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Twin Pines Minerals Exploration
Work Plan
Phase I – Piezometer Installation & Drilling of Exploratory Borings
Charlton County, Georgia
TTL Project No.: 000180200804.00
August 23, 2018

PROJECT BACKGROUND

TTL has been engaged by Twin Pines, LLC (TP) to provide environmental and engineering services for a project located in southeast Georgia. TTL is currently providing services to delineate wetlands and assist with associated permitting services as well as stormwater construction services at the Site.

The study area (Site) includes a 1012-acre "Loncala Tract" to the north and a potential land purchase to the south of an additional approximately 2,913 acres (Figure 1). These lands lie near and adjacent to the southeast margin of the Okefenokee Wildlife Refuge and about 10 miles north of the Florida-Georgia line. The Okefenokee Wildlife Refuge encompasses approximately 402,000 acres. Groundwater in the Okefenokee Swamp (approximately 438,000 acres that wholly contains the Okefenokee Wildlife Refuge) generally occurs at or near the land surface. A topographic ridge known as "Trail Ridge" that is oriented north-south extends through the approximate central portion of the subject property. The ridge is about 40 miles inland from the Atlantic coast. Trail Ridge extends north from northeast Florida a distance of approximately 100 miles into southeast Georgia. Throughout its length, the ridge is generally 0.6 to 1.2 miles wide. Trail Ridge is known for an occurrence of concentrated heavy metals. These minerals have been and are currently being mined at locations along and near Trail Ridge.

Although there has been considerable evaluation of the mineral resources along Trail Ridge, not much is known regarding the groundwater hydrology (occurrence and movement). As a result, the proposed level of investigation is merited to formulate a better understanding of the hydrologic system.

Previous Studies

The U.S. Geological Survey (USGS, Force and Rich, 1989) reports "this prominent topographic ridge (Trail Ridge) which stands tens of meters above adjacent landforms in the coastal plain, impounds the Okefenokee Swamp". Sands in the area of the property are fine to medium, clean, well-rounded Eolean beach sands. TTL suspects these sands exhibit a hydraulic conductivity in the range of 1×10^{-3} cm/sec. Though TTL currently lacks data to evaluate groundwater conditions in the area of the property, we theorize, based on our current knowledge and experience, a conceptual model of groundwater occurrence at the Site. The topography of the area west of the ridge is relatively flat. The area east of the ridge is comparatively much steeper topographically and slopes to the east. Several small streams along the eastern slopes of Trail Ridge flow to the east. Based on topography, we suspect the groundwater west of the ridge is relatively very flat with a very shallow gradient while groundwater east of the ridge occurs at relatively lower elevations and likely exhibits a steeper slope

and gradient to the east. In order to better understand the subsurface conditions in the area of the Site, TTL is currently in the process of reviewing and evaluating approximately 172 exploratory boring logs that have been generated from on-site drilling by TP in preparation of more extensive studies. Based on review of readily available geologic publications/literature, TTL estimates the elevations of the uppermost surficial aquifer near the Site to be approximately 120 feet above mean sea level (amsl).

Conceptual Mining Plan

TTL currently understands the proposed mining operation will not require dewatering of the Site. The mine excavation will consist of an approximately 90-foot wide x 50-foot deep x 100- or 200-foot long sections of mining. TP will use a drag line to excavate soil and minerals, drop mined material into an equipment hopper adjacent to the drag line and pump a slurry mixture of sand and water to the wet plant. The target minerals will be removed and approximately 98% of soil will be returned to the pit in a somewhat drier state. TP has indicated that the water used in the mining process would be essentially a closed loop system once the plant is charged. TP has also indicated that after the first pit is excavated they should be returning the unused sand back to the excavation within hours so that they are constantly excavating and filling (i.e. no spoil piles will be generated).

PROPOSED SCOPE OF SERVICES

Phase I – Piezometer Installation & Drilling of Exploratory Borings

In order to evaluate the groundwater hydrology of the Site, TTL recommends that the hydrogeological evaluation be conducted in two phases. TTL recommends that Phase I include the drilling and construction of a series of shallow piezometers in a series of linear and parallel locations oriented north-south across the Site. This pattern of piezometers will allow for a series of transects oriented east-west to aid in the evaluation of groundwater occurrence and direction of flow.

TTL is proposing to install 28 piezometers across the Site during Phase I in order to develop a potentiometric surface map and perform slug and bail tests in selected piezometers (Figure 2). As stated previously, TTL has very limited information related to the hydrogeology beneath the Site, therefore, we have estimated depths of the 28 piezometers based on topographic elevations and the assumed potentiometric surface of the uppermost aquifer at the site (see Table 1). We are also proposing the drilling of an anticipated four to eight exploratory borings to attempt to determine depth of the underlying confining clay (Hawthorn Formation), which also represents the bottom of the uppermost aquifer. This information is needed in order to design a pumping well that fully penetrates the uppermost aquifer. We will collect samples (Shelby Tube) of the underlying clay in order to perform laboratory permeability tests on samples.

Based on the data we collect during Phase I, we plan to design and implement a Phase II work plan. The Phase II plan will involve working with Hydro Geo Chem (HGC) to design a fully penetrating pumping well and pumping test for the uppermost aquifer beneath the Site. TTL will contract with HGC for assistance in design, data collection, and analysis of the pilot test and data. HGC is an Arizona firm incorporated in 1978 with offices in Tucson and Scottsdale, Arizona, that has provided professional hydrogeologic services to numerous public and private sector clients for more than 35 years. HGC is registered with the Arizona Board of Technical Registration as a professional services firm providing civil engineering, environmental engineering, geological engineering, and geology (Firm Number 11339) services. HGC is nationally recognized for its expertise in applying advanced hydrologic and geochemical techniques to the solution of complex environmental problems. For more than 35 years, HGC has developed a philosophy for environmental restoration and minimize environmental liabilities, maximize remediation efficiencies, and saved millions of dollars for their clients.

The data obtained during the aquifer pumping test will be used to estimate values of transmissivity and storativity for the aquifer system which can be used to model groundwater beneath the site (Phase II). TTL will provide a separate proposed scope of services for Phase II upon conclusion of Phase I services. Please note that based on the limited hydrogeological data available for the site, additional data acquisition needs, beyond the scope of this proposal, may also be identified.

Drilling and Observation Well Installation

TTL proposes to drill and install 28, two (2)-inch diameter piezometers at the Site. Using a track-mounted sonic drill rig, TTL will advance soil borings/piezometers at discreet locations across the Site as shown on Figure 2. Prior to the initiation of drilling, TTL will stake the locations of each boring using a hand-held GPS unit. Each of the 28 soil borings will be advanced to a depth of approximately 10 feet below the estimated groundwater surface (uppermost saturated zone). Based on our review of previously drilled borings by TP and readily available publications, TTL estimates depths of borings to range from approximately 15 to 50 feet BLS. TTL will attempt to set a 0.010-inch machine-slotted PVC well screen from near the bottom of the well to approximately at or 5 feet above the saturated zone. The remainder of the borehole above the screen will be cased with solid PVC casing. Natural sand will be used to form a filter pack around the well screen to a depth of about two feet above the top of the screen and a 2-foot thick bentonite pellet seal will be placed above the sand pack and hydrated. The remaining portion of annulus above the bentonite seal will be grouted by pumping a cement/bentonite grout under pressure from the bentonite seal to land. Surface completion will include installation of a 2-foot X 2-foot concrete well pad and a flush-mount steel lockable well cover. During advancement of the borings, soil samples will be continuously retrieved and described in the field by a TTL professional. A boring and well construction log will be developed for each boring/piezometer. Once an exploratory boring is completed, it will be grouted by injecting a cement/bentonite grout under pressure from total depth to land surface.

TTL understands that TP is currently performing sonic drilling at the site and utilizes on-site surface water for drilling water. We will apply the same method for obtaining drilling water during our field work. However, if an adequate water-supply is not available, this may cause a delay in our drilling schedule

Soil Sampling and Testing

The eight exploratory soil borings will be drilled and sampled continuously to estimated depth of 150 BLS in order to assess the depth to the base of the uppermost aquifer (i.e. lower confining clay unit). An undisturbed Shelby tube sample from the lower clay unit will be collected from three (3) of the eight (8) deep boreholes. Each undisturbed soil sample will be submitted for permeability/hydraulic conductivity in TTL's soils laboratory.

Up to two soil samples per piezometer boring will be collected for grain-size analysis at TTL's soil laboratory. We estimate that up to 56 grain-size samples will be submitted for analysis.

Surveying of Piezometers Soil Borings

The piezometers will also be surveyed by a Georgia Licensed Land Surveyor to establish elevations of the top of casing (measuring point) and ground surface. The northing and easting coordinates will be shown on site aerial photograph and provided in an AutoCAD format. Water levels corrected to elevations will be used to prepare a groundwater contour map for purposes of estimating groundwater flow direction. Land surface elevations will also be obtained for each of the deep exploratory borings in order to generate accurate subsurface cross-sections.

Piezometer Development

After a minimum duration of 24 hours following completion of the piezometer installations, ten (10) selected piezometer will be developed by a TTL technician using a pump, bailer, or other appropriate method. Depth to water measurements will be made in each piezometer once the water column has stabilized. Each piezometer will be developed for a maximum of four (4) hours each or until the turbidity measurements have stabilized or are less than 10 Nephelometric Turbidity Units (NTUs).

Slug and Bail Testing

Following completion of well development, TTL will perform a slug and bail test on each of ten (10) selected piezometers. Slug and bail tests will be performed in order to estimate the hydraulic conductivity of the shallow water-bearing zone. The hydraulic conductivity values will be used to evaluate the rate of groundwater recharge in the shallow zone and information from the slug and bail tests will be evaluated and utilized in designing the aquifer pumping test (Phase II).

Monitoring of Groundwater Levels

Once the piezometers are installed, TTL will initiate a program of monitoring of water levels twice a month for a minimum of three months. Following the initial three month period, water levels will be measured and recorded on a monthly basis over the next nine months to complete an annual cycle of water level measurements. TTL will also install a rain gage on the Site in order to develop a permanent local record of precipitation. This data will be used in conjunction with the groundwater data in order to develop an over-all interpretation of hydrologic conditions at the Site.

Reporting

Upon completion of the field work and associated piezometer installation and testing, TTL will evaluate the information from the tasks cited above and prepare a "Draft" report summarizing our findings from the drilling, and test results. We will design a fully penetrating pumping well and pumping test for the uppermost aquifer beneath the Site. TTL will contract with HGC for assistance in design, data collection, and analysis of the pilot test and data. The report will include well logs with construction information for each piezometer and exploratory soil borings, hydrogeologic cross sections, and results of calculations for slug and bail tests. The report will also include recommendations and a design for a pumping test with associated schedule for implementation. If additional data acquisition needs are identified, these additional work elements will also be identified.

TTL, Inc.

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James R. Smith / c.o.

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Attachments: *Figure 1*
Figure 2
Table 1

Force, E.R. and Rich, F.J., 1989, Geologic evolution of Trail Ridge Eolian heavy-mineral sand and underlying peat, northern Florida: U.S. Geological Survey, Professional Paper 1499, 16 p.

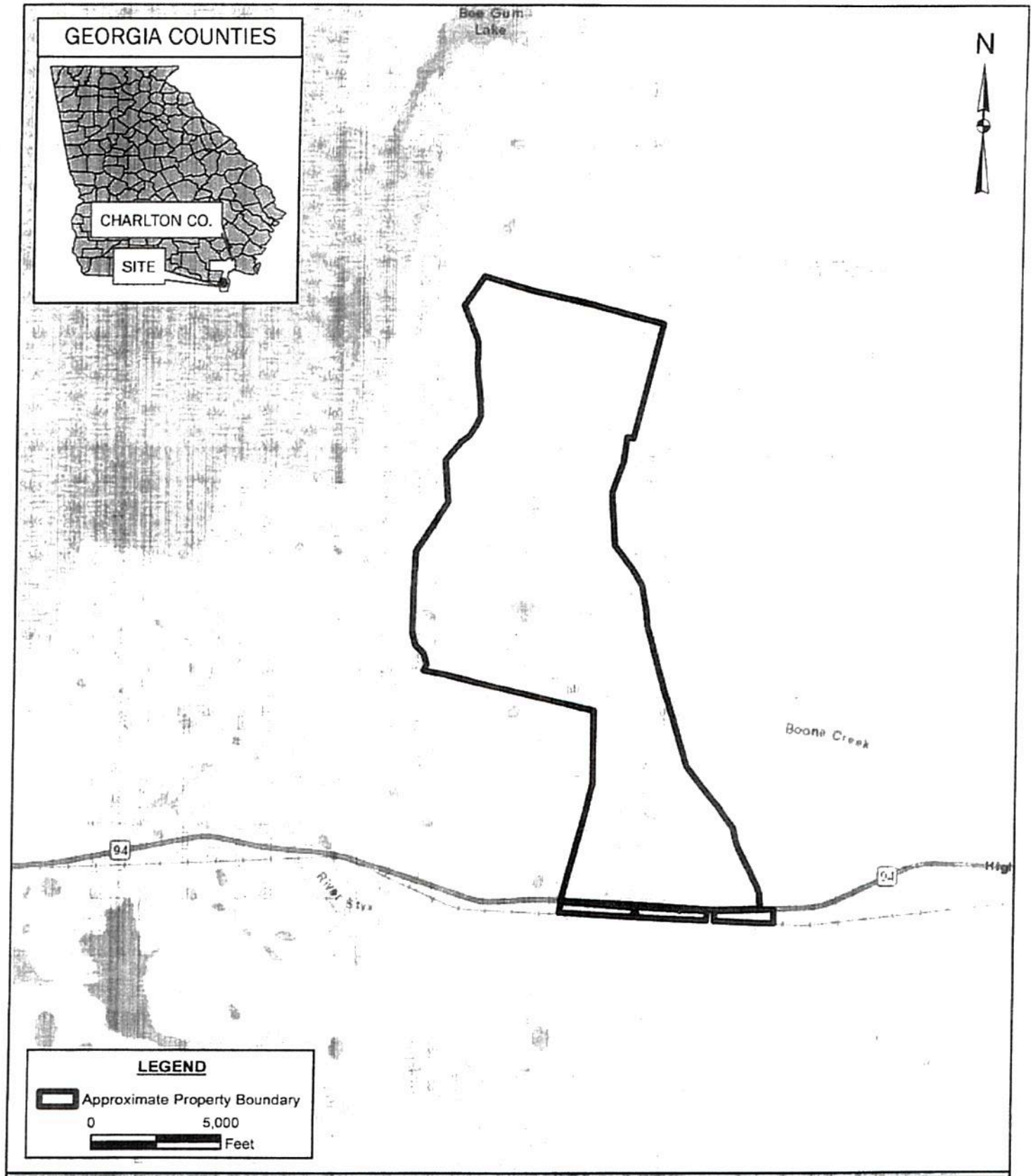

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FIGURE 1: SITE LOCATION MAP

TWIN PINES MINERALS

CHARLTON COUNTY, GEORGIA

DRAWN BY: AGW	
CHECKED BY: J.SMITH	
DRAWING DATE: 8/2/2018	
REVISION DATE: N/A	
TTL JOB NO: 000180200804.00	
APPROXIMATE SCALE: 1" = 3,000'	

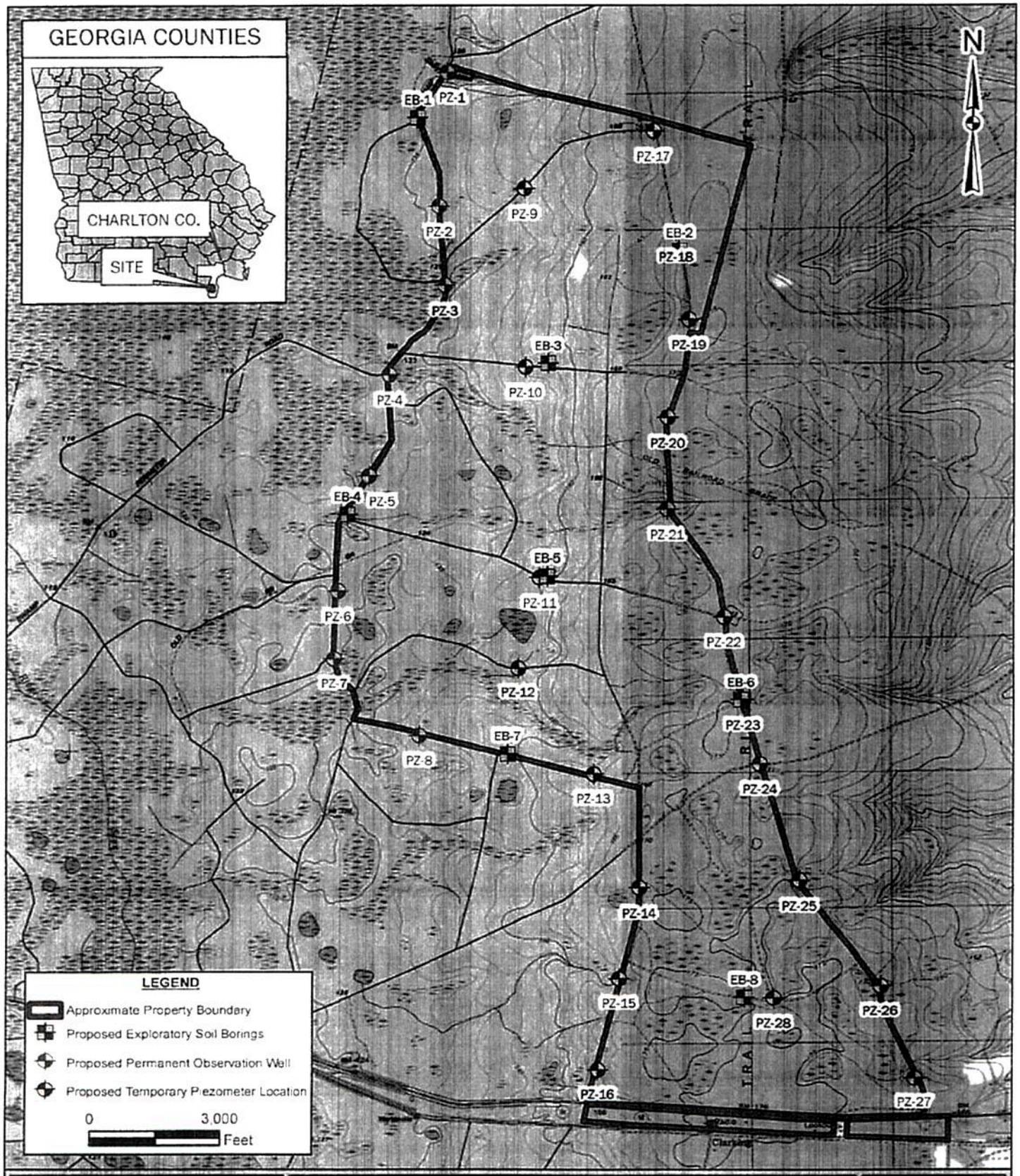

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FIGURE 2: PROPOSED PIEZOMETER & EXPLORATORY BORING LOCATION MAP

TWIN PINES MINERALS

CHARLTON COUNTY, GEORGIA

BASEMAP: Moniac Georgia/Florida USGS 7.5 Minute Topographic Map (1968) and Saint George Georgia/Florida USGS 7.5 Minute Topographic Map

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DRAWING DATE: 08/02/2018	
REVISION DATE: N/A	
TTL JOB NO. 000180200004.00	
APPROXIMATE SCALE: 1" = 3,000'	

TABLE 1.
ESTIMATED CONSTRUCTION DEPTHS OF PIEZOMETERS
TWIN PINES PROJECT

Piezometer	Estimated Topo Elevation (ft. amsl)	Estimated GW Elevation (ft. amsl)	Estimated Depth to GW (ft bgs)	Estimated Construction Depth of Piezometers
PZ-1	125.00	120.00	5.00	14.00
PZ-2	125.00	120.00	5.00	14.00
PZ-3	125.00	120.00	5.00	14.00
PZ-4	125.00	120.00	5.00	14.00
PZ-5	125.00	120.00	5.00	14.00
PZ-6	125.00	120.00	5.00	14.00
PZ-7	125.00	120.00	5.00	14.00
PZ-8	135.00	120.00	15.00	25.00
PZ-9	135.00	120.00	15.00	25.00
PZ-10	135.00	120.00	15.00	25.00
PZ-11	150.00	120.00	30.00	40.00
PZ-12	140.00	120.00	20.00	30.00
PZ-13	155.00	120.00	35.00	45.00
PZ-14	170.00	120.00	50.00	60.00
PZ-15	165.00	120.00	45.00	55.00
PZ-16	165.00	120.00	45.00	55.00
PZ-17	160.00	120.00	40.00	50.00
PZ-18	165.00	120.00	45.00	55.00
PZ-19	170.00	120.00	50.00	60.00
PZ-20	170.00	120.00	50.00	60.00
PZ-21	165.00	120.00	45.00	55.00
PZ-22	170.00	120.00	50.00	60.00
PZ-23	170.00	120.00	50.00	60.00
PZ-24	170.00	120.00	50.00	60.00
PZ-25	170.00	120.00	50.00	60.00
PZ-26	170.00	120.00	50.00	60.00
PZ-27	170.00	120.00	50.00	60.00
PZ-28	170.00	120.00	50.00	60.00
Total Estimated Piezometer Footage				**1158.00**

ft. amsl = feet above mean sea level

ft. bgs = feet below ground surface

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From:	Somerville, Eric
To:	"Mark Tanner"; Jarod.M.Lopes@usace.army.mil
Cc:	single@greenfuelsenergy.com; Mark Fowler; Cindy House-Pearson; Christopher Stanford; Sheryle Reeves; Jim Smith - Home; Christopher Terrell; Marcel Scheeff; Bill Wikoff (FWS); "Lusk, Michael"; Garvey, Kimberly L
Subject:	EPA comments - Twin Pines Mineral Exploration Work Plan (SAS-2018-00554)
Date:	Wednesday, September 5, 2018 8:43:00 AM

Greetings All-

Thank you for forwarding the proposed "Twin Pines Mineral Exploration Work Plan," dated August 23, 2018. I have reviewed the Work Plan and respectfully submit the following comments for your consideration.

The hydrology of the Okefenokee Swamp and adjacent areas of southeast Georgia and northeast Florida has been the subject of numerous investigations, including general overviews and descriptions (e.g. Clarke et al., 1990; Loftin, 1997; Thom et al., 2015), hydrologic models (e.g. Brook and Hyatt, 1985; Brook and Sun, 1987; Loftin et al., 2000; 2001; Mao et al., 2013), evapotranspiration rates (e.g. Yin and Brook, 1992) and the effects of the region's hydrology on its fire regime (e.g. Yin, 1993), to name but a few.

By comparison, the "Previous Studies" section of the Work Plan cites only a single 1989 publication and does so only to generically characterize Trail Ridge itself. The Work Plan further states that "... not much is known regarding the groundwater hydrology (occurrence and movement)" along Trail Ridge. I am concerned that the project proponents may not have conducted a rigorous review of previous efforts to characterize the region's hydrology. While I am admittedly uncertain whether a 30-year old water budget for the Okefenokee Swamp watershed (~Brook and Hyatt, 1985) would provide useful insights into our present endeavor, the volume of published material on the region's hydrology warrants a close review. The present Work Plan leaves me uncertain that such a review has been conducted.

In general, the questions to be answered by the hydrologic investigation are not framed very clearly in the Work Plan. Consequently, the conceptual framework demonstrating how the proposed instrumentation will allow for collection and analysis of data to answer those questions is insufficiently described.

The description of piezometers in the Work Plan fails to include a number of important details. For example, over what interval will the proposed piezometers be screened? Should there not be pairs of nested piezometers screened at different intervals (i.e. some shallow and some deep) in order to assess the potential for groundwater movement upward or downward through any existing impeding soil layers? In addition to piezometers, perhaps shallow monitoring wells screened throughout the upper soil profile would be useful for assessing near-surface soil saturation; not as a substitute for piezometers, but as a compliment to them. Again, I believe the questions to be answered by the investigation need to be clearly and unambiguously described. Only then can the proposed data collection (i.e. instrumentation) and analysis be critically reviewed.

During our conference call on August 7, 2018, I understood a representative of the project team to state that mining will always be at least one mile away from the Okefenokee National Wildlife

Refuge boundary, and in fact, excavation would typically not occur within 1,000 feet of the project site's western property boundary. If the latter is true, why can the hydrology study not include an additional array of permanent piezometers east of the western property boundary? Arrays of instrumentation that include not only the ones proposed on the western property (i.e. PZ-1 thru PZ-7), but also eastward and arguably westward of them would better illustrate lateral water movement across the hydraulic gradient between the mining area and the undisturbed areas to the west than a single array of instruments alone.

The Work Plan indicates that Phase II of the proposed hydrologic investigation will include an aquifer pump test to estimate transmissivity and storage in the aquifer system, which "can be used" to model groundwater. I am admittedly not a modeler, but I must nonetheless question whether a distributed model that incorporates both surface water and groundwater might be more applicable here (e.g. GSSHA, GSFLOW, etc.). Considering that our concerns include not only aquifer flow, but also the potential effects of shallow groundwater perturbation on nearby unmined wetlands, these models that incorporate surface soil moisture, groundwater levels, stream and surface water interactions, etc. seem highly applicable. I note too, that the Work Plan states that the proposed aquifer pump test "can be used" to develop a model; not "will be used." I'm not suggesting that the project proponents are trying to play word games with us, but words do have meaning, and those meanings can make a difference in expectations.

Thank you for allowing me to review the draft Work Plan. I look forward to continued discussions about the hydrologic investigation and the project itself more generally. Please do not hesitate to contact me if you have any questions or would like to arrange additional meetings or conference calls.

Regards.

-Eric

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From: Mark Tanner [mailto:mtanner@ttlusa.com]
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Cc: single@greenfuelsenergy.com; Mark Fowler <mfowler@twinpinesminerals.com>; Cindy House-Pearson <chpearson@ttlusa.com>; Christopher Stanford <cstanford@ttlusa.com>; Sheryle Reeves <sreeves@ttlusa.com>; Jim Smith - Home (b)(6) Personal Privacy Christopher Terrell <cterrell@ttlusa.com>; Marcel Scheeff <mscheeff@ttlusa.com>
Subject: FW: 000180200804.00 Twin Pines Mineral Exploration Work Plan

Jerod (USACE), Eric (USEPA), and Bill (USF&WS),

This email contains a copy of the Work Plan for the hydrogeological evaluation (see attached PDF) on the Twin Pines Minerals project in Charlton County, Georgia. Per the request of the USACE, USEPA, and USF&WS as made during our meeting in Savannah on August 7, 2018,

this Work Plan is transmitted on behalf of TTL's Client, Twin Pines Minerals. Upon completion of your reviews, please contact any of the following with TTL if you have questions:

Jim Smith - (b)(6) Personal Privacy [redacted]
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Thank you,

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