Twin Pines Minerals, LLC

LOCAL GROUNDAWATER/SURFACE WATER HYDROLOGY AT TWIN PINES MINE

Prepared For:

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PROPOSED HEAVY MINERALS MINE
ST. GEORGE, CHARLTON COUNTY, GEORGIA

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INTRODUCTION

On July 3, 2019, Twin Pines Minerals (TPM) submitted an individual permit application to the U.S. Army Corps of Engineers for impacts to water of the United States to develop a heavy mineral sand mine along Trail Ridge in Charlton County, Georgia (Figure 1). The proposed mine is located 3.2 miles west of St. George, Georgia, along Georgia State Highway Route 94. Trail Ridge is a 0.6 to 1.2 mile wide and 99 mile long topographic ridge that separates the Okefenokee Basin and Swamp from the coastal plain of Georgia (Force and Rich, 1979). It represents the crest of a former beach complex and was formed as inland sand dunes near the proposed Twin Pines Mine (e.g., Pirkle et al. 1993). The ridge is underlain by a shallow aquifer, locally known as the surficial aquifer, which forms a hydrologic divide between the Okefenokee swamplands to the west and the Saint Mary's River to the east. At the proposed mine site, the water table is very shallow with water depths of only a few feet. The surficial aquifer is perched on the clays of the upper Hawthorn Group, which is considered to be the upper confining unit to the Floridian Aquifer in the region (e.g., Williams and Kuniansky, 2016).

The proposed permit area is approximately 2,414-acres, located southeast of the Okefenokee National Wildlife Refuge (ONWR) boundary; however, TPM will only mine an approximate 1,268-acre area located about 2.7 miles from the ONWR boundary (Figure 2). The portion of the proposed permit area extending from the western mining boundary to the edge of the permit boundary will be avoided and will provide a buffer to the ONWR.

The project study area consists of approximately 12,000-acres of land located near St. George, Charlton County, Georgia. This area is comprised of five (5) tracts identified as Loncala, Dallas Police & Fire, Keystone, TIAA, and Adirondack. To evaluate local groundwater elevations, surface water elevations, and precipitation history, field activities were performed both within the proposed mining area and on adjacent properties outside of the proposed mining area footprint. Reference to "project study area" in this report refers to activities conducted within the proposed mining area and adjacent tracts.

Field activities performed to collect local surface water, precipitation, and groundwater data at the site included the following:

- Installation of 23 staff gauges at surface water locations across the project study area.
- Collection of local precipitation data from three rain gauges installed by Twin Pines personnel at the northern, central, and southern portions of the project study area.
- Deployment of 111 data loggers in select piezometers, observation wells, and staff gauge locations.

The purpose of the above-referenced activities was to obtain water-elevation data that could be used to evaluate (1) the response of groundwater and surface water to precipitation events, (2) groundwater and surface water interaction, (3) fluctuations of water elevations over time, and (4) groundwater flow direction and velocity.

STAFF GAUGE INSTALLATIONS

A total of 23 staff gauges were installed to evaluate surface water elevations across the project study area. Each staff gauge segment measured approximately 3.3 feet in length and was mounted to a metal fence post or pressure-treated wood post so that the base of the gauge was positioned at ground surface. A list of the 23 staff gauges installed and their identifiers is provided in the Table 1. A map of staff gauge locations within the project study area is provided in Figures 3.

RAIN GAUGE INSTALLATIONS

TPM personnel installed three (3) HOBO rain gauge data loggers at the site in November 2018. The three rain gauge locations (RG01, RG02, and RG03) were installed at the northern, central, and southern portions of the project study area. Locations of the rain gauges are shown on Figure 4. The data loggers for each rain gauge recorded the cumulative accumulation of precipitation in units of hundredths of an inch. Rain gauge data was manually downloaded in the field by TPM representatives on a monthly or bi-monthly basis. The precipitation data was compiled into spreadsheets and the total daily precipitation accumulation (in inches) was computed for each rain gauge. Each rain gauge was reset after a download event. Daily precipitation data for the project study area was collected and analyzed from November 28, 2018 to October 16, 2019 (latest download). A summary of the daily precipitation data recorded at the rain gauges is provided in Table 2.

DATA LOGGER INSTALLATIONS

Piezometers and Observation Wells

Between January and July, 2019, TTL installed 88 In-Situ, Inc. Rugged Troll 200 non-vented data loggers equipped with a cable setup for direct-read at land surface in select piezometers and observation wells (Figure 5). Each data logger deployed was programmed to record groundwater elevation, water pressure, and temperature data at ten-minute intervals. Additionally, In-Situ, Inc. Rugged BaroTroll 200 data loggers were deployed at land surface across the site to measure and log barometric pressure and temperature. Table 3 list piezometers and observation wells where data loggers were deployed.

TTL personnel used a tablet and/or laptop to manually download Rugged Troll and BaroTroll data from each monitoring location. The In-Situ, Inc. BaroTroll 200 data and Win Situ 5/Baro Merge Software were used to automatically correct groundwater elevation data (recorded with the Rugged Troll 200) for barometric pressure changes. This corrected data was exported and compiled into a separate spreadsheet for each monitoring location. Due to the high number of measurements recorded at 10-minute intervals, the data was simplified to show one corrected groundwater elevation measurement per month (each measurement selected at approximately the same calendar date/time each month). These monthly groundwater elevations are listed in Table 4.

Staff Gauges

Between January and May 2019, TTL installed In-Situ, Inc. Rugged Troll 200 non-vented data logger/cable combinations at the 23 staff gauge locations across the project study area (Figure 3). Each data logger/cable combination deployed was programmed to record surface water elevation, water pressure, and temperature data at ten-minute intervals. The data loggers were installed at each staff gauge with the transducers tip positioned at the approximate ground surface.

The data from the staff gauge data loggers was downloaded and subsequently corrected in the same manner described in the preceding section for piezometers and observation wells. The data was also simplified to show one corrected surface water elevation measurement per month (each measurement selected at approximately the same calendar day date/time each month). These monthly surface water elevations are listed in Table 5.

SUMMARY

Rain Gauge Data

Review of Table 2 and the rain gauge graphs in Appendix A indicates that the greatest rainfall occurred during the months of December 2018 and July 2019 with monthly rainfall gauge totals of about 8 and 14 inches, respectively. Additionally, during the November 28, 2018 to October 16, 2019 rain gauge monitoring period, monthly rainfall totals varied from about 0.1-inch to over 2-inches in measurements recorded at the three rain gauges. This range of differences in rainfall between the three rain gauges is related to the size of the project study area and indicates variation in local weather patterns. For example, during site field activities, field personnel observed rainfall occurring on the north side of the study area while no rainfall was observed on the southern half of the study area. Hydrograph plots for the three rain gauges are included in Appendix A.

Hydrograph Data

Data logger measurements were used to generate hydrographs for comparing daily groundwater and surface water elevations to precipitation data. Hydrograph plots comparing daily groundwater elevations and precipitation data from the closest rain gauge are included in Appendix B. Hydrograph plots comparing daily surface water elevations and precipitation from the closest rain gauge are included in Appendix C. Hydrographs plots comparing a combination of daily groundwater and surface water elevations and precipitation from the closest rain gauge are included in Appendix D. Piezometers and staff gauge data logger measurements recorded at 10-minute intervals were converted to a Portable document format (PDF) and are provided in Appendix E.

Review of the hydrographs indicates that depths to groundwater beneath the site generally range from just below ground surface (bgs) to five feet bgs; however, during periods of increased precipitation, the water levels in some piezometers were observed to temporarily rise above the top of the well casings. Groundwater and surface water elevations generally declined from January through June 2019 followed by a sharp increase during the month of July and a second decline from August to October, which correlates with seasonal rainfall fluctuations at the site. During the January to June and August to October periods of decline of groundwater levels, surface water elevations also decreased and were dry at several staff gauges locations. The hydrograph data indicates that both groundwater and surface elevations showed similar response times to precipitation events at the site, which suggest that the infiltration rate was generally greater than the runoff rate at the monitored locations. Additionally, changes in groundwater elevations and time of response compared to precipitation data were generally the same in shallow and deep piezometer pairs.

An examination of the rain gauge data reveals that rainfall across the project study area varies spatially. Hydrographs show that groundwater levels respond quickly to distant rainfall events, even when the closest rain gauge shows no observed precipitation. These rapid responses reflect the high hydraulic conductivity of the surficial aquifer at Trail Ridge. Many observed surface water levels show a significant lag with precipitation data, suggesting that surface water levels in these areas are influenced by groundwater flow.

Hydrograph data from 8 of 12 shallow and deep piezometer pairs within or adjacent to the permit area indicated less than a 0.5-foot separation in groundwater elevations between the deep and shallow piezometers (Figure 6 and Appendix F). These eight piezometers are identified as PZ33D/S, PZ31D/S, PZ29D/S, PZ30D/S, PZ55D/S, PZ28D/S, PZ25D/S, and PZ27D/S. Hydrographs from the remaining three shallow and deep piezometer pairs PZ16D/S, PZ48D/S, PZ57D/S, and observation wells OWB1D/S/BS showed separation of groundwater elevations that ranged from 1 to 3 feet above mean sea level (amsl). The small separation between groundwater elevations in these shallow and deep piezometers/wells, as well as, similar response times to rain events indicates that permeability of subsurface soils within the majority of proposed permit area is generally homogenous.

Groundwater elevations in deep piezometers PZ01D, PZ03D, PZ36D exhibited artesian conditions, with groundwater elevations that rose above those of their respective partner shallow piezometer. These three piezometers are located outside the proposed permit area, along the west-northwestern boundary of the project study area. Data collected from shallow and deep piezometer pairs PZ39D/S, PZ45D/S, PZ58D/S, and observation wells OWA1D/1S/1BS, located northeast of the proposed permit area, showed differences of groundwater elevations ranging from about 4 feet to 13 feet. The groundwater elevation differences in these shallow and deep piezometers/wells indicates that the permeability of subsurface soils northeast of the proposed permit area is likely more heterogeneous.

Potentiometric Surface Map Data

Water elevation data collected on January 26, April 26, and July 26, 2019, was used to generate potentiometric surface maps of the surficial aquifer (Figures 7 through 9, respectively). Review of the potentiometric surface maps indicates that groundwater elevations at the site generally mimic land surface topography with groundwater flowing to the west and east of Trail Ridge. This indicates that Trail Ridge represents a hydrologic divide within the underlying surficial aquifer. Groundwater flow along the west side of Trail Ridge is to the west. Groundwater flow along the east side of Trail Ridge is to the east. Review of Table 4 indicates that groundwater elevations beneath the site range from a high of about 174 feet above mean sea level (amsl) along the crest of Trail Ridge to 108 feet amsl along the east side of the project study area. Depths to groundwater in the shallow piezometers beneath the site generally range from just below land surface to about 5 feet below ground surface (bgs).

Assuming steady groundwater flow, the Darcy flux and the groundwater velocity can be estimated by determining the hydraulic gradient along a streamline, averaging the hydraulic conductivity values determined from slug tests, and assuming an effective porosity (0.32 for medium sand; McWorter and Sunada, 1977; Yu et al, 1993). Four streamlines were selected from the July 2019 potentiometric surface map (Figure 9), the horizontal distance between select equipotentials was determined for each streamline, and the hydraulic gradient was determined. The resulting hydraulic gradients were 5.573×10^{-3} for the northwest streamline, 6.456×10^{-3} for the southwest streamline, 8.729×10^{-3} for the northeast streamline, and 6.066×10^{-3} for the southeast streamline. The average hydraulic conductivity from slug tests conducted in the permit area (south streamlines) was 10.3 feet per day (ft/day), and slug tests conducted in the northern part of the study area had an average hydraulic conductivity of 16.0 ft/day. The average groundwater velocity along the west and east sides of the ridge was approximately 0.24 ft/day and 0.32 ft/day, respectively, in July 2019. The average Darcy Flux along the west and east sides of the ridge was approximately 0.08 ft/day and 0.10 ft/day, respectively, in July 2019.

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