NORWEST
CORPORATION

Suite 1830, 1066 W. Hastings Street
Vancouver, BC V6E 3X2
Tel: (604) 602-8992
www.norwestcorp.com

OQM | Organizational Quality Management Program

June 26, 2017

Project #: 924-3

Lupin Mine Incorporated
Suite 202-750 West Pender Street
Vancouver, BC V6C 2T7

Attn: Karyn Lewis
Project Coordinator

Subject: Lupin Mine Landfarm Monitoring Wells

LANDFARM

Lupin Mine Incorporated (LMI) has commissioned Norwest Corporation (Norwest) to provide a design, as-built documentation, and operation support guidance for the pilot landfarm at the Lupin Mine. The landfarm is designed to remediate hydrocarbon-impacted soil in the satellite tank farm. The landfarm is designed with primary and secondary containment to prevent the release of hydrocarbon-impacted water into the surrounding environment. This document provides Norwest's professional opinion with regards to the stipulated requirement to install monitoring wells around the landfarm.

DESIGN

A set of professionally stamped drawings were submitted to the Nunavut Water Board (NWB) in July 2016. The landfarm foundation is a concrete reinforced slab with an estimated minimum thickness of 0.25m and a surrounding footing that ranges from 0.25m to 1.8m high. The design was to place an impermeable liner over the concrete slab and footing to create primary (liner) and secondary (concrete) containment. Locally available esker sand was used to construct the containment berm and the sump. The containment earth berm is approximately 1.3m in height with the floor graded to drain toward the sump situated at the west side of the facility. A reinforced, UV protected liner was deployed over the finished subgrade.

The landfarm design was based on the approved landfarm management plan under approved water license, which did not include installation of monitoring wells. To monitor the performance of the primary containment liner, a leakage detection pipe was added into the subgrade, between the liner and concrete foundation. The 100-mm OD galvanized steel pipe is located in the southwest corner of the sump. The pipe is approximately 2m in height measured from the concrete surface with a 90° elbow at the bottom

and extends 2.5m horizontally into the landfarm. The horizontal section of the pipe is perforated and wrapped with geotextile to allow leachate collection and prevent clogging from fines.

MONITORING

LMI's current care and maintenance water license, Type "A" License 2AM-LUP1520 (NWB 2015), Part E 25, stipulates the installation of two observation wells down-gradient of the landfarm for monitoring of groundwater impacts from operation of the landfarm. There is a risk that installing the wells that are close to the facility could compromise the integrity of the concrete secondary containment due to potential degradation of permafrost below the concrete slab from drilling.

It is Norwest's opinion that installing new observation wells around the landfarm is inessential due to the double containment system and presence of the leakage detection pipe. The function of the leakage detection pipe is to monitor the integrity of the primary containment liner. If the liner is compromised, leachate will be collected upon the secondary containment (concrete foundation). The advantage of this system is that a liner leak will be detectable early in the operation of the landfarm. Breaching of the concrete pad (secondary containment) is not foreseeable during regular operation of the facility. Relying on the sampling of observation wells outside of the facility will not readily detect a leak in the containment systems of the landfarm.

It is Norwest's professional opinion that the combination of primary/secondary containment and leakage detection will render the observation wells unwarranted. The leakage detection pipe will identify any leakage in the primary liner while within the secondary containment. Furthermore, the leakage detection pipe does not suffer from the long attenuation delays, and would provide immediate response to allow suspension of the operation while contaminants still within the secondary containment.

RECOMMEDATION

In place of the well installation, LMI would incorporate additional procedures during operation to ensure the monitoring is done regularly to prevent impact to the environment during landfarm operation. Procedures such as monitoring frequency and testing protocols would be added to the monitoring plan according to best practice under supervision of a qualified personnel.

CLOSURE

The purpose of this letter is to provide a professional opinion on the subject of monitoring wells for the Lupin landfarm. This letter has been prepared for Lupin Mine Inc. (LMI). The text contained herein presents documentation of the review and inspection work carried out by Norwest regarding the construction of the landfarm at the Lupin Mine, Nunavut. This report represents the opinion of Norwest based on information provided by LMI and observation made during the engineer's site inspection.

All data contained herein has be reviewed and interpreted by Alvin Tong, PEng., with the review completed by James McKinley, Ph.D., PEng.

Yours sincerely,

NORWEST CORPORATION

Author

Alvin Tong, P.Eng.
Senior Geotechnical Engineer

Reviewer

Jim McKinley, P.Eng., Ph.D.
Water Resource Manager