Project No. 4473-01
August 15, 2016
Revised October 7, 2016

Hansen Bros. Enterprises
P.O. Box 1599
Grass Valley, CA 95945

Attention: Jeff Hansen

Reference: Hansen Bros. Greenhorn Creek Aggregate Mining Expansion
Use Permit No. U15-008, Reclamation Plan No. RP15-001
Nevada County, California

Subject: Geotechnical and Hydrological Feasibility Assessment

Dear Mr. Hansen:

Holdrege & Kull (H&K) prepared this letter to summarize our preliminary geotechnical engineering evaluation of the Hansen Bros. Enterprises (HBE) proposed Greenhorn Creek Aggregate Mining Expansion, and to provide an opinion regarding the feasibility of the proposed expansion from a geotechnical and hydrological engineering standpoint. The findings presented herein are based on H&K’s review of project documents, observation of surface conditions at the proposed aggregate harvesting areas, and review of published maps and literature. This feasibility assessment is intended to support a use permit application for the proposed expansion.

Based on the findings presented herein, and the mitigation measures included in the Mining and Reclamation Plan (BT Consulting, 2016), H&K’s opinion is that the proposed aggregate harvesting expansion is generally feasible from a geotechnical and hydrological engineering standpoint. H&K’s primary concerns are related to the potential for localized slope instability and erosion during the winter season. Therefore, H&K recommends that slope conditions in the active harvesting area be reviewed on an annual basis during the late summer to evaluate the soil and rock conditions exposed by aggregate removal. If specific geotechnical recommendations are required during the course of the project, subsurface investigation and analysis may be required to develop specific geotechnical design criteria.
INTRODUCTION

HBE owns and operates a gravel extraction and washing plant (Greenhorn Plant) located north of You Bet Road on Greenhorn Creek in Nevada County, California. The Greenhorn Plant is located in Section 2, Township 15 North, Range 9 East and Section 35, Township 16 North, Range 9 East based on the Mount Diablo geodetic datum (USGS, 1979), on portions of Nevada County Assessor’s Parcel Numbers (APNs) 12-800-04, 12-800-05 and 38-450-29. The Greenhorn Plant location and the proposed aggregate harvesting expansion areas are depicted on Figures 1 and 2. This feasibility assessment is intended to support a use permit application for the proposed aggregate harvesting expansion.

Project Description

The project is described in the Amended Surface Mining and Reclamation Plan for Greenhorn Creek Harvesting and Material Processing in Grass Valley, California (BT Consulting, May 2016). An environmental assessment (HBE, 2015a) and a reclamation plan application (HBE, 2015b) contain supporting information.

The existing sand and gravel harvesting area is located along Greenhorn Creek to the north-northeast (upstream) of the Greenhorn Plant. HBE proposes to expand the harvesting area to include four parcels located adjacent to the existing harvesting area. Three of the four parcels, APNs 38-430-02, 38-380-15, and 38-380-16, are located along the sides of the existing harvesting area, and the slopes of the existing harvesting area extend into the subject adjacent parcels. The fourth parcel, APN 38-370-17, is located upstream of the existing harvesting area and will be used to extend the operation further upstream to sustain the existing operation. The proposed expansion areas are depicted on Figures 1 and 2.

HBE does not propose to increase the scope of the existing gravel extraction and washing plant operations. Rather, HBE proposes to permit additional harvesting areas with the intent to continue the operation in its current/historic capacity.

The aggregate harvesting area is a stream canyon with steep, fairly heavily wooded sides rising several hundred feet to rounded ridge tops. The Mining and Reclamation Plan (BT Consulting, 2016) describes the material to be harvested as aggregate material that consists of a range of large cobble to fine sand. Material is to be harvested from dry sand bars and transported to the Plant. The width of the aggregate deposit varies from approximately 40 feet wide to approximately 600 feet wide. HBE (2015b) estimates the average depth of the aggregate deposit to be approximately 30 feet.
The Mining and Reclamation Plan (BT Consulting, 2016) states that the project will remove a sand and gravel that was deposited as a result of historic hydraulic gold mining, and will return the canyon to a setting similar to its pre-hydraulic mining configuration. According to the Mining and Reclamation Plan (BT Consulting, 2016), the resulting stream channel will be made to be of sufficient size to pass the 100 year peak flow, and if the bedrock canyon walls underlying the aggregate deposit to be removed are less than 35 percent, then no adjustments to the slope are planned. Sand and gravel will be left against slopes that are steeper than 35 percent. Figures from the Mining and Reclamation Plan depicting current and proposed slope configurations are attached.

**Adjacent Land Use**

Zoning of adjacent land is depicted on Figure 2, which is based on the County of Nevada Geographic Information System (GIS; County of Nevada, 2015). In the vicinity of the Greenhorn Plant and the proposed harvesting expansion areas, land is generally zoned as low-density agricultural and forest. Some adjacent land is zoned as forest/mineral extraction combining district, allowing for surface mining and providing for public awareness of the potential for surface mining.

As depicted on Figure 3, approximately 107 developed low-density residential parcels are located within a one-mile radius of the Greenhorn Plant. Because land in the vicinity of the Project includes National Forest and low-density zoning designations, it is not expected in the near future that a significant increase of the residential density will occur.

**Environmental Review**

H&K understands that an Initial Study and Checklist is under preparation by the County of Nevada. Our opinion is that the following items related to geology/soils and hydrology/water quality qualify to be designated as “less than significant with mitigation.”

- Result in exposure to or production of unstable earth conditions such as landslides, earthquakes, liquefaction, soil creep, mudslides, ground failure (including expansive, compressible, collapsible soils), or similar hazards.
- Result in disruption, displacement, compaction, or over-covering of the soil by cuts, fills, or extensive grading.
• Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

• Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

• Result in any increase in wind or water erosion of soils, on or off the site.

• Changes in siltation, deposition or erosion, which may modify the channel of a river, or stream, or the bed any bay, inlet or lake.

• Result in excessive grading on slopes of over 30 percent.

• Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site.

• Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site.

• Create or contribute to runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.

**Mitigation Measures**

The Mining and Reclamation Plan (BT Consulting, 2016) includes the following environmental mitigation measures related to hydrology and water quality:

• The materials to be mined are limited to the aggregate deposits (placer materials).

• At least two surveyed cross sections within the creek bed gravel extraction area and immediately adjacent terrace/slope surfaces are required at five year intervals.

• Extraction of sand and gravel from the channel is to be regulated to control channel degradation in order to prevent undermining of bridge supports, exposure of pipelines or other structures buried within the channel, loss of spawning habitat, lowering of groundwater levels, destruction of riparian vegetation, and increased stream bank erosion.
Stream relocation is not to be performed in a manner that causes damage to adjacent properties during periods of high water. The installed berms along the channel are required to be at a height that is the lowest possible to contain the creek. Before the winter period, the berms are required to be lowered to a height that will allow the channel to meander.

Temporary stream channels are required to be built in clean gravels and not excavated in silts or soil.

Gravel extraction is prohibited within 25 feet of the main channel of Greenhorn Creek to prevent dewatering of the creek channel. If the 25-foot distance results in dewatering of the channel; the distance shall be increased. Monitoring of extraction activities is required to prevent or cease any action that may result in dewatering of the creek.

Structures and associated materials not designed to withstand high season flows are required to be removed to areas above the high water mark before such flows occur.

Mining within Greenhorn Creek is restricted to periods of low stream flow and dry weather during the period of April 1 to December 31 of the same calendar year. Mining activities are to be timed with awareness of precipitation forecasts and likely increases in stream flow. Mining activities within the floodplain are required to cease until all reasonable erosion control measures, inside and outside of the floodplain, have been implemented prior to all storm events. Work is prohibited when there has been two inches of rain (or more) in a 24-hour period (revegetation, restoration, and erosion control work is not confined to this period).

Erosion and sedimentation is required to be controlled during all phases of construction, operation, reclamation, and closure of the mining operation to minimize siltation of lakes and watercourses. The operation is required to ensure that surrounding land and water resources are protected from erosion, gullying, sedimentation, and contamination.

Precautions to minimize turbidity and siltation are required to be taken, and adequate erosion and siltation controls measures are required to be used to prevent turbid or silt-laden water from entering the stream.

Inspection of the mined areas and mitigation of potential erosion concerns is required during the fall season of each year.
LITERATURE REVIEW

H&K reviewed readily available geologic literature pertaining to the project locations, as summarized below.

Geologic Setting

According to the Geologic Map of Western Nevada County, California (California Division of Mines and Geology, 1990), recent alluvial deposits are mapped within the Greenhorn Creek canyon, and are generally underlain by Calaveras Complex metasedimentary and volcanic rocks.

The California Geological Survey Open File Report 96-08, Probabilistic Seismic Hazard Assessment for the State of California and the 2002 update entitled California Fault Parameters, indicate the site location is within the Foothills Fault System. The Foothills Fault System is designated as a Type C fault zone, with low seismicity and a low rate of recurrence. The 1997 edition of California Geological Survey Special Publication 42, Fault Rupture Hazard Zones in California, describes active faults and fault zones (activity within 11,000 years), as part of the Alquist-Priolo Earthquake Fault Zoning Act. The map and document indicate the site is not located within an Alquist-Priolo active fault zone.

Soil Survey

The Soil Survey of Nevada County Area, California (USDA, 1993) indicates that the Greenhorn Creek corridor in the proposed harvesting expansion areas is classified as Placer Diggings (tertiary river deposits and placer mined areas). Upland slopes are mapped as Josephine-Mariposa complex and Mariposa-Maymen complex.

The Josephine-Mariposa complex is generally described as Josephine gravelly loam and Mariposa gravelly loam, with angular gravel fragments comprising 10 to 35 percent of the soil material. Rock outcrop typically covers 2 to 25 percent of the surface area. Runoff is medium to rapid, and the erosion hazard is moderate to high.

The Mariposa-Maymen complex is generally described as Mariposa gravelly loam and Maymen gravelly loam, with rock outcrops covering 2 to 25 percent of the surface. Runoff is rapid and erosion hazard is high.
Hydrogeology

HBE (2015b) estimates that the typical depth to groundwater within the recent alluvial deposits ranges from approximately 0 to 20 feet in the Greenhorn Creek harvesting area, and estimates that the typical depth of the alluvial deposits is approximately 30 feet.

Beneficial uses of the underlying ground water include domestic, industrial, and agricultural supply (CRWQCB, 1998). The Project is located within the Sacramento River Hydrologic Region, which comprises most of the northeastern portion of California.

The Project is not located within an alluvial groundwater basin as recognized by the California Department of Water Resources (DWR, 2014). Rather, groundwater underlying the recent alluvial deposits in the Greenhorn Creek canyon is generally located in bedrock fractures. This fracture-flow hydrogeology results in high spatial variability with respect to groundwater elevation and supply. The depth to groundwater and the quantity of available groundwater depends to a large extent upon the location of a specific groundwater supply well with respect to water-producing bedrock fractures.

Surface Water Hydrology

Surface water drainage is via Greenhorn Creek, tributary to Rollins Reservoir and the Bear River. No streamflow data are available for Greenhorn Creek, and no gauging station data are available from the National Water Information System (USGS, 2015) or NID (2015; personal communication).

The existing beneficial uses of Rollins Reservoir and the Bear River downstream of the discharge are municipal and agricultural supply; industrial supply; water contact and noncontact recreation; aesthetic enjoyment; groundwater recharge; fresh water replenishment; and preservation and enhancement of fish, wildlife and other aquatic resources (CRWQCB, 1998).

Previous Geotechnical Investigation

No previous geotechnical investigation of the subject property is known.

Climatology

The Greenhorn Creek watershed is depicted on Figure 5. Climatic data for the weather station at Nevada City, California were obtained from the California Data Exchange Center (CDEC, 2015). The Project is located approximately 6 miles
southeast of the weather station. Monthly average precipitation reported for the Nevada City weather station is listed in the following table.

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<th>Month</th>
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**FIELD INVESTIGATION**

H&K performed a surface reconnaissance of the proposed harvesting expansion areas in July 2016 to observe existing slope gradients and surface conditions in the proposed harvesting areas.

**FINDINGS AND CONCLUSIONS**

The findings presented herein are based on H&K’s review of project documents, observation of surface conditions at the proposed aggregate harvesting areas, and review of published maps and literature. Based on the findings presented herein, and H&K’s review of the mitigation measures included in the Mining and Reclamation Plan (BT Consulting, 2016), H&K’s opinion is that the proposed aggregate harvesting expansion is generally feasible from a geotechnical and hydrological engineering standpoint.

H&K’s primary concerns are related to the potential for localized slope instability and erosion during the winter season. Based on the steepness of the existing
natural slopes, we anticipate that permanent slopes over 30 percent will be present. The existing slopes consist of relatively resistant bedrock with shallow soil cover.

H&K recommends that slope conditions in the active harvesting area be reviewed on an annual basis during the late summer to evaluate the soil and rock conditions exposed by aggregate removal. If specific geotechnical recommendations are required during the course of the project, subsurface investigation and analysis may be required to develop specific geotechnical design criteria. Specific geotechnical and hydrologic concerns are discussed below.

**Seismic Hazards**

The project site is located within the Foothills Fault System and is not contained within or near an Alquist-Priolo special studies zone. H&K’s opinion is that ground rupture and surface faulting at the site is not likely. The site may experience moderate ground shaking caused by earthquakes occurring along off-site faults. Earthquakes may cause localized instability of slopes associated with the proposed aggregate harvesting areas. However, we anticipate the localized instabilities will consist of shallow (less than 2 feet) raveling of sand and gravel that was left on the side slopes of the harvested areas. Our opinion is that these instabilities will not pose a hazard.

Ground motions may initiate secondary events such as liquefaction and landslides. The likelihood of secondary seismic hazard impacts will be reduced if site grading is performed in accordance with the Mining and Reclamation Plan and the California Building Code.

**Flooding**

As aggregate harvesting progresses, the resultant slope configurations should be monitored in the fall, prior to the rainy season, to identify potential configurations that would contribute to localized flooding. We anticipate that surface water velocities will increase as the sand and gravel is removed, due to the decrease in channel width. The channel will continue to shape into more of the natural channel that existed before hydraulic mining. Even with increased velocities, we do not anticipate that the chance of flooding will be increased. In general, the residences are located above and extend laterally far enough away from Greenhorn Creek that flooding will not impact habitable structures or the downstream bridge any more than what currently exists.
Currently the sand and gravel above the Red Dog Narrows is blocking the Narrows by acting as a dam. Catastrophic failure of this dam could increase flooding downstream. Removing the sand and gravel above the Narrows would decrease the chance of blockage within the Narrows and decrease the chance of flooding downstream.

If conditions are identified that could constrict flow in the creek, additional grading may be necessary to reduce the potential for localized flooding.

**Landslides**

H&K did not observe evidence of landslides nor conditions that would be prone to seismically induced landslides. Our opinion is that the hazard of seismically induced landslides is low, provided that the slopes at the aggregate harvesting areas are monitored and surveyed routinely as described above and pursuant to the Mining and Reclamation Plan.

**Slumps or Land Subsidence**

The proposed aggregate harvesting areas are generally underlain by variably weathered rock, which comprises the original pre-mining drainage course. The bedrock generally does not present a hazard of slumping or subsidence.

Our opinion is that sand/gravel extraction above the narrows will reduce the surcharge loading of the soil/rock conditions in the narrows. Sand/gravel removal will most likely redirect the channel over time back to its original alignment before hydraulic mining, which would direct flow east of the narrows, decreasing the chances of erosion.

In the past, rock overhang in the narrows has collapsed. Our opinion is that future rock fall is possible; however, it should not pose a hazard to surrounding residences.

**LIMITATIONS**

No geotechnical investigation can eliminate all uncertainty. Professional judgment and interpretation are inherent in the process and uncertainty is inevitable. As the aggregate harvesting operation progresses, H&K should be retained to observe slope conditions and to modify these general recommendations if necessary to account for specific slope configurations or weaker materials that were not encountered during this feasibility assessment. If specific geotechnical recommendations are required during the course of the project, subsurface
investigation and analysis may be required to develop specific geotechnical design criteria.

The following limitations apply to the findings, conclusions and recommendations presented in this report:

1. Our professional services were performed consistent with the generally accepted geotechnical engineering principles and practices employed in northern California. No warranty is expressed or implied.

2. These services were performed consistent with our agreement with our client. H&K is not responsible for the impacts of any changes in standards, practices, or regulations subsequent to performance of our services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report. This report is solely for the use of our client unless noted otherwise. Any reliance on this report by a third party is at the party's sole risk.

3. If changes are made to the nature or design of the project as described in this report, then the conclusions and recommendations presented in this report should be considered invalid. Only H&K can determine the validity of the conclusions and recommendations presented in this report. Therefore, we should be retained to review all project changes and prepare written responses with regards to their impacts on our conclusions and recommendations. However, H&K may require additional fieldwork and laboratory testing to develop any modifications to our recommendations. Costs to review project changes and perform additional fieldwork and laboratory testing necessary to modify our recommendations are beyond the scope of services presented in this report. Any additional work will be performed only after receipt of an approved scope of services, budget, and written authorization to proceed.

4. The analyses, conclusions and recommendations presented in this report are based on site conditions as they existed at the time of H&K's investigation. We have assumed that the subsurface soil and groundwater conditions encountered during our investigation are generally representative of the subsurface conditions throughout the entire project site. However, the actual subsurface conditions at locations beyond the investigated area may vary. Therefore, if the subsurface conditions encountered during construction are different than those described in this report, then we should be notified.
immediately so that we can review these differences and, if necessary, modify our recommendations.

5. The elevation or depth to groundwater underlying the project site may differ with time and location.

6. The project site map shows approximate area of investigation as determined by approximate field measurements. Therefore, the location should not be relied upon as being exact nor located with surveying methods.

7. H&K’s geotechnical investigation scope of services did not include evaluating the project site for the presence of hazardous materials or historic mining operations.

8. The findings of this report are valid as of the present date. However, changes in the conditions of the property can occur with the passage of time. The changes may be due to natural processes or to the works of man, on the project site or adjacent properties. In addition, changes in applicable or appropriate standards can occur, whether they result from legislation or the broadening of knowledge. Therefore, the recommendations presented in this report should not be relied upon after a period of two years from the issue date without H&K’s review.

H&K appreciates the opportunity to provide geotechnical engineering services for this important project. Please contact us if you have questions regarding the findings of this assessment.

Sincerely,

DREGE & KULL

Chuck Kull, G.E. 2359
Principal

Attached: References
Figures

Copies: PDF to Hansen Bros. Enterprises /Attn: Jeff Hansen, jhansen@gohbe.com
PDF to BT Consulting /Attn: Alicia Brenner, abrenner@gobtc.net

F:\1 Projects\4473 HBE Greenhorn Creek Expansion\Geotechnical Review\01 Text\4473-01 Geotechnical Feasibility Assessment, HBE Greenhorn Expansion (10-7-16).docx
REFERENCES


California Department of Fish and Wildlife (CDFW), 2007. Lake and Streambed Alteration Agreement, Notification 1600-2007-142-R2. June 12

California Data Exchange Center (CDEC), 2015. California Department of Water Resources. Precipitation records accessed online at http://cdec.water.ca.gov/


California Division of Mines and Geology (CDMG), 1990. Geologic Map of Western Nevada County, California. Plate 1a of the Mineral Land Classification of Nevada County, California. Special Report 164


National Climate Data Center (NCDC), 2009. Average rainfall data for Nevada City weather station, 1931 to 1955, WorldClimate web portal, accessed online in June 2009 at www.worldclimate.com

Nevada Irrigation District (NID), 2015. Personal communication with Brian Powell.


USGS, 1979. Chicago Park 7.5-minute Quadrangle Map, 1949, photo revised 1979
FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
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<td>Figure 1</td>
<td>Location Map</td>
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<td>Figure 2</td>
<td>Land Use Zoning</td>
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<td>Figure 3</td>
<td>Vicinity Development Density</td>
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<td>Reclamation Maps (BT Consulting, 2016)</td>
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<td>Greenhorn Creek Watershed</td>
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Figure 4
Reclamation Maps
NOTE
EXISTING CONTOURS AT FIVE FOOT INTERVALS ARE INTERPOLATED FROM USGS CHICAGO PARK QUADRANGLE, 7.5-MINUTE SERIES, DATED 2012

LEGEND
A ZONE OF UNDISTURBED UPLAND VEGETATION
B ZONE OF MIXED UPLAND AND RIPARIAN VEGETATION FROM NATURAL RESEEDING OR PLANTING IF REQUIRED
C STREAM THREAD - BEDROCK

SECTION A - A
HORIZONTAL SCALE: 1" = 100'  VERTICAL SCALE: 1" = 50'

SECTION B - B
HORIZONTAL SCALE: 1" = 100'  VERTICAL SCALE: 1" = 50'
NOTE
EXISTING CONTOURS AT FIVE FOOT INTERVALS ARE INTERPOLATED FROM USGS CHICAGO PARK QUADRANGLE, 7.5-MINUTE SERIES, DATED 2012

LEGEND
A ZONE OF UNDISTURBED UPLAND VEGETATION
B ZONE OF MIXED UPLAND AND RIPARIAN VEGETATION FROM NATURAL RESEEDING OR PLANTING IF REQUIRED
C STREAM THREAD - BEDROCK
Figure 4f

**LEGEND:**

1. Zone of undisturbed upland vegetation
2. Zone of mixed upland and riparian vegetation from natural reseeding or planting if required.
3. 25-year storm zone vegetation will consist of natural re-vegetation of riparian species on all areas above low 25-year flow. Planting will be assisted if required.

**NOTES:**

1. Ground slopes in area A are actually estimated and plotted at 25-35%.
2. Shape of channel bottom inferred from similar areas where gravel has been excavated.

Date prepared: 5/16/89