Faro/Vangorda

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Mr. Bill Dunn, P.Eng.
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Dear Mr. Dunn:

Re: Geotechnical Review of Faro and Vangorda Pits

INTRODUCTION

As requested, Piteau Associates Engineering Ltd. has completed a review of geotechnical concerns in the Faro and Vangorda Pits. This review and letter report follow similar reviews conducted in the past. The most recent letter report is dated March 25, 1992.

Mr. A. Stewart visited the site on April 9 and 10, 1992. During that time, geologic mapping was reviewed, inspections of the pit walls were made, and results of ongoing pit monitoring were reviewed. Discussions were held with mine personnel regarding these matters. Subsequent to the site visit, additional mapping was conducted in the Vangorda Pit by mine personnel, the results of which were forwarded to Piteau Associates for assessment.

The following summarizes the results of the geotechnical review. Some general aspects which have already been covered in previous letter reports will not be repeated herein.

FARO PIT

General

At the time of the site visit, mining on the east wall of the pit had reached the 3350 ft elevation and drilling was progressing from the 3350 ft level to the ultimate pit bottom at the 3310 ft elevation. As noted in our previous report, the remaining mining is scheduled for below the calc-silicate area and the southern portion of the north slump area. Mining is to be completed by about the middle of April.

During the site visit, temperatures remained slightly below freezing and the pit slopes had a cover of snow. There was no evidence of any rockfall activity and the slopes were performing well. The impact and safety berms that had been

established appeared to be providing adequate catchment. However, some cracking was observed in the face just below the crest of the 3390 ft berm. While it is possible that this cracking is related to stresses acting at the toe of the slope, it is more likely that the cracking is related to the highly folded nature of the rock mass in this area.

Geologic Mapping and Interpretation

Geologic mapping conducted since our last site review indicates that in general the lithology and structural geology are as expected. The "major structures" (i.e. the Faro and Northbound Faults) and joint sets that were described in our report of March 25 as having a significant influence on slope stability in the active mining area, do not appear to have changed appreciably. As such, the discussion contained in our previous report is still considered to be valid. Notwithstanding the general geologic similarity of the recently mined slope, it was noted by Mitch Wasel that severe folding of the bedrock sequence has been exposed, the result being that, in some areas, phyllite has daylighted on the slope. S2 foliation has been undercut locally, which could lead to bench scale failures similar to one which previously occurred. As discussed above, the cracking observed along the crest of the 3390 bench crest is likely related to the folding.

Slope Monitoring

Slope movement rates on the east wall, as determined by prism monitoring, have remained constant or continued to decelerate since our previous report. In this regard, nine prisms have been monitored every four or five days since early March; three in the south slump area, two in the upper portion of the calc-silicate area and four recently installed prisms in the lower portion of the calc-silicate area between about the 3500 and 3550 ft levels. Results of the monitoring indicate that the prisms in the south slump area and the upper calc-silicate area are moving at less than about 5 to 7mm/day. The four recently installed prisms do not appear to have experienced any movement.

It is recommended that prism monitoring be continued as long as mining is actively taking place in the pit. In addition, to protect personnel and equipment in the bottom of the pit, daily visual inspections of the bench face below the 3390 ft bench crest should be carried out. Particular attention should be paid to the portions of this bench face that are highly cracked and where phyllite has been exposed. It is anticipated that some loosening of this area of the slope could occur during the final blast, which could in turn cause some rockfalls or possibly even a bench scale slope failure.

VANGORDA PIT

General

At the time of the site visit, mining in the northern half of the pit was progressing on the 1128 to 1092m levels. While overburden was still being mined in some areas, the overburden/bedrock contact had been exposed in nearly all areas of the ultimate wall. It is noteworthy that phyllite has been exposed in the northeast corner of the pit on the 1128 and 1122m levels. In this area, the S2 foliation dips from near horizontal to about 45° out of the slope (i.e. to the southwest) and at about 20° to 30° along the slope (i.e. parallel to the slope trend). While it is apparent that careful control blasting has been used along this portion of the ultimate wall, it is also apparent that the resulting bench face angle is related to the orientation of the S2 foliation. In this regard, it was observed that where foliation is almost flat lying or dips about 20° to 30° along the slope, a bench face angle of about 60° to 65° was able to be established. However, where foliation dips about 45° directly out of the slope, the bench face has broken back to an angle of about 50° to 55°. As expected, even with control blasting, the resulting bench faces appear somewhat ragged and it is likely that some degree of degradation and ravelling will occur with time. Due to the apparent geologic structural similarity between this area of the Vangorda Pit and the northeast and southeast slopes of the proposed Grum Pit, it is anticipated that the rock mass in these two areas will behave in a similar manner. Thus, it is recommended that ongoing mapping and documentation of the northeast wall of the Vangorda Pit be carried out to provide a "preview" of the likely behaviour of the equivalent slopes in the Grum Pit. Continued efforts to improve control blasting techniques are also recommended.

Cross Fault on West Side of Pit

As discussed in our reports of November 9, 1991 and March 25, 1992, a fault identified as the "Cross Fault" has been mapped in the pit in the vicinity of Section 12. Previous mapping indicated that this fault dipped between 40° and 62° toward 348°, and also appeared to be a wide fault zone rather than a single fault plane. Results of recent mapping on the west wall of the pit indicate that while the dip of the fault appears to range from about 40° to 80°, its average dip is likely about 60°. Similarly, the dip direction seems to range locally from about 315° to 010°, with an overall average of about 345°. The width of the fault zone is likely to be at least 50 to 60m. Within the fault zone, the rock mass appears to be highly broken, with a number of near vertical joints dissecting the slope. Based on blasthole drilling in the area, it has also been observed that the fault zone is water bearing and very permeable. At

the time of the site visit, a sump that was being constantly pumped had been established in the fault zone.

Based on the available information that indicates the Cross Fault dips an average of 60° toward 345°, it would appear that the portion of the west wall between about Sections 12 and 8 could be adversely effected by the fault zone. As the fault zone appears to dip more steeply than the interramp slope angle, and to be about 30° oblique to the trend of the slope in this area, it will not likely be completely undercut during mining. However, the numerous shear planes within the fault zone and the generally broken nature of the rock within this zone will likely cause instability in the vicinity of the haulroad in this area of the pit. In this regard, it is anticipated that bench scale plane and wedge failures will occur along with general degradation of the rock mass. While this could result in there being considerable difficulty in maintaining the haulroad at full design width in this area, it is likely that such problems could be overcome by backfilling and buttressing the area of the haulroad in question. Specifically, once mining has reached the 1062m level, it is recommended that sufficient waste rock backfill be dumped into the mined out "slot" south of Section 8 to adequately buttress the haulroad on the west side of the pit.

There are some indications that the Cross Fault could be more extensive than that discussed above. Although it has not been substantiated by mapping, blasthole drilling results from the 1098 subgrade indicate that the fault zone could be at least 70 to 80m wide. In addition, the trend of the fault zone may change to the north, tending to follow the trend of the west wall of the pit. If either or both of these possibilities are in fact the case, the impact of the fault on the stability of the west pit wall would be more severe than discussed above. While backfilling the pit in the area south of about Section 8 would help buttress the haulroad, it would not likely be sufficient to stabilize the western pit slope to the north of about Section 8. As such, other remedial measures, such as flattening the slope, would have to be considered. To arrive at a more accurate geologic interpretation of the Cross Fault, and thus allow a more definitive assessment of the need for remedial measures on the western wall of the pit, it is recommended that mapping and assessment of the fault zone be continued as each bench is exposed.

The pipeline from the sump in the fault zone was observed to discharge just behind the pit crest. To prevent any of this water from seeping back into the fault zone and thus into the pit, it is recommended that the discharge line from the sump be extended to at least the western side of the haulroad along the west side of the pit.

Northwest Fault

No additional information beyond that discussed in our March 25 report is available. Thus, as previously discussed, it is recommended that ongoing mapping and interpretation of this fault be carried out, and that stability assessments be updated on a regular basis as more geologic information becomes known.

Cracking on Interim Haulroad

As confirmed by daily monitoring conducted by Peter Ledwidge, cracking and some movement has continued to occur along the edge of the internal interim haulroad in the northern portion of the pit. However, it is understood that the ramp was moved a few metres northward such that there is at least 5 to 6m between the edge of the travelled portion of the ramp and the first cracks. As discussed in our previous letter report, it would appear that movement and sloughing of this portion of the haulroad is likely to continue. Thus, regular visual monitoring of this area should be continued.

West Wall Overburden Slope North of Section 8

On the west wall of the pit, north of about Section 8, it was observed that the overburden/bedrock contact is between about the 1104 and 1110m elevations, resulting in a benched overburden slope up to about 30 to 35m high. The overburden appears to be comprised primarily of glacial till that is similar to that exposed at the pit crest in most other areas of the pit. While this till often stands very steeply over limited slope heights equivalent to that of a typical mining bench, it was observed that at least two slope failures have occurred in this material. Bench faces have been oversteepened to the point where the bench crests are overhanging in a number of locations. It is understood that in at least one area, the lack of a sufficiently wide safety bench is due to the underdigging of one lift and the overdigging of the lift below. Loose overburden blocks appear to have been left along one bench crest.

Based on the above slope conditions, it is concluded that there will likely be further incidents of slope failure along the area in question, most likely during spring thaw and/or in association with blasting at the toe of the slope. Because the main haulroad into the bottom of the pit is to be located underneath this portion of the wall at about the 1070 to 1080m elevations, it is recommended that some remedial measures be implemented. As discussed, once the snow has melted from the slopes, the area should be inspected and a determination made as to the feasibility of eliminating the overhangs by flattening the bench faces. If the bench faces cannot be safely flattened to

the point where failures are unlikely to occur, it is recommended that this area of the western pit slope be monitored. In this regard, it is recommended that regular visual inspections be carried out. The use of prism monitoring and/or direct monitoring of crack widths (i.e. measuring the distance between two steel pins driven into firm ground on either side of a tension crack) should also be implemented.

Slope Monitoring

In addition to the monitoring discussed above for the western side of the pit and for the interim haulroad, and as discussed in our March 25 report, it is recommended that prisms be installed along the bench on which the Vangorda Creek flume is located. Visual inspections of this bench should also be carried out at least every second day and after any blasts in the area. Two or three prisms should also be installed along the crest of the eastern side of the pit where significant overburden thicknesses have been encountered and some slope movements have occurred in the past.

I hope the above is sufficient for your needs at this time. If you have any questions concerning the above, please do not hesitate to contact us.

Yours very truly,

PITEAU ASSOCIATES ENGINEERING LTD.

Alan F. Stewart, P.Eng

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