

From: [Doyle, Jessica FLNR:EX](#)
To: [Harrison, Donald EMPR:EX](#)
Cc: [Lapcevic, Pat FLNR:EX](#); [Martinka, Rusto ENV:EX](#)
Subject: O.K. Industries Ltd. Millstream Road Quarry Review of Groundwater Quantity Impacts
Date: Friday, December 21, 2018 2:51:07 PM
Attachments: [20181221 OK Industries Millstream Quarry Groundwater Quantity Review.pdf](#)
[Order in Council 549 mine drainage.pdf](#)

Hi Don,

Please find my review of the OK Industries Ltd. Millstream Road Quarry Groundwater Risk Assessment attached. I focused my review on potential impacts to groundwater quantity.

Please do not hesitate to contact me if you have any questions or would like to discuss. **s.22**
s.22

Happy Holidays!

Jessica

Jessica Doyle M.Sc. P.Geo

Regional Hydrogeologist (First Nations), West Coast
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Date: December 21, 2018

File: 58000-30/OK Industries Millstream Quarry

Donald Harrison
Senior Inspector of Mines
BC Ministry of Energy, Mines and Petroleum Resources
3rd Floor, 1810 Blanshard St,
Victoria, BC V8W 9M9
778-698-7014
Donald.Harrison@gov.bc.ca

To Donald Harrison:

Re: O.K. Industries Ltd. Millstream Road Quarry Groundwater Risk Assessment:
Review of Groundwater Quantity Impacts

Thank you for providing the opportunity to review and comment on the O.K. Industries Ltd. Millstream Road Quarry – Environmental Effects and Mitigation Draft Report (the Report). This review focused on aspects related to potential impacts to groundwater quantity at and adjacent to the proposed rock quarry located at Lot 1, Section 5, Range 3 West, Highland District (VIP70242), District of Highlands, BC (the Site). Impacts to groundwater quantity in the Report was described in the Groundwater Risk Assessment included in Appendix II.

As described in the Report, the proposed rock quarry would reduce the topographic elevation to 95 m above mean sea level and will involve stripping of the overburden soil veneer and several meters of saturated bedrock aquifer.

The Report describes three aquifer systems beneath the site: a perched overburden aquifer, a shallow bedrock aquifer described to be within the weathered and fractured portion of the bedrock, and a deep bedrock aquifer that is part of the regionally extensive mapped aquifer 680. During this review, local groundwater flow is referring to groundwater flow through the upper bedrock system and regional flow is through the deeper regional fracture network throughout aquifer 680. It is important to recognize that bedrock aquifers are highly heterogenous and are likely to have preferential flow paths dependant on the size and connectivity of the fracture network.

Based on this review, the following summarizes potential impacts to groundwater quantity:

Impacts to local groundwater flow gradients

- The proposed rock quarry will change local groundwater flow gradients in the shallow bedrock, particularly along the irregular northwest boundary of the

Summary of Comments on October 21, 2003

This page contains no comments

Millstream Meadows CRD Property (Millstream Meadows). Here, existing topography is high relative to the surrounding land, and groundwater levels indicated on the cross sections in Figures 3-5 show they are also higher relative to surrounding groundwater levels.

- It is noted that there are no monitoring wells situated on the topographic highs to confirm that shallow water levels mimic topography in these areas.
- Based on the proposed excavation extent shown on the cross sections in Figures 3 and 4, local (shallow) groundwater flow gradients could be reversed so that they flow from Millstream Meadows towards the Site.
- The report assumes the potential to impact groundwater quantity on site is low based on the predicted low flow gradients and low permeability of the shallow bedrock. No hydraulic field testing (pumping tests, rising or falling head tests etc.) or analytical analyses were included in the Report to support this assumption.
- It is unknown if the proposed blasting would impact shallow bedrock permeability and groundwater flow.



Impacts to local groundwater recharge and discharge

- Based on the interpretation that groundwater levels in the shallow bedrock mimic topography, topographic high areas are local recharge areas to the overburden and shallow bedrock aquifers.
- Recharge contributes to the shallow flow system which likely discharges to the nearby streams and wetlands (likely predominately during winter months).
- Local groundwater discharge to the nearby streams and wetlands could be impacted by altered flow gradients. Knowing seasonal groundwater fluctuations in the unconsolidated and shallow bedrock aquifers is important to understanding the potential contribution of summer base flow to streams to ensure Environmental Flow Needs (EFNs) are protected.

Impacts to regional groundwater flow

- The nested monitoring well MW00-1 is completed in both the shallow bedrock and deeper bedrock aquifers. The hydraulic head in the deeper aquifer is higher than that in the shallow aquifer, indicating an upward gradient.
- The hydraulic head is higher than the base of the proposed elevation of the excavated quarry. If a fracture that is hydraulically connected to the aquifer that the deeper well is completed in, there is potential for an artesian spring to form. This could have a significant impact to surface flows and water management on site and should be considered in the water management plan.



Impacts to nearby groundwater users

- Given the upwards groundwater flow gradients from the deeper bedrock zone, the shallow groundwater zones unlikely contribute to deep regional recharge. Therefore, changes in local recharge patterns are unlikely have significant effect to groundwater quantity off site
- If an artesian spring forms from the deeper, regional aquifer system, there could be potential to impact nearby groundwater users who are accessing groundwater from



-
- Number: 1 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:07:09 PM -08'00'
In the absence of field testing or analytical analyses, is this assumption reasonable?
Yes, according to Jessica.
-
- Number: 2 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:10:43 PM -08'00'
See blasting report (IBC).






impacts expected to be negligible.
-
- Number: 3 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:12:41 PM -08'00'
Check water management plan

Potential for artesian spring is small and if so, volumes likely to be low
-
- Number: 4 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:14:01 PM -08'00'
Deep bedrock zone unlikely to be impacted.

that system. Continuous monitoring of the groundwater levels in the deeper system is recommended.



Several assumptions in the Report were made without data to support them. Identified data gaps include:

- Monitoring wells located on the topographic highs to validate that groundwater levels in the shallow bedrock mimic topography inferring local recharge areas and existing flow gradients away from the Site. 
- Groundwater levels measured at different times of year in the existing monitoring wells to understand seasonal changes to local and regional groundwater flow. 
- Field testing data to support assumptions of the hydraulic properties of the shallow bedrock aquifer. 
- Analytical analyses to quantify flow gradients and potential fluxes to the Site both during and post excavation. 
- Assessment of changes to shallow bedrock permeability and potential impacts to shallow groundwater flow as a result of blasting. 

In addition to the recommendations included in Appendix II of the report, the following is also recommended:

- Ensure the water management plan accounts for potential continuous groundwater discharge onto the Site if an artesian spring is developed.
- Address the above-mentioned data gaps to support the assumptions made in the Report.
- Monitor groundwater levels in at least one deep monitoring well during all phases of operation.

Finally, a groundwater authorization under the *Water Sustainability Act* (WSA) could be required in certain quarry or mine dewatering situations. An information update describing licencing requirements and exemptions can be viewed at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water_rights/wsa_and_mines_information_update_feb_2018.pdf. In addition, the amendment to the WSA for mines drainage works is attached.

If you have any questions, comments or would like to discuss this matter further, please do not hesitate to contact me.

Sincerely,

Jessica Doyle M.Sc., P.Geo.

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Jessica.Doyle@gov.bc.ca

Page: 3

-
- Number: 1 Author: Doharris Subject: Sticky Note Date: 2019-03-11 5:01:46 PM
i.e. in well MW00-1?
-
- Number: 2 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:14:26 PM -08'00'
is this assumption reasonable?
Yes.
-
- Number: 3 Author: Doharris Subject: Sticky Note Date: 2019-03-11 4:59:09 PM
Does this data exist? Check with Hemmera
-
- Number: 4 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:18:12 PM -08'00'
is this critical or can one reasonably rely on the assumptions made?

Not likely critical, and assumptions are generally sound.
-
- Number: 5 Author: Doharris Subject: Sticky Note Date: 2019-02-28 1:22:36 PM -08'00'
Are the assumptions based on this reasonable?
Flow gradients likely to be small
-
- Number: 6 Author: Doharris Subject: Sticky Note Date: 2019-03-11 4:44:54 PM
See blasting report - shallow bedrock permeability may be changed by blasting. It is reasonable to assume changes to groundwater flow in the shallow aquifer "are unlikely to have significant effect to groundwater quantity off site." (see 2nd last bullet, page 2)

Cc. Pat Lapcevic, Section Head, Water Protection
Rusto Martinka, Hydrogeologist, Environmental Protection Division

Attached: Order in Council 549 mine drainage

This page contains no comments

From: [Martinka, Rusto ENV:EX](#)
To: [Harrison, Donald EMPR:EX](#)
Cc: [Doyle, Jessica FLNR:EX](#)
Subject: RE: O.K. Industries Ltd. Millstream Road Quarry Review of Groundwater Quantity Impacts
Date: Thursday, January 10, 2019 12:11:06 PM
Attachments: [2019-01-10 OK Industries - ENV water quality review.pdf](#)

Hello Don,

Please see the attached regarding my evaluation of water quality risks and their management at the proposed Millstream Quarry.

In summary, I accept the Proponent's conclusion that risks to water quality from the Project are low, but those risks should still be managed through permitting. I also provide some suggestions for the Proponent on developing the monitoring plan.

Let me know if you want to chat.

cheers

Rusto Martinka
250-751-7056

From: Doyle, Jessica FLNR:EX
Sent: Friday, December 21, 2018 2:51 PM
To: Harrison, Donald EMPR:EX
Cc: Lapcevic, Pat FLNR:EX; Martinka, Rusto ENV:EX
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