TROUT LAKE MOLYBDENUM PROPERTY RECLAMATION CASE STUDY

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ABSTRACT

Rescan Environmental Services Ltd. provided environmental science and engineering solutions for the Trout Lake Molybdenum Reclamation Project for Newmont Exploration Canada Ltd. (Newmont).During the late 70s, Newmont and Esso Minerals Ltd. (with Newmont as operator), conducted exploration for molybdenum. A large exploration drilling program identified a significant molybdenum ore zone at depth which appeared amenable to underground development. In 1982 when molybdenum prices collapsed, Newmont stopped work at the site. The portal was closed off and well secured in compliance with the Mines Act requirements.

In 1997, Newmont's land group inadvertently allowed the claims to lapse and a local prospector picked up the property. Newmont remained responsible for the clean-up of the property under the Reclamation Permit and as such, the BC Ministry of Energy & Mines contacted Newmont. Newmont spent over $500,000 to clean-up the site to a level where they were indemnified of any further claims under Reclamation Permit #MX-5-55.

This paper will provide an insight into the novel work completed in order to indemnify Newmont of any further claims from Trout Lake property.

This project involved:

- Licensing and permitting issues to carry out closure
- An analysis of a novel approach to controlling metal leaching and acid rock drainage
- Control drainage from an underground adit
- Hydrocarbon contamination clean-up
- Removal and disposal of machinery and infrastructure: what were the challenges?
- Issues with wildlife (beavers)
- Working in extreme forest fire hazard conditions and
- Operational and safety requirements working with a major mining company.

In recognition of outstanding reclamation achievement, Newmont was awarded the 2004 Citation from the Technical and Research Committee on Reclamation, Mining Association of BC, and Ministry of Energy and Mines, for the Trout Lake Molybdenum Project in the Mineral Exploration Category.

INTRODUCTION

Rescan™ Environmental Services Ltd. (Rescan) was retained and appointed "Agent" by Newmont Exploration of Canada Limited (Newmont) to reclaim the Trout Lake exploration property. The reclamation work followed the Trout Lake Exploration Project Closure Plan (Rescan, 2003) which

approved by the British Columbia Ministry of Energy and Mines in May 2003 through the amendment of Reclamation Permit #MX-5-55.

The Trout Lake property is located 4 km from the community of Trout Lake approximately 70 km southeast of the town of Revelstoke in southeastern British Columbia. (Figure 1).

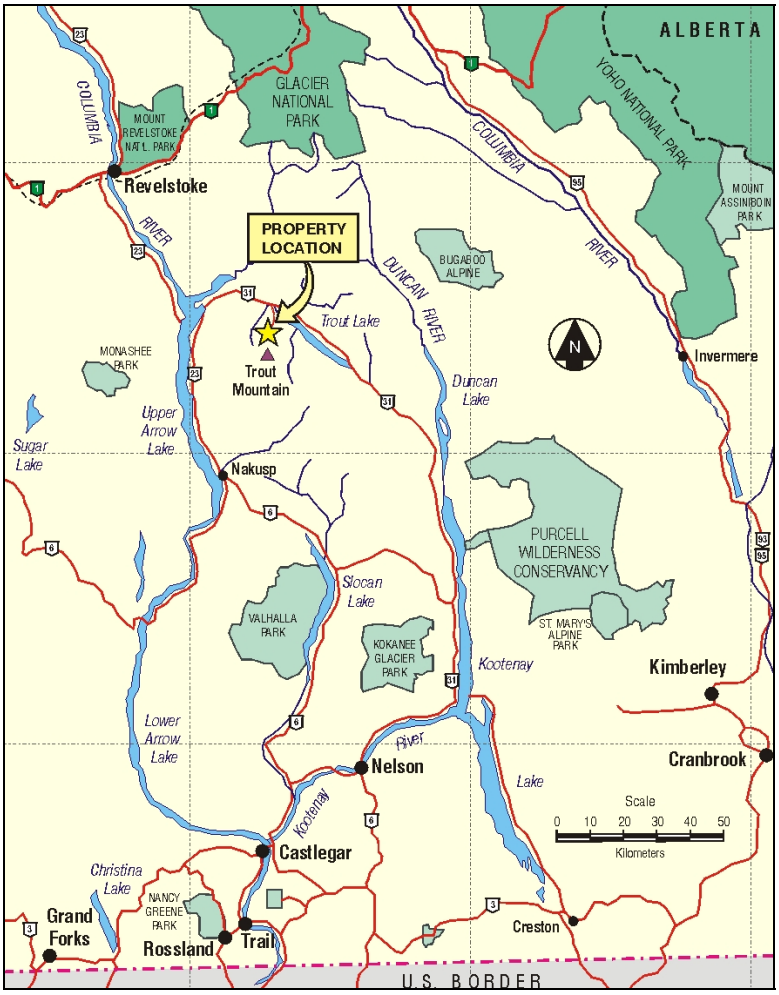

Figure 1. Trout Lake Exploration Property Location

In the late 1970's and early 1980's Newmont, with partner Esso Minerals conducted an advanced exploration program on the Trout Lake molybdenum prospect. A development adit was driven to gain access to the ore body for bulk sampling and metallurgical testwork. The adit was a 1,500 m long incline that was developed to the centre of the mineralized zone.

An upper small adit developed prior to Newmont's involvement, was a decline located approximately 1,000 m uphill from the main development area on crown grants land. The main adit area consisted of a maintenance yard, underground water sedimentation pond, ore handling bins, ore storage pad and underground rail system. A 30 person camp was established near the main portal area, as well as two

core storage areas, one near the camp and one near the upper adit. The core storage areas were collapsed, resulting in the core samples being mixed and unidentifiable.

PRE-RECLAMATION CONDITIONS

During the development of the reclamation plan for the Trout Lake exploration property, four primary concerns were identified: safety to human and wildlife, acid rock drainage, hydrocarbon contamination, and water management. The main safety hazards were the unmarked concrete bins with 3 meter drop off and the deep sedimentation pond latent with very fine mud. The wood debris around the site from old buildings was a fire hazard. Rusty metal pails, drums and maintenance shop waste presented a threat to wildlife. Long-term acid rock generation potential from the exposed ore piles could threaten downstream water quality and aquatic life. Hydrocarbon contamination around the maintenance shops was identified. Finally, beavers had moved into the area and built a series of small dams causing the area to be flooded. In addition, the upper adit was open and accessible to humans and animals.

A site plan showing pre-reclamation structures and conditions is presented in Figure 2. In addition to the aforementioned metal and wood debris, there was a collapsed steel snow shed and steel cover at the main portal, concrete pads at the maintenance shop and core storage areas as well as concrete pylons which remained from the old camp infrastructure. Rail steel supported by creosote preserved rail ties was located between the main adit and the concrete ore bins and the maintenance area.

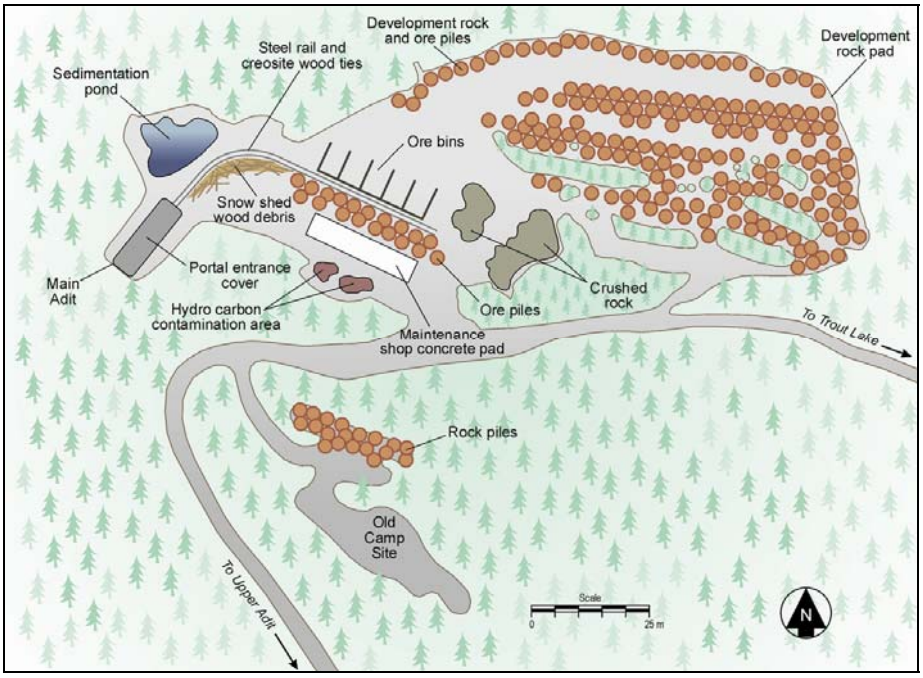

Figure 2. Trout Lake Exploration Site – Main Portal Area prior to Reclamation

The hydrocarbon staining was visible on the overburden adjacent to the former maintenance building area. Core storage racks near the old camp area had collapsed and were a tangled mess. The roof of the core shack at the upper adit had caved in, creating a safety hazard to hikers and wildlife.

Water flowing from the main portal fed into a sedimentation pond. The pond was constructed and used during the underground development work to settle out sediments before discharging to the receiving environment. One hundred and eighty nine ore piles of potentially acid generating (PAG) rock were located on top of a pad constructed of overburden and adit development rock.

RECLAMATION WORK AT TROUT LAKE

Objectives

The primary objective of the reclamation work at the Trout Lake exploration site was to return the property to a state comparable to what existed prior to the exploration. To achieve this objective, plans were made to reduce the potential for acid rock drainage and metal leaching from the ore piles, contain and monitor the water flowing from the main portal, eliminate safety hazards associated with structures and a general site clean-up to remove scrap metal and wood debris. In addition, it was important to remove the opportunity for beavers to block off the water from the portal causing a potential safety hazard and risk downstream if the water level overtopped the make-shift dams.

Work Summary

The reclamation work was completed under Permit MX-5-55 amended by the Ministry of Energy and Mines on May 20th, 2003. Work at the site began in early July and was completed by the end of August 2003.

In general, the reclamation at the site consisted of the following: potential acid generating material was compacted and encapsulated, a permanent drainage system installed in the main portal, and non-recoverable and inert debris was buried. All disturbed areas were covered with topsoil and revegetated. Prior to commencing the reclamation work at the Trout Lake exploration site, the road to the site was upgraded to allow vehicles and heavy equipment access. The as-built reclamation activities are described in the following sections and Figure 3 summarizes the main features of the reclaimed site.

Clean-up and Burial of Scrap Metal and Wood Debris

The Closure Plan (Rescan, 2003) called for the collection of the assorted debris (scrap metal, wood debris and concrete structures) and either removal off site or in the case of wood debris burning on site. However, due to the heightened forest fire risk at the time of project implementation, the plan was amended to allow for the burial of untreated wood debris on site. Small pieces of scrap metal and assorted concrete were also buried on site. Three pits were excavated in natural till near the main portal to bury the three types of material separately. Pits were also dug at the core storage areas and the old campsite for burial of the concrete pad and piles.

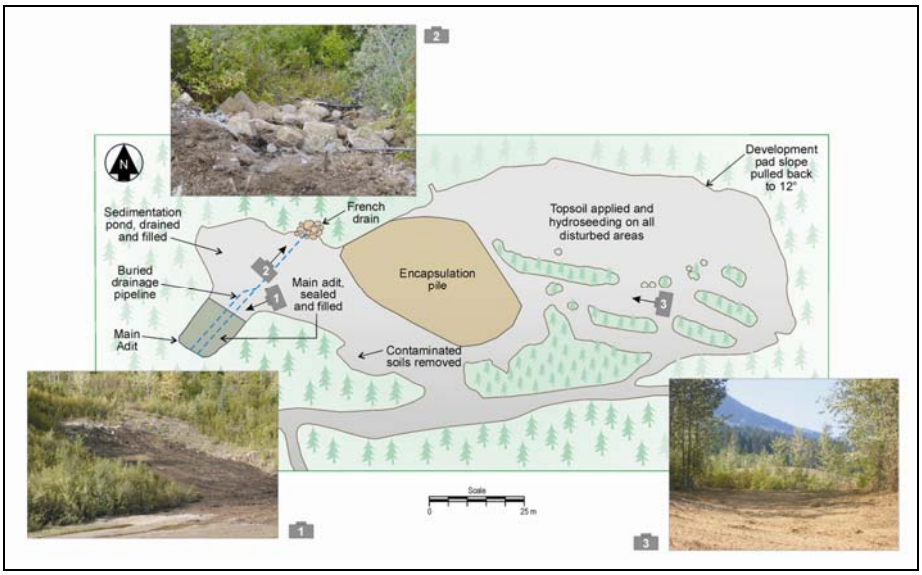

Figure 3. Trout Lake Main Portal Area – Reclaimed Site

Hydrocarbon Cleanup

The underground workings at the Trout Lake exploration site were serviced with a narrow gauge rail system and a small diesel power generator plant was located at the site to service a camp and the workings. All equipment was removed from the site at the cessation of exploration activities; however some hydrocarbon soil contamination was evident in the immediate vicinity of the power plant location. Details of hydrocarbon remediation activities are listed below:

1. Obtained pre-excavation step-out soil samples (analysis of LEPH and HEPH);
2. Excavation and transport of hydrocarbon contaminated soils to a registered disposal facility; and
3. Collection of confirmatory post-excavation soil samples (analysis of LEPH, HEPH, BTEX and VPH).

Hydrocarbon contaminated soils were excavated from within a confined area in the immediate vicinity of the former exploration power plant. Both step-out and post-excavation soil sampling confirmed that soils with hydrocarbon contamination exceeding the B.C. CSR standards for Commercial Land use were removed from the site. All hydrocarbon contaminated soils excavated from the site were loaded onto haul trucks and deposited at the soil disposal facility operated by Quantum Environmental in Vernon, B.C.

Upper Adit Area

The historic upper adit area is located on crown grants at an elevation of 1,300 m and approximately one kilometre uphill from the main portal area. The infrastructure at this site consisted of one portal with a narrow gauge rail, abandoned mining equipment, and a collapsed core shack.

As the upper adit did not produce water, it was backfilled and sealed. All scrap material and debris was transported to the main adit area for disposal/burial. The rock dump outside of the upper adit was

recontoured and seeded to blend into the adjacent landscape. The upper core shack was dismantled and buried.

Main Adit Portal Closure

The plan to close the main portal was predicated on diverting clean water from the adit across the main workings through a buried pipe and diffusion of the clean water away from the property through a French drain. The estimated flows from the adit varied from 30 to 500 L/s. The drainage system was also designed to eliminate the problems encountered with beavers at the site.

The work consisted of cleaning the debris inside the portal entrance including the debris brought in by the beavers, removal of the steel fenced enclosure and doorway, ventilation pipes and water lines and steel rails. The portal entrance support beams and steel cover were left in place as a safety measure while work progressed inside the adit. Once the area was cleaned, a temporary till and sand bag coffer-dam was installed to divert water into a temporary pipe on one side of the adit. Once the water was diverted, the floor of the adit was cleaned with high pressure water flow to expose clean rock in order to build a water tight concrete dam across the adit to retain water at a meter elevation in order to operate a passive overflow into two 18 inch or 458 mm ID HDPE drainage pipes converging into one 458 mm ID line extending out to a French drain. The concrete dam was installed approximately 8 meters inside from the portal entrance.

The adit was backfilled to the coffer-dam with material taken from the development pad and local till material. Fill material was build up along the outer face of the portal and contoured to blend with the surrounding topography. The area was covered with topsoil and hydroseeded.

Potential Acid Generating Rock Mitigation

The 1997 Rescan Site Audit indicated that oxidation of the ore piles was occurring. Potentially acid generating (PAG) rock was identified during the initial site investigation. Analysis of samples from site ore piles indicated a potential to generate net acidity *i.e.*, Net Potential Ratio < 3.0. Analysis of samples obtained from the development rock pad indicated that while sulphide concentrations were generally lower (as compared to the ore piles) it still had the potential to generate acidity.

Inspection of the ore piles indicated that oxidation of sulphide minerals had penetrated the piles approximately 10 cm in over 20 years. Oxidation staining was not observed on the development rock pad. A review of the results from the site inspection and the static ABA laboratory test indicated that water retention by the ore piles had significantly hindered ingress of oxygen, limiting oxidation of sulphide minerals to the outside 5 to 10 centimetres of the piles.

The results from the 1997 inspection indicated that the presence of fines within the ore piles and development rock pad materials greatly enhance the water-shedding capacity/oxygen barrier ability of the materials. The moisture was retained in the voids inside the pile thus creating a barrier to oxygen. Natural compaction (sealing) of the piles was the main factor prohibiting the ingress of oxygen causing

accelerated oxidation. Considering the natural state of the piles, it was concluded that enhanced compaction of these materials would further control the ingress of oxygen and moderate oxidation to a very low rate.

Field observations, discussions with dry cover specialists and the recent work on the Vancouver Island Highway (Morin *et al.* 2003), where encapsulation of reactive rock in the base of the road was used as a means for controlling ARD, convinced us that relocation, compaction and encapsulation of the ore piles would provide a suitable mitigation strategy for reducing the acid generation rate over the longer term.

ARD sampling and analysis of the fill material was carried out during closure construction work. Samples were obtained from fill material from the Development Rock Pad, final lift material from the Development Rock Pad and top soil used for all site final cover. Results from the sampling program confirmed that the fill material is not likely to generate acidity at a rate to cause a problem.

Encapsulation of Ore Piles

Based on preliminary investigations of the PAG material, where it was noted that natural compaction increased water retention and prevented infiltration thereby minimizing oxidation of the PAG materials, an alternative and novel encapsulation concept was developed and proposed. Physical compaction was selected as a viable method to maximize water retention while minimizing water infiltration and potential ARD.

Construction of the encapsulation pile was carried out using an excavator, two off road haul trucks, bulldozer and a 30 t vibratory compactor. Clean development rock stockpiled near the former camp area was transported, placed, and compacted as a coarse base pad on which the PAG rock was layered in 50 cm lifts and compacted. Coarse rock and fines from the ore piles located on the development pad and main portal area were loaded into the haul trucks using an excavator and moved to the encapsulation pile area. Drill core from the core shed was incorporated with the material from the development pad. A total of approximately 12,410 m^3 of material was moved and compacted into the pile. The haul trucks dumped the material onto the pad and it was spread with a bulldozer. Large boulders were removed and the crushed rock was spread to ensure mixing of the material to facilitate compaction.

The material was compacted in a total of sixteen 50 cm lifts using a 30 t vibratory compactor. The final dimensions of the pile were approximately 100 m x 70 m x 10 m high. Water was applied to every lift in order to optimise compaction. The side slopes of the completed lifts were well compacted with the vibratory compactor. On completion, the pile was covered with a 50-60 cm layer of overburden and a 20-25 cm layer of topsoil.

Field verification of compaction was performed during construction of the encapsulation pile, using The Clegg Impact Soil Tester (Clegg Hammer) to confirm that the target compaction density in each lift was met.

Reclamation of Sedimentation Pond

The water sedimentation pond, located 20 m from the main adit, was slowly decanted and filled with 1,850 m^3 of material from the development rock pad and then covered with surrounding till. Topsoil was placed over the area and hydroseeded.

An underdrain was constructed to manage water that might seep through the fractures and around the coffer-dam in the adit. This emergency drain was installed to reduce the risk of water building up in the backfill area downstream of the coffer-dam.

Recontouring of Development Rock Pad

Following the removal of all the ore piles from the development rock pad, the steep downhill slope was pulled back and recontoured in order to make it more compatible with the surrounding natural contours. Prior to reclamation, the slope was 37º. Approximately 4000 m^3 of rock and till was removed from the outer edge and used to cap the encapsulation pile, fill in the sedimentation pond and seal the main portal. The final slope of the rock pad was approximately 12º. During the resloping, care was taken to preserve the alder trees that had grown on the development pad during the past 22 years.
Topsoil and Revegetation

Borrow material along the existing road right of way was used as a source of topsoil. The material was primarily glacial till containing approximately 15% cobble/gravel with the bulk consisting of a sandy loam with high organic content. The borrow material was an ideal growth medium

The topsoil was spread over all disturbed areas as reclaimed areas became ready for soil application. This progressive reclamation optimized use of the equipment on site. All exposed surface areas received a minimum of 15 cm of topsoil. The topsoil layer on the encapsulation pile and the development rock pad was increased by 10 cm for a final soil cover of 25 cm. This additional soil thickness was applied to increase the barrier on the potential acid generating material and to promote a good start for the revegetation. The volume of topsoil applied over the reclaimed area was approximately 5,000 m^3.

All disturbed areas were revegetated to stabilize the surface material and return the site to a state that blends into the surroundings. Areas with exposed soil were hydroseeded with a seed mixture, fertilizer and tackifier. The project site was inspected 20 days after being hydroseeded. Grass seedlings had emerged and the germination rate was good.

MONITORING PROGRAM

Environmental monitoring is an important step in measuring the success of the closure and reclamation of the Trout Lake Project. The main features to measure the success of the project is the structural integrity of the adit drainage system, effectiveness of encapsulation pile to control ARD, effectiveness of recontouring to control erosion at the development rock pad, revegetation success and water quality.

The Trout Lake exploration site was inspected once a year for three years following closure (2004 to 2006). In summary, the monitoring program consists of:

- **Inspection of Structures:** The condition of the features at the project site will be inspected for structural integrity. In particular, the occurrence of soil erosion or mass movement of material from the encapsulation pile, development rock pad, adits and old camp areas will be inspected. The main adit drainage system will be inspected to ensure that it is operating as planned. The perimeter of the encapsulation pile and the development rock pad will be inspected for seepage.
- **Water Quality Monitoring:** Water samples will be collected from three sample sites that represent background non-disturbed conditions, on-site reclaimed conditions and the receiving environment. These sampling areas were sited and used previously for water quality monitoring and there are historical data available for comparison and trend analysis.
- **Flow Rate:** The flow rate through the adit drainage system will be measured during each site inspection using a swoffer flow meter at the manhole access port.
- **Revegetation:** Revegetation at the project site will be evaluated by visual assessment. The areas that were disturbed during closure and hydroseeded will be inspected. The areas that have poor or no vegetative growth will be broadcast seeded at the time of the inspection. In addition, areas that have minor amounts of surface soil erosion will be seeded.

CONCLUSIONS

This paper describes the actions taken on behalf of Newmont Exploration of Canada Limited for the reclamation and closure of the Trout Lake Exploration Property. The primary objective of the reclamation work at the Trout Lake site was to return the property to a safe condition comparable to that which existed prior to exploration. To achieve this objective, four main concerns were addressed:

1. the major safety hazards were eliminated;
2. a general site clean-up was conducted to remove scrap metal and wood debris;
3. a reduction of potential acid drainage and metal leaching was obtained by isolating and compacting the potential acid generating material; and
4. water flowing from the main portal was contained to minimize beaver intrusions and to allow for monitoring water quality.

REFERENCES

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