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March 25, 1999 Project No. M725101

Mainland Sand and Gravel Ltd.
9512 - 194A Street
SURREY, B.C. V4N 4G5

Attention: Ted Carlson
President

Subject: **Hydrogeology and Water Use at the Mainland Sand and Gravel Ltd. Rock Quarry on the North Side of Sumas Mountain**

Dear Sirs:

1.0 INTRODUCTION

In accordance with our letter of proposal to Mainland Sand and Gravel Ltd. (MSGL), dated March 3, 1999, the purpose of this letter is to report on our evaluation of groundwater conditions at the site of MSGL's Sumas Mountain rock quarry and, in particular, to provide our assessment as to whether groundwater withdrawal by the new water source well will have any impact on Wades Creek, a fish-bearing stream. This letter is based on:

- Observations made by Ed Livingston on a visit to the quarry property on March 17, 1999.
- Discussions with Ted Carlson by 'phone, and Messrs. Laurie Carlson, Louis Szlovicsak and others during Livingston's March 17 site visit.

The operation - in particular as it affects groundwater from the well excavated in rock - was described in PHCL's proposal letter of March 3, 1999, stated to be as follows:

1. MSGL have a long established rock quarry at the end of Cox Road on Sumas Mountain. MSGL have applied to B.C. Ministry of Energy, Mines and Petroleum Resources (MoEMPR) for a permit to extend the present quarry.

2. As part of the processing of the permit application, MoEMPR contacted other Ministries and agencies which might be concerned with the application. A Department of Fisheries and Oceans (DFO) inspector was concerned about the new source of water which would be used for dust control in the operation. Mr. Carlson took the inspector, Mr. Conrad Johanson, to the proposed new source of water which is a "well" constructed by blasting in rock in an area where previous drilling had shown that there is groundwater.

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3. Mr. Johanson stated that he is concerned about whether removal of groundwater from the proposed new source would reduce the flow of Wades Creek which is a fish-bearing stream. Therefore, as a condition of granting a permit to extend the quarry operation, MoEMPR has asked for an hydrogeological report to deal with the issue of interference with Wades Creek.

From the site investigation and discussions with Quarry personnel, we further understand that:

4. The present source of water for the operation is a dug well in gravel; the well is about 10 m (33± ft) deep and is constructed with concrete casing, about 1.2 m (4 ft) in diameter. The static water level, which is at about 6 m (20± ft), shows little annual fluctuation. The well is equipped with a ¾ hp submersible pump, discharging to a manifold against line pressure of about 40 psi. The pump runs most of the time, winter and summer.

5. The main water use, year round, is to cool two gyratory rock crushers. Most of the warmed water returns to the ground. In the time between the main rainy season and the dry summer weather, the well is occasionally used to fill a water truck for watering roads to control dust. In summer, the roads are treated with calcium chloride and no more water is used. During the dry summer months, very fine sprays of water are used, as required, to control dust at the crushers, screens and conveyor discharges. This water goes to the atmosphere.

6. The actual rates of water use at the Quarry are unknown. However, a new ¾ hp submersible pump, pumping from a depth about 6 m against pressure of 40 psi, can deliver about 1.15 *l*ps (15 igpm). Thus, the consumptive use (not returned to the aquifer) in winter months is very small; in summer months, consumptive use probably averages only about 0.38 *l*/sec (5 igpm), as the plant where dust control is required seldom runs more than one shift.

7. The newly excavated rock well on the western part of the floor of the pit will be used to supplement the existing dug well. It may be used to fill the water truck and may eventually be equipped with a pump to deliver water, by way of a buried pipe, to the main operations area.

2.0 TOPOGRAPHY AND GEOLOGY

The subject MSGL Quarry is constructed on the lowermost steep slope of Sumas Mountain but the operations area (shops, office, crushers, screens, stockpiles, etc.) is on the floodplain of the south bank of the Fraser River. The floodplain seems to merge with the low combined fan of Wades and Chadsey Creeks, which join on the upstream side of the culvert under the haul road leading to the barge-loading facility. The floodplain is locally about 500 m wide, probably because of the sand and gravel which has been discharged by the creeks. The thickness of the sediments making up the fan-floodplain is unknown, but we guess that it is more than 50 m thick north of railway; information provided by the existing dug well shows that the floodplain sediments extend to a depth greater than 10 m thick in the operations area.

The surficial geology is more complex southwest of the main quarry and the operations area where, according to Mr. Szlovicsak, seismic and other evidence indicates that there is an area of very thick overburden. This area of potentially thick sediments over the bedrock is located at the mouth of the Wades Creek valley, where the Creek has apparently been diverted northeastward. From Ed Livingston's field investigation, the thick overburden is believed to be a glacial moraine deposited by ice which flowed southward from the Hatzic Valley, probably during the Sumas glacial event about 10,000 years ago. Similar sediments further upstream on the Fraser River provide other evidence for such glacial deposition.

The northwest slope of Sumas Mountain is thinly covered by a discontinuous cover of glacial debris, probably largely sandy, stony, silty till, on which has developed the soil which supports the forest cover.

3.0 GROUNDWATER HYDROLOGY

The groundwater hydrology of the Quarry area is quite simple on a large scale but is more complex on a small scale because of the local geology. On a large scale, part of the water from precipitation goes into the ground in recharge areas. After infiltrating, the water flows below the ground surface, whether in overburden or in rock fractures, in a groundwater flow system driven by gravity, to discharge areas where it becomes or enters surface water.

In the subject area, the top and most of the slopes of Sumas Mountain are a groundwater recharge area. The main discharge area of the northwest side of Sumas Mountain is the Fraser River, with almost all of the discharge taking place below the floodplain and directly into the River below water level where it cannot be observed. The total proportion of precipitation which becomes groundwater is probably not more than 15%. Recharge varies seasonally from almost zero in the growing season, when vegetation uses almost all of the precipitation, to a much larger proportion in winter and early spring.

On a small scale, the groundwater hydrology of the Quarry area is more complex, with small-scale local groundwater flow systems superimposed on the regional system. For example, the upper part of Wades Creek valley is a local discharge area and groundwater discharge maintains the low flow (base flow) of the Creek during late summer and early fall. The lower part of Wades Creek, where it is flowing over gravel, is a recharge area for the gravel aquifer composed of floodplain and fan sediments. Thus, groundwater feeds the upper part of the Creek which then discharges part of the water into the gravel on the floodplain. When the losses to the gravel are greater than the base flow, the lower part of the Creek stops flowing.

The water in the new rock well located on the floor of pit, is water which is flowing through fractures in the rock on its way from the recharge area to the discharge area, probably below the level of the Fraser River. During the rainy season, precipitation in the pit area is recharging the

fractured rock but the fact that the water level in the well is reported to have little seasonal fluctuation, shows that the water in fractured rock at the well is not entirely from local precipitation. The amount of water flowing through fractured rock is not only dependent on the intensity of fracturing, but also on whether the fractures are open. Many fractures in the subject area seem to contain metamorphic minerals such as chlorite; if so, such fractures will carry little, if any, water. This may explain the uneven distribution of water-bearing zones despite the appearance of the rock as being intensely fractured.

4.0 POSSIBLITY OF INTERFERENCE TO WADES CREEK FROM WELLS

Based on general understanding of the site hydrogeology, knowledge of the quarry operation from discussions with MSGL owners and staff, we have no hesitation in stating that use of the new rock well (and/or the existing dug well) will have no perceptible effect on the flow of Wades Creek, even at times of minimum flow. The basis for this statement is the following:

1. The amount of water being used, or anticipated to be used, in the continued operation of the quarry is negligible in comparison to the amount of groundwater flowing through the quarry area toward the Fraser River, whether in fractured rock or in the sand and gravel of the floodplain.
2. Neither the new rock well or the existing dug well intercept groundwater which is discharging into the Creek. The existing dug well takes water which is lost from the Creek as it flows over the floodplain sediments and the new rock well intercepts water flowing through rock fractures, most of which is discharging into the Fraser River below river level.

5.0 CLOSURE

We trust that we have adequately addressed the issue as to whether withdrawal of groundwater used in the operation of MSGL's quarry on the north side of Sumas Mountain will have any effect on flows in Wades Creek, a fish-bearing stream and which is of concern to Department of Fisheries and Ocean. However, please do not hesitate to contact the undersigned if there are any questions about the contents of this letter or if further explanation is needed.

Yours truly,
PACIFIC HYDROLOGY CONSULTANTS LTD.

Ed Livingston

Ed Livingston, P. Eng.
Associate Consultant