The study plan will involve a phased, multiple-year approach that will include field investigations from 2012 through 2015 with associated studies and engineering analysis. The estimated level of effort is estimated to be in excess of 4,500 hours plus expenses. The total cost of the study will be between an estimated $1,000,000 and $1,500,000. This work is part of a much larger geotechnical investigation program for the Project that will be undertaken through the engineering design activities.

4.5.9. Literature Cited

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4.5.10. Figures

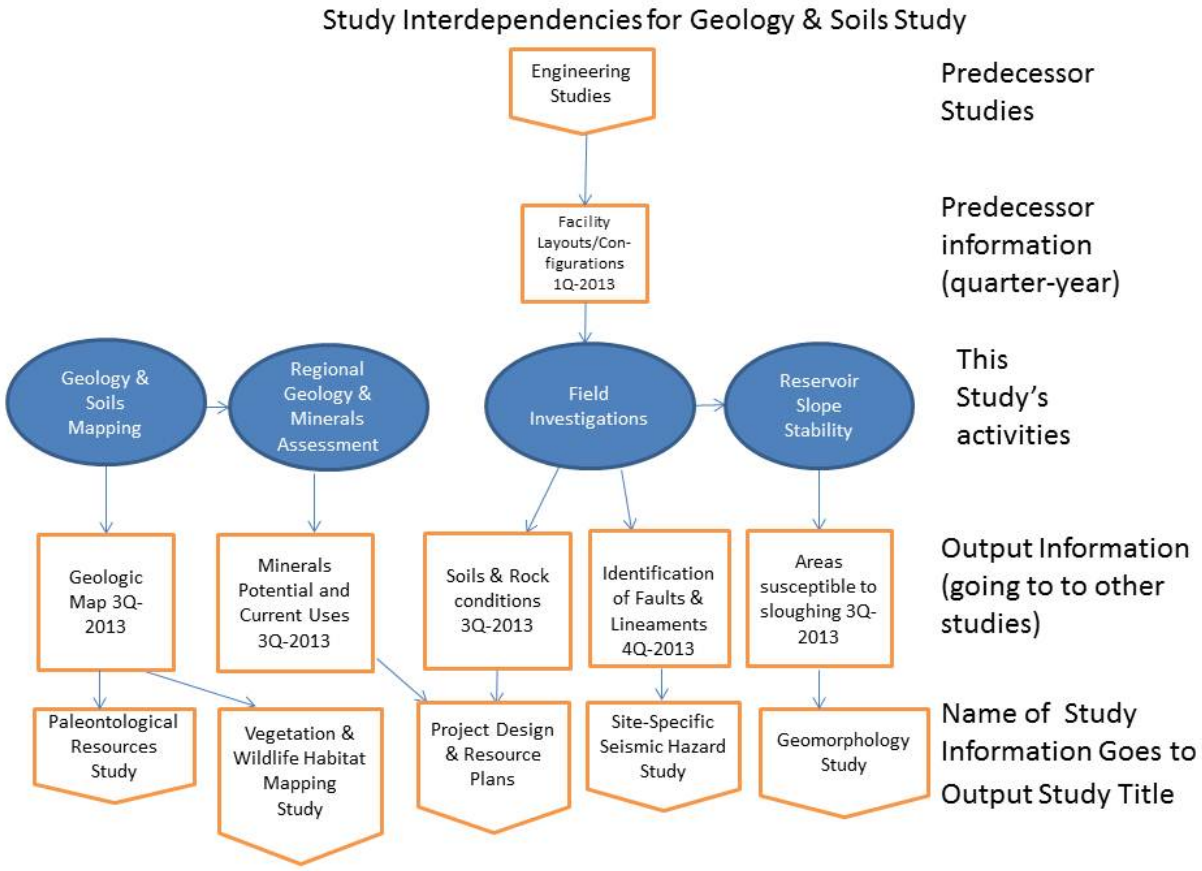

Figure 4.5-1. Interdependencies for Geology and Soils Study.