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Geotechnical Summary
MRL Aggregate Resource Evaluation
TMR (Thorndyke Mineral Resource
Area)
Jefferson County, Washington
Job No.FredHill.01R

INTRODUCTION

This summarizes our site observations and subsurface exploration data and provides our conclusions and opinions with regard to the geologic conditions and aggregate resource present in the TMR. In general, the proposed TMR (Thorndyke Mineral Resource area) is located south of SR 104, northwest of Thorndyke Road, and generally east of Thorndyke Creek. The property is situated within a larger block of timber resource property that is owned and managed by Pope Resources.

GEOLOGIC CONDITIONS

Interpretation of the geologic conditions at the site are based on our review of the available geologic literature, our site observations, and over 100 test pits and nineteen borings completed in the site area. The borings ranged in depth from approximately 35 feet to 420 feet (to Elevations 300 to 15 feet above sea level). Observation wells were installed in the borings and have been monitored for up to 2 years.

In general, the soils in the region consist of (from oldest to youngest): undifferentiated pre-Vashon glacial and interglacial sediments that are overlain by Vashon advance outwash, glacial till (hardpan) and recessional outwash sediments. Locally, ice marginal or ice contact deposits occur along the margins of ridge and shoreline slopes. Alluvial silts with organic debris occur in isolated valley floor areas near the toe of slopes. These silty soils perch surface water (wetlands) locally.

The older glacial and interglacial sediments are exposed along portions of the Hood Canal shoreline bluff located east and south of the TMR area and were encountered in the deeper borings in the site area. These soils typically consist of bedded silts or clays, sands and gravels and occasional glacial till deposited by pre-Vashon glaciers and meltwaters. These older sediments are in a very dense or very hard condition where undisturbed.

The TMR is situated within a Vashon glacial outwash area located west of the Hood Canal Bridge in the northeast portion of the Toandos Peninsula. During the Vashon glacial period, approximately 10,000 to 15,000 years ago, the pre-glacial geomorphic conditions of the TMR combined with the advancing and receding glacial ice conditions to deposit thick layers of high quality aggregate (sand and gravel) material within confined areas. These aggregate materials were deposited in front of the

advancing glacial ice and also as the ice melted and receded. The geomorphology or topography and pre-glacial geology of the area, in conjunction with the high energy of glacial melt waters, resulted in the thick layers of clean sand and gravel material being concentrated in this geographic area.

During ice retreat, the glacial outwash channels extended through the Thorndyke and Shine areas. Within the outwash channel areas, the glacial till is thin or absent, as a result of non-deposition or removed later by erosion of the scouring melt water (river) during ice retreat. Where this occurred, recessional sand and gravel deposits were deposited directly over the advance sand and gravel deposits, resulting in a thick section of high quality aggregate material that is economic for extraction.

Thick deposits of clean high-quality sand and gravel material, like those that occur in the Thorndyke area, are rare. Aggregate resource deposits of this nature and size are rare throughout the world. Although the Puget Sound area is blessed the several of these large aggregate deposits, to date no others have been identified in the Kitsap or Olympic Peninsula areas. The TMR is a valuable resource that will provide aggregate resource material to the region on a long-term basis. The location of the TMR in a relatively unpopulated area reduces the potential impacts to developed areas. It is important that this area be identified and set aside as a resource area, for the future aggregate needs of the region and understanding of the public.

SUBSURFACE CONDITIONS

General

Subsurface conditions at the site were evaluated by excavating over 100 track-hoe test pits and completing nineteen borings in the TMR and surrounding area. Observations wells were installed in the borings to monitor groundwater conditions. The test pits extended to depths of several feet to approximately 20 feet. Many of the test pits encountered sand and gravel to the full depth explored. The borings were completed with an air-rotary drilling rig to depths ranging from approximately 35 to 420 feet below the existing ground surface. Soil samples were collected on a 10-foot interval for further evaluation. Laboratory analyses (sieve tests) of select soil samples were completed from both the test pits and borings. Exploration and laboratory data for the TMR will be maintained in our files.

Nineteen observation wells have been installed within the TMR area to monitor groundwater conditions. The wells range from 35 to 420 feet in depth, extending to between Elevations 300 and 15 feet above sea level. Intermittent near surface seasonal perched aquifers and two deeper confined aquifers were encountered in our explorations and the Shine Pit well. Near-surface seasonal perched water is associated with wetland and lake areas identified within the TMR and surrounding areas. The aquifers encountered underlie most of the region and generally flow toward Thorndyke Creek and the Hood Canal shoreline area.

Aggregate Quality

Based on our site observations throughout the region, excavation of the trackhoe test pits, and completion of the borings, the sand and gravel deposits located within the TMR consist of high quality commercial sand and gravel with cobbles and occasional boulders. The fines content (material passing the US. No. 200 Sieve) varies, but is typically less than 5 percent. This aggregate material is suitable to produce high quality commercial pit run and a variety of select commercial aggregate products. The sand and gravel resources in this area are unusual because of the low fines content, thereby having very little reject or unsuitable soil material. Any reject soil material that cannot be

exported from the site will be utilized for reclamation of the site in accordance with DNR (Washington Department of Natural Resources) regulations.

Adequate coarse gravel, cobbles and boulders occur in the aggregate material observed/encountered to produce commercial crushed products. Sufficient fine to medium sand occurs as lenses and at depth to provide for material binder and select concrete and commercial specialty sand products.

Aggregate Quantity

Based on the results of our subsurface explorations and data review, the aggregate resource quantity within the TRM is that of a regional area resource, capable of supplying a variety of quality commercial aggregate products to local intra-state and inter-state regions on a long-term basis. There are no other known aggregate resources of this quality and quantity in the Olympic and Kitsap Peninsula areas.

Surface and Groundwater Conditions

Within the MRL area, surface water occurs seasonally within Thorndyke Creek located west of the site and as seasonal perched near-surface water in localized wetland and lake areas in the east portion of the site. Based on the results of our explorations and preliminary mine plan, the lower mining limits will be above the nearby channel bottom elevations of Thorndyke Creek. Mining will not be conducted below the water table.

The seasonal water in the isolated wetland areas is perched on localized layers of fine-grained soil (silty/clay) and organic debris that accumulated since the retreat of the Vashon glacier. These materials have a low permeability and perch surface water that accumulates in these low-lying areas. These wetlands and lakes are not in direct continuity with the underlying aquifer systems. Mining will be setback from these areas.

Two aquifers were encountered in borings/observation wells and test pits. Water supply wells in the area typically produce water from the lower of the two aquifers encountered in the site area, or from even deeper pre-Vashon sediments like that at the Bridgehaven community. The upper aquifer encountered at the site occurs within the Vashon outwash materials. Based on the water levels measured in the observation wells, groundwater flow of this aquifer is to the south. We expect that this aquifer provides spring flow along portions of Thorndyke Creek and the south shoreline Hood Canal (approximately Elevation 100).

The pre-Vashon aquifer system encountered in the TMR is overlain by a generally impermeable silt/clay layer (aquitar) and is therefore a confined aquifer. This is evidenced by water levels in Boring 14 (located near Wahl Lake) and the Fred Hill process area water well, which rose approximately 150 feet (artesian condition) after well completion. This aquifer was not encountered in a deep well completed in the southeast portion of the TMR (Boring 18). The Bridgehaven wells are completed in an aquifer that is an additional 100 feet or more below the pre-Vashon aquifer in the site area.

CONCLUSIONS

Based on the results of our subsurface explorations, site reconnaissance, review of the available data and our experience, it is our opinion that the proposed TMR contains nearly unique, significant and beneficial aggregate resources. Aggregate products from the TMR area will be utilized for a variety of private and public projects, including private and public road construction. The TMR aggregate material will be available for existing and future projects in potential local, intra-state and inter-state markets.

The aggregate resources identified and historically mined within the TRM are high quality and of sufficient quantity to be considered a long-term commercial aggregate resource. The aggregate materials observed are suitable for use in the production of a variety of select aggregate and crushed rock products. Products produced from the area will include select fill and drainage materials, concrete production, crushed rock products, and a variety of select specialty products commonly used for construction/earthwork projects.

Surface water in the TMR will not be impacted by the proposed mining activity. The mining depth will not extend laterally to or below the nearby Thorndyke Creek channel. A minimum 200-foot buffer has been established from Thorndyke Creek such that no mining will occur in that area. Mining will remain a minimum of 10 feet above the water table that potentially discharges to Thorndyke Creek (as seeps or springs).

Seasonal perched wetlands in the TMR area will not be effected by the mining activity. These wetlands are perched on accumulated silt/clay and organic material. Setbacks from the wetland areas will preserve these perching layers, thereby protecting the wetland environments.

Lost Lake is also in a perched condition, but on glacial till (hardpan). Lost Lake is a classic kettle lake, formed in a depression in the till surface. Kettle lakes are typically formed by a large block of glacial ice separated separated from the glacier during its retreat. Buffers and mining setbacks will adequately protect Lost Lake.

Groundwater in the site area will be protected from potential impacts from mining. A significant amount of subsurface data has been developed for the site and surrounding area. Mining will not extend into the aquifers below the site, but will remain a minimum of 10 feet above the water table. The observation wells completed in the site area will be utilized to monitor groundwater levels prior to and during mining operations.

The pre-Vashon aquifer in the site area is separated from the Vashon aquifer and the overlying sand and gravel soils to be mined by a thick sequence of silt and clay materials. These soils form an aquitard that restricts the downward migration of the overlying groundwater and thereby protects the underlying pre-Vashon aquifer.

The still deeper aquifer that supplies water to the Bridgehaven wells and single-family residence along the shoreline area is situated below an additional zone of impermeable silt and clay soils, over two hundred feet below the proposed mining depth. The Bridgehaven wells are situated more than 1.5 miles east-southeast of the mine site.

The pre-Vashon aquifers are artesian in nature, demonstrating significant hydrostatic pressures. The artesian condition of these aquifers within the area of the site preclude the downward movement of overlying groundwater and protects the groundwater from any potential contamination by mining activity within the TMR area.

In addition to the above geologic and hydrologic conditions that will preclude any significant adverse impact, mining operations at the site will be conducted in accordance with BMPs (Best Management Practices) and current regulatory requirements. Mining at the site will be monitored by a variety of State and Jefferson County regulatory agencies on an on-going basis.



We have prepared this report for Fred Hill Materials and their representatives for use in evaluating the potential aggregate resources of the above-described area. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared.

If you have any questions regarding this report or need additional information please call.

Yours Very Truly,
GeoResources

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