EVALUATION OF THE PERFORMANCE OF REHABILITATION ACTIVITIES AT THE HOLLINGER TAILINGS MANAGEMENT AREA (HTMA)

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Introduction

The Hollinger Tailings Management Area (HTMA, or Site) is located in Timmins, Ontario northeast of the intersection of Highways 655 and 101, and in part occupies a portion of the historical basin of Gillies Lake. The Site is owned and maintained by Goldcorp Canada Ltd. Porcupine Gold Mines (PGM). The HTMA consists of two distinct historical mine waste deposits, the Hollinger (or Gillies Lake) Tailings Area (HTA) and the McIntyre Concentrate Dump (MCD). Deposition of combined gold tailings to the Gillies Lake basin by Hollinger Mines took place from approximately 1917 to the late 1950's. The MCD was used by the McIntyre Mine for storage of off spec sulphide rich gold concentrate from the sulphide flotation process in the mill between the 1933 and 1956, at which time it was filled to capacity. In 1988 and 1989, a gold recovery project took place at the site that consisted of re-mining the tailings and sulphidic concentrate, and subsequent generation of acid rock drainage that drained towards Town Creek.

Rehabilitation Activities at the HTMA

Plans for rehabilitation at the Site were documented in the HTMA Closure Plan (SENES, 2007) and its subsequent amendment (Goldcorp Canada, 2009). For the

purposes of Site closure planning the HTMA was divided into six closure areas including (Figure 1):

• Area 1, the McIntyre Concentrate Dump;

- Area 2, Gillies Pond, a remnant of Gillies Lake within the HTMA;
- Area 3, situated southwest of Gillies Pond;
- Area 4, the western portion of the site immediately adjacent to Highway 655
- Area 5, situated at the north end of the site adjacent to the McIntyre Tailings Management Area; and,
- Area 6, Town Creek and the area northwest of Gillies Pond.



Figure 1. Location of the Hollinger Tailings Management Area (HTMA) in Timmins, ON

During the closure planning process PGM collaborated with the City of Timmins and Mattagami Region Conservation Authority (MRCA) to determine a long-term land-use plan that would benefit the community. According to the plan, the Site will be maintained as a green space for walking and hiking and will not be used for activities that could physically disrupt the vegetation. The overall objectives of the rehabilitation work at HTMA included:

- Improving surface water quality in Town Creek and groundwater quality on site in the long term;
- Improving the long-term physical stability of the tailings to eliminate mine hazards, stabilizing soils to reduce steep slopes and limit surface erosion so that no further tailings enter Town Creek; and,
- Improving the aesthetics of the HTMA by removing debris and vegetating the surface.

Closure and rehabilitation works at the Site were implemented in two phases (AMEC, 2014a; 2014b). Phase 1 included the following general activities that took place during 2009 and 2010:

- Construction of temporary and permanent outlet control structures for Gillies Pond;
- Diversion of drainage from the MCD and the southern portion of Area 3 into the south end of Gillies Pond;
- Diversion of drainage from the northern portion of Area 3 into the north end of Gillies Pond;
- Rehabilitation of Town Creek and construction of a new channel from the outlet of Gillies Pond to a point 500 metres (m) downstream of Hwy 655; and
- Rehabilitation of Areas 5 and 6.

Phase 2 was completed in 2011 and 2012 and included the following general activities:

- Relocation of the upper 0.5 m of acid generating tailings from the southern portion of Area 3 into Gillies Pond to prevent further acid generation;
- Relocation of concentrate from the MCD into Gillies Pond to prevent further oxidation and acid generation;
- Application of a cover to southern portion of Area 3 and the MCD comprising sand and gravel topped with a vegetative medium layer (biosolids);
- Reshaping the banks of Gillies Pond and placing rip rap on the slopes for erosion protection; and,
- Rehabilitation of the former settling ponds located east of Gillies Pond.

The application of biosolids in the fall of 2012 was the final rehabilitation activity at the HTMA. At present the primary activities at the Site are related to monitoring.

Assessment of the Performance of the Rehabilitation Activities

PGM retained EcoMetrix Incorporated (EcoMetrix) to assess the performance of the rehabilitation measures at the HTMA (EcoMetrix, 2015). Among other things, the assessment comprised the following:

- A summary and interpretation of a post-rehabilitation biological monitoring survey in Town Creek;
- An analysis of water quality trends in, and treatment requirements for, Gillies Pond; and,
- An evaluation of water quality in Town Creek post-rehabilitation.

The first of two planned post-rehabilitation biological monitoring surveys in Town Creek was implemented in the fall of 2014. The survey included the characterization of water quality, sediment quality, benthic macroinvertebrate community structure, fish community structure and aquatic habitats in Town Creek (Azimuth 2015). Based on the results of this study it can be concluded that:

- The channel constructed to convey drainage from the HTMA to Town Creek is functioning as designed, as is available as aquatic habitat over its entire length.
- The establishment of riparian vegetation is advancing along the entire length of the channel, dominated at this time by herbaceous plants (grasses) with a limited number of poplar and willow seedlings having emerged in the downstream section.
- Metal levels in creek sediments show an increasing trend with increasing distance downstream of the HTMA and were within the range of those measured in previous assessments (Minnow, 2001, 2003).
- Benthic invertebrate density and diversity was similar at the three survey stations with some shift in community composition from upstream to downstream, likely associated with habitat differences. Benthic invertebrate community endpoints were similar to those measured in previous assessments (Minnow, 2001, 2003).
- Fish were collected along the entire study area length, which included the constructed channel and Town Creek to its mid-reach, indicating that water quality even in the most upstream areas of the system is not a limiting factor to fish presence. There appear to be no complete barriers to upstream fish

migration from the Mattagami River to the mid-reach of Town Creek, though some limits to fish passage within certain areas of the creek appear to be present. Fish abundance and diversity was higher in 2014 than it was in previous assessments (Minnow, 2001, 2003).

Regular surface water sampling at the Gillies Pond Outlet has been conducted since 1991. Historically water quality at this location was influenced by both source term loadings associated with the tailings deposited in the HTA, as well as the solids stored in the MCD. One of the primary objectives of the rehabilitation measures implemented at the Site was to address these source term contributions for the purpose of improving water quality downstream in Town Creek.

For the purpose of the analysis of water quality trends in the HTA constituents of potential concern (COPCs) including pH, arsenic, copper, lead, nickel, total suspended solids (TSS) and zinc were considered. Following implementation of rehabilitation measures at the HTMA the following has been noted. The pH in Gillies Pond has been circum-neutral to moderately alkaline, has been within the discharge limit range of 6.0 to 9.5 at all times and has not been subject to the depressed pH and seasonal patterns seen between the late 1990s and 2008 (Figure 3). Concentrations of arsenic (Figure 4) and metals (Figures 5 through 8) have decreased by several orders-of-magnitude, have met their respective discharge limits at all times and have not shown the seasonal pattern seen between the late 1990s and 2008. The TSS levels (Figure 9) have become less variable following the implementation of rehabilitation measures, have been below the daily and monthly limits since 2009 and have been typically less than 5 mg/L.



Figure 3. pH Levels in Gillies Pond 1991 through 2014



Figure 4. Arsenic Concentrations Levels in Gillies Pond 1991 through 2014



Figure 5. Copper Concentrations in Gillies Pond 1991 through 2014



Figure 6. Lead Concentrations in Gillies Pond 1991 through 2014



Figure 7. Nickel Concentrations in Gillies Pond 1991 through 2014



Figure 8. Zinc Concentrations in Gillies Pond 1991 through 2014



Figure 9. TSS Levels in Gillies Pond 1991 through 2014

Regular surface water sampling in Town Creek has been conducted since 1998. The influence of HTMA discharge on water quality in Town Creek prior to rehabilitation measure implementation was more significant in the headwater area of the creek than it was in the mid and lower reaches. In the headwaters water quality largely mimicked that of the HTMA discharge, whereas in the mid and lower reaches COPC concentrations varied considerably. Improvements in water quality in the upper reach of Town Creek (monitoring station DS655 at the Hwy 655 crossing) were observed immediately following the implementation of rehabilitation measures at the HTMA. The pH levels became circum-neutral to slightly alkaline (Figure 10), arsenic (Figure 11) and metal (Figure 12 through 15) levels decreased by one to two orders of magnitude and TSS levels (Figure 16) have decreased and are generally less variable. Since implementation of rehabilitation measures at the HTMA COPC levels have met site-specific surface water quality objectives (SWQOs) in almost all instances and moreover COPC levels are generally close to or below Provincial Water Quality Objectives (PWQOs).



Figure 10. pH Levels at Town Creek Monitoring Station DS655, 2007 through 2014



Figure 11. Arsenic Concentrations at Town Creek Monitoring Station DS655, 2007 through 2014



Figure 12. Copper Concentrations at Town Creek Monitoring Station DS655, 2007 through 2014



Figure 13. Lead Concentrations at Town Creek Monitoring Station DS655, 2007 through 2014



Figure 14. Nickel Concentrations at Town Creek Monitoring Station DS655, 2007 through 2014



Figure 15. Zinc Concentrations at Town Creek Monitoring Station DS655, 2007 through 2014



Figure 16. TSS Levels at Town Creek Monitoring Station DS655, 2007 through 2014

AMEC (2007) developed an empirical model to predict post-rehabilitation water quality at the Hwy 655 crossing (monitoring station DS655). The predictions, as well as actual concentrations over the period 2012 through 2014 at DS655 are summarized in Table 2. Overall it is evident that the HTMA rehabilitation measures had a greater positive influence on water quality than predicted. The pH values at DS655 post-rehabilitation exceed predictions for both the spring freshet and summer low flow conditions by 1 to 2 pH units on the low end of the prediction and by between 0.5 and 1.0 pH units on the high end. For each of the other COPCs monitoring data collected between 2012 and 2014 are one to two orders of magnitude less than the values predicted for the postrehabilitation era.

Table 1: Comparison of Predicted Post-Rehabilitation CPOC Predictions to Actual 2012

CPOC	Predicted Concentrations (mg/L)		Actual Concentrations (mg/L)	
	Freshet	Low Flow	Freshet	Low Flow
рН	5.2 to 7.0	6.0 to 7.5	7.2 to 8.0	7.4 to 8.0
Arsenic	0.006 to 0.02	0.001 to 0.1	0.0003 to 0.0077	0.0003 to 0.0052
Copper	0.03 to 0.2	0.01 to 0.3	0.0026 to 0.0135	0.0003 to 0.0177
Lead	0.01 to 0.1	0.01 to 0.1	0.0004 to 0.0015	0.0004 to 0.0152

to 2014 Monitoring Data

Nickel	0.05 to 0.2	0.01 to 0.2	0.0045 to 0.0227	0.0006 to 0.0227
Zinc	0.2 to 0.9	0.1 to 1.0	0.0006 to 0.0263	0.0022 to 0.03

Recommendations for Revisions to the Site-wide Monitoring Program

Based on the results of the performance assessment of the rehabilitation measures at the HTMA recommendations for revisions to the current site-wide monitoring program have been developed. The program will continue to comprise three primary components including groundwater, surface water, and aquatic biology. Monitoring for each of these components has been defined in terms of: sampling locations; sampling frequency; sample collection protocol including analytes and/or endpoints of interest; sample analysis protocols; and, interpretation of results. General requirements and frequency for reporting, as well as for quality assurance and quality control provisions have also been considered. Site-wide monitoring program commitments will be defined and harmonized in consideration of current Site-environment interactions, post site-wide remediation, as part of the planned 2016 Closure Plan Amendment.

Summary and Conclusions

Over the period 2009 through 2012, PGM implemented rehabilitation measures whose purpose was to, in part, improve the long-term surface and groundwater within Town Creek. Improvements measured in water quality at the HTMA, and downstream in Town Creek, were observed immediately following implementation of rehabilitation measures. The effectiveness of the rehabilitation measures are reflected by the extent to which the quality of water released from the HTMA has improved and stabilized and by all COPCs that have met their respective discharge limits at all times. The improvements in water quality at the HTMA are also reflected in Town Creek, particularly in its upper reach where the influence of the HTMA discharge is more conspicuous. Following the implementation of rehabilitation measures COPC levels have met respective SWQOs in almost all instances and moreover COPC levels are generally within the range of, or below PWQO levels. The results of the 2014 Town Creek biological survey indicated

that water quality even in the most upstream areas of the system is not a limiting factor to fish distribution. Overall, based on the data and analyses presented herein it can be concluded that the rehabilitation measures implemented at the HTMA have been successful in meeting the Closure Plan objectives as it concerns surface water quality.

Literature Cited

- AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC).
 2007. Predictions of Chemical Concentrations at Highway 655 after Closure of the Hollinger Tailings Management Area. June 2007.
- AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC).
 2014a. Hollinger Tailings Management Area Rehabilitation Project Summary.
 January 2014.
- AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC).
 2014b. Hollinger Tailings Management Area Summary As-Built Report. January 2014.
- Azimuth Environmental Consulting Inc. (Azimuth). 2015. Goldcorp Canada Ltd. Hollinger Tailings Management Area 2014 Biological Monitoring. March 2015.
- EcoMetrix Incorporated (EcoMetrix). 2015. Hollinger Tailings Management Area Comprehensive Evaluation Report. March 2015.
- Minnow Environmental Inc. (Minnow). 2001. Biological Assessment McIntyre Concentrate Dump Closure.
- Minnow Environmental Inc. (Minnow). 2003. Biological Assessment Town Creek Upstream of Highway 655.

- Porcupine Gold Mines (PGM). 2009. Hollinger Tailings Management Area Closure Plan Amendment. April 2009.
- Senes Consultants Ltd. (Senes). 2007. Closure Plan for the Hollinger (Gillies Lake) Tailings Area. January 2007.

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