GOLDER

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GPR INVESTIGATION FOR AKHIOK ELECTRICAL DISTRIBUTION, AKHIOK, ALASKA

Karl:

Golder Associates Inc. (Golder) is pleased to present our summary of findings for the geophysical investigation for the proposed electrical distribution alignment in Akhiok, Alaska. The objective of the survey was to identify potential shallow bedrock and/or other obstructions using ground penetrating radar (GPR). Our services were conducted in accordance with our email proposal to you dated February 4, 2019, and our letter of authorization from you on August 28, 2019. The geophysical survey was performed August 27-29, 2019.

1.0 PROJECT UNDERSTANDING

We understand that CRW Engineering Group, LLC (CRW) is designing a shallow buried electrical distribution line to replace the aging system currently in place in the village of Akhiok, Alaska (Figure 1). In order to accommodate a minimum burial depth of approximately three feet for the electrical distribution line, CRW requested using GPR to identify the estimated depth to shallow bedrock or other obstructions along the proposed alignment. Based on site plans provided by CRW in August 2019, the proposed electrical distribution line runs from the FAA tower near the airport along Airport Way to the Akhiok School and along the perimeter of the residential area of Akhiok. Two proposed alternate alignments run through the undeveloped portion of Akhiok directly west of the Akhiok church.

2.0 GEOPHYSICAL SURVEY

Golder used the GPR method to identify potentially shallow bedrock and other obstructions along the proposed electrical distribution alignment.

2.1 Methodology

GPR relies on electromagnetic (radar) pulses that are directed into the ground from an antenna. Reflections of these pulses from subsurface features are produced where there is a contrast between the electrical properties of subsurface objects, such as sharp subsurface density contacts. The reflected electromagnetic pulses are received by the antenna, converted into an electric signal, and recorded by the GPR unit. The GPR unit compiles these pulses to produce a cross-section or profile image of the subsurface beneath the path of the antenna; often termed a radargram.

The depth penetration of a GPR signal is a function of the antenna frequency and the conductivity of the subsurface material. As the frequency of the GPR antenna increases, the resolution (ability to detect smaller dimensioned objects) increases, but the depth of subsurface penetration decreases. A lower frequency antenna is capable of greater subsurface penetration, but with reduced resolution. Materials that are electrically conductive such as clay or salt-enriched soils tend to attenuate the GPR signal resulting in decreased subsurface penetration.

A Geophysical Survey Systems Inc. (GSSI) model UtilityScan GPR system with 350 MHz HS (hyperstacking) antenna was used in this investigation. The HS technique uses multiple stacking (averaging) during data acquisition in order to improve signal-to-noise ratio and improve data quality. While the UtilityScan system is capable of resolving depths to within 0.1 foot, vertical variations in soil electrical properties (e.g., frozen, dry, saturated) limit the accuracy of burial depth interpretations. Golder normally assumes an error of +/- 15 percent for vertical depth observations made using GPR. Site-specific depth calibrations are used to determine the average velocity and typically applied to an entire site.

2.2 Field Work and Results

The geophysical survey was carried out by Golder geophysicist Jessica Feenstra and selected line locations were surveyed in the field by CRW surveyor Emily Davenport on August 27-29, 2019. The geophysical survey consisted of walking the GPR unit along the proposed electrical distribution alignment and identifying the estimated depth to bedrock from the GPR radargram in real-time (Image 1, left). Prior to determining the GPR-derived depth to bedrock and obstructions, a site-specific depth calibration was used to determine the average dielectric constant of the area. The GPR-derived depth to an existing culvert was compared to the known culvert depth based on visual inspection of the culvert outlet. This site-specific depth calibration resulted in an average dielectric constant of nine (9) for the area. The depth calibration assumes the soil properties are relatively consistent across the site. Changes in soil properties can affect the depth reading determined by the GPR.

In addition, the GPR-derived depth to bedrock was field verified by excavating a test pit in a location identified to have shallow bedrock (Image 1, right). Prior to excavating the test pit, the interpreted depth to bedrock based on GPR data was three feet. Akhiok Mayor Dan McCoy excavated the test pit using a local backhoe. Mr. McCoy excavated the test pit until refusal was encountered on bedrock: a depth of approximately three feet. The test pit consisted of moist, sandy silt overlaying competent bedrock. A layer of weathered bedrock was not encountered at the soil/bedrock contact.

Image 1: GSSI UtilityScan 350 MHz HS GPR System (left) and Test Pit Excavation with Mayor Dan McCoy (right).

The locations of shallow bedrock and observed obstructions along the proposed electrical distribution line are provided in Figure 2. Observed depth to bedrock is indicated by color approximately every 50 feet along the proposed alignment, and observed obstructions are directly annotated on the figure. In general, bedrock appeared to be located at a depth of about two to three feet along the residential areas of Akhiok where the road embankment is not built up above the native terrain. Bedrock appears to be three to five feet deep on the road out to the school, and three to five feet deep or more on the road out to the airport. Along this alignment the road embankment is built up three or more feet above the native terrain. Bedrock appeared to be at a depth of about three to five feet or more within the undeveloped area directly west of the church. However, the terrain through this area is very hummocky and thickly vegetated which made it difficult to maintain coupling of the GPR with the ground surface. Without a defined contact with the ground surface, the quality of the data and inferred depth to rock in these areas may be suspect.

Based on bedrock outcrops at the beach just south of the village and adjacent to the road out to the airport, the bedrock appeared to be competent, steeply-dipping shale overlain by a mantle of silt to sandy silt (Image 2). Due to the steeply-dipping nature of the shale, the surface of the bedrock underlying the village of Akhiok is highly irregular and should be expected to vary significantly in depth over relatively short horizontal distances. Personal communication with Mr. McCoy indicated that the bedrock depth varies from two to more than six feet over short horizontal distances in the graveyard. According to Mr. McCoy, the bedrock is not rippable with a backhoe and we agree with this conclusion. Blasting has not been utilized by Mr. McCoy, but he believes it was used in the past to install the water line. Mr. McCoy is not aware of any successful attempts of blasting through the entire shale bedrock formation.

I may be feasible to cut narrower trenches in the rock for electric conductor installation. A wide variety of rock trenching equipment should be commercially available for this process, particularly if relatively shallow rock trench cuts are needed. The conductor may require bedding material if placed in a rock trench cut. Also, trench cuts may channel water and the potential for piping of bedding material should be considered if this approach is taken.

We recommend meeting with your design team to further review the field findings and discussion options to achieve the desired conductor embedment depths after review of this submittal.

Image 2: Exposed Bedrock Along the Beach Just South of Akhiok

3.0 USE OF TECHNICAL MEMORANDUM

This technical memorandum has been prepared for CRW for the proposed electrical distribution system in Akhiok, Alaska. The work program followed the standard of care expected of geophysical professionals undertaking similar work in the State of Alaska under similar conditions. No warranty expressed or implied is made.

Golder geophysics services were conducted in a manner consistent with that level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions, subject to the time limits, and financial and physical constraints applicable to the services. GPR is a remote sensing geophysical method that may not detect all subsurface features of interest or concern. The following limitations to the methodology and site conditions have an impact on the accuracy of the locate survey results. It is the responsibility of the field geophysicists to minimize error where possible; however, heterogeneity in the earthen materials and certain site conditions imaged cannot be avoided.

- **GPR signal penetration and noise:** Fine grained soils, saturated soils and poor contrasts in electrical properties between survey targets and surrounding subsurface materials reduce the signal-to-noise ratio that is relied upon to observe reflecting objects and accurately determine their depth. Additionally, vertical variations in soil electrical properties (e.g., frozen, dry, saturated) limit the accuracy of depth interpretations. Golder normally assumes an error of +/- 15 percent for vertical depth observations made using GPR.
- **GPR anomaly identification:** GPR is a remote sensing technique that images objects and layers based on changes in electrical properties. GPR operators are only able to identify the presence of anomalies in the data. The source of these anomalies are interpreted based on a 'best guess' from what information is available in as-built drawings and knowledge of what subsurface features are likely present in areas investigated. Anomalous reflective objects such as boulders or additional utilities in the vicinity of the survey targets may be misinterpreted or mask the detection of target utilities. The accuracy of the interpreted depth to a subsurface reflector is dependent on calibrating the system at a location where the depth to a reflector is known.

4.0 CLOSING

It has been our pleasure assisting you with this project. Please contact Jessica (865-2533) or Rick (865-2537) if you have any questions or require additional assistance.

Golder Associates Inc.

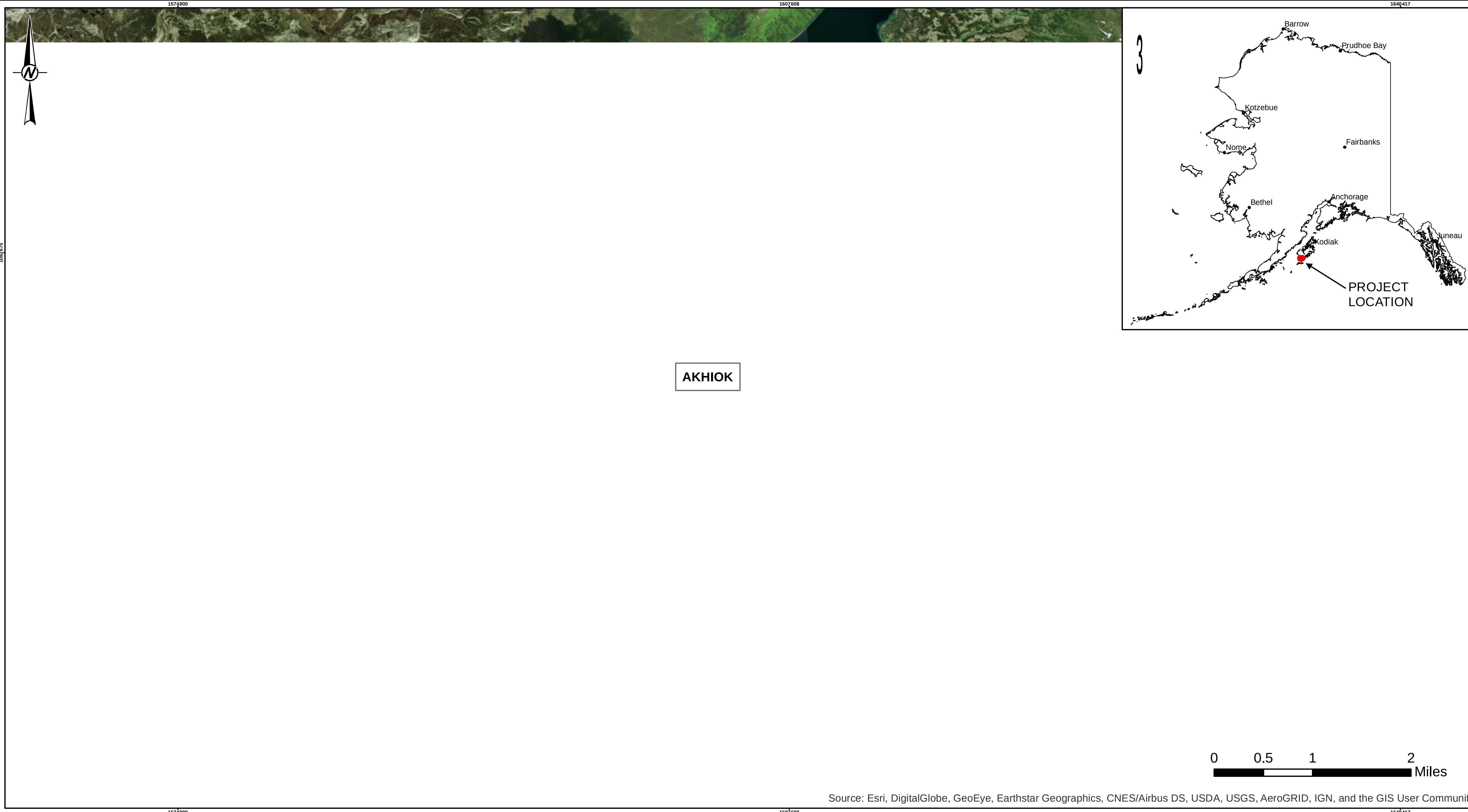
Jessica P. Feenstra
Project Geophysicist

Richard A. Mitchells, PE
Principal, Senior Geotechnical Engineer

Attachments: Figure 1: Vicinity Map
Figure 2: Depth to Bedrock and Underground Obstructions Map

JPF/RAM/mlp

https://golderassociates.sharepoint.com/sites/104177/project files/6 deliverables/final/19117350 gpr survey akhiok final 3.19.2020.docx



REFERENCE(S)
ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, GIS USER COMMUNITY

CLIENT
CRW ENGINEERING GROUP, LLC

CONSULTANT

YYYY-MM-DD	2019-09-18
DESIGNED	-
PREPARED	JPF
REVIEWED	RAM
APPROVED	

PROJECT
GPR INVESTIGATION FOR AKHIOK ELECTRICAL DISTRIBUTION
AKHIOK, ALASKA

TITLE
VICINITY MAP

PROJECT NO.	PHASE	REV.	FIGURE
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