

# **Mine Rehabilitation in an Urban Environment**

## ***A Successful Industry – Government Cooperative Strategy***

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### **Abstract**

In December 1999, a unique agreement between Kinross Gold Corporation and the Ontario Ministry of Northern Development and Mines provided the legal framework for the rehabilitation of certain mine workings associated with the former Hollinger and McIntyre Mines in the City of Timmins, in northeastern Ontario.

The technical program commenced in January 2000. Over six hundred potential mine hazards were identified through a detailed review of the mine archives. These hazards consisted of areas of overburden and backfill subsidence, open and covered raises and shafts, crown pillars, open stopes and pits at the surface, and derelict/abandoned mine structures.

A strategy of risk assessment, field investigation, instrumentation, communication with stakeholders, and development of site-specific engineering solutions to these hazard areas was implemented successfully.

Ultimately, through a structured process of engineering risk assessment, the program will be successfully brought to a conclusion. Engineered closure plans are being developed and implemented in accordance with a schedule negotiated with MNDM.

This program has been a successful industry-government cooperative technical program, implemented over a number of years in a challenging urban environment.

### **Industry – Government Cooperation**

#### ***The Legal Framework***

In December 1999, a unique agreement between Kinross Gold Corporation and the Ontario Ministry of Northern Development and Mines provided the legal framework for the rehabilitation of certain mine workings associated with the former Hollinger and McIntyre Mines in the City of Timmins, in northeastern Ontario.

The mine properties, in receivership after the financial collapse of their former owner, Royal Oak Mines, are located near downtown Timmins. A purchase of the properties was unlikely given the perceived liabilities associated with the mine hazards, despite the presence of a significant mineral inventory on other associated properties that were offered for sale as a package by the receiver.

The agreement defined the scope of shared responsibilities between the new owner, Kinross

Gold Corporation, and the Provincial Government represented by MNDM. A cost sharing formula was agreed upon together with a joint operating responsibility for technical programs, administered through a steering committee.

It was agreed that Kinross, acting on behalf of the steering committee, would initially make contact with property owners for the purpose of gaining access to potential mine hazard sites. The Ontario Mines Act gives the MNDM authority to act as well, but in all cases, programs were successfully developed in cooperation with the property owners.

At the conclusion of mine rehabilitation efforts on a property, the property owner was provided with a letter describing the work that was completed, together with a clear understanding of the engineering limitations of constructed structures and the requirements for continued access for monitoring.

Work completed under the agreement was documented and the information was provided to the City of Timmins for inclusion in their geographical information system. The City developed a by-law requiring the building permit process to consider the presence of mining hazards and mine rehabilitation works. Communications between the City and the Ministry of Northern Development and Mines were strengthened with the ultimate goal of reducing the potential for infrastructure to be impacted by mine hazards in the future.

### **The Challenge of an Urban Environment**

The City of Timmins has a rich mining heritage extending over a period of nearly one hundred years. With the proliferation of historical mines in close proximity to public infrastructure and private property, land use conflicts were inevitable.

The steering committee recognized early in the process that close communications with the City of Timmins would be required. The Timmins Mine Workings Coordinating Committee was established as a forum where the mine rehabilitation program could be effectively discussed with the City's Chief Administrative Officer, Chief Engineer and Director of Planning.

Many of the mine rehabilitation programs were highly visible in the community. Some of the programs required the temporary closure of public roadways while others required exemption from noise by-laws on a temporary basis to allow for activities during non-business hours. Public and media curiosity was very common as the work progressed. As a consequence, the steering committee was active in providing information to the public through a series of press releases and public notices coordinated through the City of Timmins. As well, several public presentations were delivered to City council and to the general public in order to communicate the program objectives and progress.

The highest priority for the steering committee was public safety. Initially, historical mine records were reviewed in order to identify potential hazards. Hazards were identified in the field and

documented. An interactive mapping and database software system was developed by MNDM in order to document over six hundred hazards and potential hazards. Hazards were prioritized based on the potential for public access and the potential consequences for contact with the hazard. Critical public infrastructure, such as First Avenue, Highway 101 and the City water tower were reviewed and programs were developed to further advance understanding of the potential hazards.

Kinross Gold Corporation developed a safety and orientation program for contractors and engineers working on the rehabilitation effort. This program included requirements for personal protective equipment, checklists for addressing work around specific types of hazards, and systems for ensuring worker safety such as the "Neil George Five Point Safety System" used in the mining industry, and a requirement for pre-operational checks on equipment.

The steering committee developed an effective emergency response protocol for addressing the rescue of individuals from mining hazards with representatives of the central mine rescue facility, the safety departments at local mining operations, and the City of Timmins Fire and Police Departments.

### **The Rehabilitation Program**

The hazards consisted of open and covered raises and shafts, crown pillars, open stopes and pits at the surface, and derelict/abandoned mine structures. With ground water rising in the mine workings to the surface, overburden subsidence was evident in several prominent locations around the City.

A detailed inventory of all fences surrounding mining hazards was conducted. Fences were repaired, proper signage installed, and a system of regular security patrols was established. In some cases, fence lines were modified in order to ensure overburden subsidence would be fully contained. Abandoned structures on the mine properties were secured.

Rehabilitation techniques were refined over a period of several years in order to achieve the most cost-effective approach to ensuring the safety of the public and preservation of land value

in a manner consistent with the Ontario Mines Act requirements for mine rehabilitation and progressive rehabilitation.

Initial programs included evaluation of the stability of First Avenue, the main thoroughfare into Schumacher. A program of diamond drilling, instrumentation and borehole camera investigations, together with a detailed assessment of rock structure and rock mechanics, resulted in the re-opening of the roadway that had been temporarily closed as a result of cracks observed in the surface.

Crown pillars under and adjacent to Algonquin Boulevard, the main highway through the center of the city, were drilled, sampled and evaluated for stability using several standard rock mechanics techniques. The pillars were determined to be stable and instrumentation was installed in order to provide for long term monitoring.

Areas of significant subsidence, particularly around the parking lot at the Hollinger Golf Course, were backfilled with loose sand. This material is readily available at reasonable cost in the area, and is an ideal material due to its ability to flow downward into the mine workings and prevent further overburden movement. A remotely controlled bulldozer was used in areas where risk to workers was extreme due to the proximity of hazards.

Several stope caps and crown pillars in close proximity to higher value structures were stabilized using “plugs” constructed of low strength cemented fill. Stopes and raises that were either open to surface or capped with cement or timber structures that do not meet the requirements of the Ontario Mines Act, were replaced by reinforced concrete structures. These structures were anchored to solid bedrock adjacent to the opening to ensure long term stability.

As many of the work sites were visible to the public, appropriate landscaping was incorporated into the projects.

The rehabilitation program undergoes an audit by an independent expert annually in order to

document progress and to provide guidance for future efforts.

The steering committee worked closely with the City of Timmins and with private property owners in order to ensure the safety of the public and in order to preserve property use and values.

## **Measuring Progress**

### *The Risk Assessment Process*

A formal risk assessment model was developed in consultation with the technical specialists who provided engineering services in support of the rehabilitation program.

The purpose of the model was to systematically identify the level of risk each mine hazard, or potential hazard, posed to the health and safety of the public.

Risk was defined in a classical sense: the probability of a “failure” is weighed with the consequences should this “failure” occur. Failure is defined in terms of the location and condition of a hazard or potential hazard. Consequences are defined in terms of the likelihood of public exposure. Hazards were categorized as stopes, raises or crown pillars in the model. The system of ranking hazards was “fine tuned” to accurately describe the system of investigations and engineering controls that were in use in the field.

Stopes and raises were categorized as being unfilled or open, filled with sand, capped with a modern structure, capped with a historical structure that was verified as adequate, or capped with an unverifiable historical structure. Crown pillars were categorized in terms of their geometry and rock competency.

The likelihood of public exposure to a hazard was defined in terms of its location within a secure fenced enclosure, at the boundary of a secure fenced enclosure, in a remote forested area, in a semi-public area or in a full public area.

Hazards were then classified into a relative numerical system defining their level of risk, from low to extreme. The database defining the hazard classifications was linked visually through a

colour-coding system to a map of the properties subject to rehabilitation under the program.

As rehabilitation programs were completed, individual hazards were re-classified to reflect their lower potential risk to the public. The frequency of hazards at each level of risk, in each category, could be calculated at different periods of time in order to numerically track progress. Progress could also be illustrated visually by plotting the risk category map at different period in time.

By the end of 2002, it was apparent that the majority of the mine hazards identified in 2000 had been investigated, the risk assessed against the program objectives, and appropriate rehabilitation steps implemented. In several cases, long term monitoring programs were developed to reduce the risk of hazards developing in the future.

### **Conclusions**

The 1999 Agreement between Kinross Gold Corporation and the Ontario Ministry of Northern Development and Mines has proven to be a successful, cooperative program for the rehabilitation of historical mining hazards in the City of Timmins.

The program implemented by the technical steering committee has improved public safety, and through consultation with the City of Timmins and the community at large, a program

has been instituted that will reduce the possibility that mining hazards will develop in the future.

The engineering risk assessment process has been successful in documenting the relative level of risk associated with each mining hazard, and provided a mechanism for tracking progress towards successfully completing the rehabilitation process.

The rehabilitation efforts have been completed in a manner consistent with the standards established in the Ontario Mines Rehabilitation Code.

Engineering closure plans for the “subject properties” are being developed and implemented in accordance with the schedule described in the 1999 Agreement.

### **Contributors to this paper:**

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