Performance and Monitoring of the Louvicourt Mine Tailings Disposal Area

Michel R. Julien¹, Eng. Ph.D. Principal
Michel Lemieux¹, Eng. M.Sc. Associate
Jean Cayouette², P. Eng. Assistant Mill Superintendent
Daniel Talbot², P. Chemist Environment Coordinator

¹Golder Associés Ltée
9200, boul. de l’Acadie, Bureau 10
Montréal, Québec
Canada H4N 2T2
PH : (514) 383-0990
Fax : (514) 383-5332
E-mail : mjulien@golder.com
E-mail : mlemieux@golder.com

²Aur Resources Inc., Louvicourt Mine
5999, 3e Avenue Est
C.P. 2117
Val d’Or, Québec
Canada J9P 6V2
PH : (819) 736-3551
Fax : (819) 736-2348
E-mail : jean_cayouette@aurresources.com
E-mail : daniel_talbot@aurresources.com

Key Words: Tailings pond, deposition, dam, dyke
Abstract: The Louvicourt Mine located near Val d’Or, Quebec has been in operation since 1994. It produces copper and zinc concentrates. The tailings generated from the ore processing operations have a strong net acid generating potential. Louvicourt Mine, a grass root project, was designed for closure with the best available technology at the time of design. In order to inhibit short and long time acid potential generation, sub-aqueous disposal was selected at the design stage. Given the fact that disposal in a natural lake was ruled out up front for obvious reasons related to loss of natural habitat and risks of permitting delays, a man made facility built with dams was planned. This mine includes therefore the first fully man-made sub-aqueous tailings disposal facility built in Canada. The requirement of using sub-aqueous disposal had serious implications on the placement of tailings. This tailings facility located about 9 km from the mine site has been selected based on the available natural confinement, the favorable foundation and hydrogeological conditions. This paper describes the site and the design criteria that were used. A presentation is also made on the placement technique to maximize storage and its impact on the operation of the basin. The performance of the basin, the dams and the decant structures is reviewed.

Résumé: La mine Louvicourt, située près de Val d’Or, Québec est opérationnelle depuis 1994. Elle produit des concentrés de cuivre et de zinc. Les résidus générés par les opérations de traitement du minerai possèdent un fort potentiel net de génération d’acide. Le parc à résidus de la mine Louvicourt, implanté dans un milieu naturel intact, fut doté dès sa conception initiale de la meilleure technologie de fermeture disponible à l’époque, soit la déposition sous couverture aqueuse et ce, dans le but de bloquer le potentiel de génération d’acide à court et à long terme des résidus. Etant donné que la déposition dans un lac naturel fut mise de côté dès le départ pour des raisons évidentes reliées à la perte d'habitats naturels et au risque d’introduire des délais dans l’émission des permis, un étang artificiel délimité par des digues a été conçu. Cette mine fut donc la première au Canada à être dotée d’une installation anthropique de disposition des résidus sous une pleine couverture aqueuse. L’exigence d’une déposition sous couverture aqueuse a eu des implications sur le mode de mise en place des résidus. L’emplacement de l’installation de gestion des résidus a été choisi en un lieu situé à environ 9 km du concentrateur sur la base du confinement naturel disponible et des conditions hydrogéologiques et géotechniques favorables. Cet article décrit le site et les critères de conception utilisés. Une présentation est faite sur la technique de mise en place utilisée pour maximiser l’entreposage et son impact sur l’opération du bassin. La performance du bassin, des digues et des structures de décantation est également revue.

Introduction

Louvicourt Mine is a base metal mine (copper and zinc, with values in gold and silver) located about 20 km East of Val d’Or, Quebec, Canada. Louvicourt Mine is a joint venture between Aur Resources (30%), Novicourt Inc (45%) and Teck-Cominco (25%). Aur Resources is the mine operator with 280 employees. Louvicourt mine has been in operation since 1994 at a rate of about 4,300 t/day. It is considered the first large scale application in Canada where a man-made
sub-aqueous tailings disposal facility has been used. As the design and construction of the Louvicourt mine project proceeded between 1991 and 1993, it was identified early on that tailings to be produced would have a net acid generating potential. Environmental concerns associated with this issue were fundamental during the design process. It can be recalled that acid mine drainage (AMD) is currently one of the most important environmental issue facing the mining industry.

The decision of using both underground disposal of tailings as paste backfill and sub-aqueous disposal in a man-made structure was at that time very innovative for the industry. As a consequence, Aur Ressources was awarded the "Environmental Award" by the Prospectors and Developers Association of Canada in march 1995. Since, the tailings area has been in operation for nearly 10 years, it was felt beneficial to provide a review of the work done and the experience gained.

It can be recalled that maintaining tailings submerged is considered one of the most effective mean to prevent acid generation. In the early nineties, a lot of research activities have been initiated to identify ways to mitigate and prevent AMD (SRK, 1988; Nicholson and al., 1989). Through the different research works sub-aqueous disposal was confirmed as an effective way to inhibit and control acid mine drainage (Aubertin and al., 2002; Li and al., 1997).

In simplified terms, acid mine drainage is generated when air (Oxygen), water and exposed sulphide bearing minerals are present simultaneously and in sufficient quantity. Oxygen diffusion rate that controls the oxygen availability for the reaction is a key parameter that can be controlled more effectively than others. Oxygen diffusion rate in water is known to be about 10,000 lower than in the air. Since the oxygen available for the reaction is directly proportional to the diffusion coefficient, the kinetics of the reaction in submerged conditions can become so slow it can basically be considered stopped. (MEND 2.12.1c, 2001).

Tailings storage facilities are permanent structures. They have to be designed for very long return period. Experience has shown that these structures can represent a long term liability. Even if the most publicized and spectacular failures of tailings storage facilities in the last 20 years have taken place on operating sites (Vicks, 1997; Davies, 2002), there have been numerous and less publicized failures of closed or abandoned facilities. Typically, failures associated with closed or abandoned sites result in the release in some cases of significant volumes of tailings and water. In order to reduce the long term liability, many jurisdictions have established design guidelines and financial guarantees to support long term maintenance (Gouvernement du Québec, 1997; Association Minière du Canada, 1998).

Sub-aqueous disposal of tailings therefore raise this question where a proven technology includes long term sustainability issues both in terms of our ability of maintaining a permanent water cover for extended dry periods and also ensuring dam stability and proper water management well beyond the end of operation (Aubertin, 1995).
This paper is presenting an overview of the project for the early stages, the design, the construction, the monitoring of the structures, the aspects related to tailings placement found to be particularly challenging and the issues related to long term management and sustainability.

**Design criteria**

As mentioned, in order to avoid treatment of excess water during and after the active period of the mine, it was decided to use sub-aqueous disposal. As research has shown (Li and al., 1997; St-Arnault and Yanful, 1993), in order to be effective, sub-aqueous disposal needs to be quasi-continual to prevent triggering the process of acid generation that then becomes difficult to stop.

It was estimated at that time that a minimum cover of 1.0 m water would be sufficient to inhibit acid generation from tailings given the size of the proposed basin (waves effect can remobilize fine particles). The use of a natural body of water like a lake is the most obvious choice to obtain the desired water cover over the tailings at all times. It was decided at early stages that a natural lake would not be used considering the loss of natural habitats, the understandable concerns in the public opinion and the expected permitting delays. The construction of a man-made impoundment was therefore selected as the preferred option by the owner.

The decision to adopt the sub-aqueous deposition technology was a binding one since it had serious impacts on the design of the facility as well as on its operation and closure.

At the design stage, i.e. during the site selection process, this technology required careful consideration to the geological setting. Indeed, for this technology to be fully efficient, the site of the future impoundment ought to exhibit foundations characterized by a continuous layer of relatively low permeability materials. Such a condition minimizes the risk of excess seepage through the foundation and reduces the difficulty of maintaining a water cover during a multi year sequence of low precipitation.

Dyke design also had to adopt the principles applicable to water retention structures since confinement dykes will continuously be in contact with water, even long after mine closure. The foundation of the dyke had therefore be properly keyed into the natural low permeability material.

Any hydraulic window detected within the foundation of the confining structures had to be treated to minimize overall seepage flow beneath the dyke. The risk of internal piping was a key concern that was addressed by using proper design methodology for filter criteria.

In addition, the dyke had to include a low permeability core to minimize seepage. A properly engineered drain had to be designed and built along the downstream vertical face of the impervious core to collect and evacuate seepage thus keeping the water table away from the dam downstream face. Both faces of the dams ought to resist erosion and frost degradation, the upstream face being additionally subjected to wave action. Also, the dams were designed to obtain required static and pseudo-static factor safety for different failure mechanisms.

In terms of design criteria, the system had to be designed to support extreme events:
• Spillways had to be able to handle and safely evacuate a Probable Maximum Flood obtained by assuming the combination of the maximum probable precipitation with the most unfavourable runoff conditions (ICOLD, 1989).
• Maintain a water cover over the tailings of 1.0 m and never less than 0.5 m.
• Design the confining structures to minimize seepage to meet long term performance objective for the water cover sustainability.
• Design the confining structures to obtain minimum static and pseudo-static safety factor of 1.3 and 1.1 respectively. The seismic event used for design was selected to be the 1:1000 years return period event.

**Water management**

The use of sub-aqueous tailings deposition technology would introduce additional constraints on how tailings could be deposited and water managed during the active life of the facility. Water management had to be controlled such that excess water could be safely accumulated and discharged while maintaining the tailings submerged. The final stage of tailings deposition in a given portion of the impoundment had to be as flat as possible in order to avoid losing valuable storage capacity if deep troughs were to be left behind. At the opposite, a rough deposition method at this stage could result in excessive amounts of tailings being concentrated in the same area with consequent exposure to the air if the pond was lowered.

As mentioned, the choice of sub-aqueous tailings deposition method resulted in strict and often delicate water management of the impoundment. Too little water coverage in the summer could lead to exposed tailings and cause problems to move the discharge point during the summer, while too much water, especially by the end of winter, could result in more difficult water management at spring time. These aspects are essentially operational ones. It is assumed that water management at closure will be simplified since the water level will be kept constant.

As far as closure is concerned, the use of sub-aqueous tailings deposition technology introduces additional risks related to the perpetual presence of water in contact with the confinement dams and the permanent use of decant structures.

It is obvious that such a system will require beyond closure a level of inspection and maintenance greater than for a dry stack of tailings that does not retain any ponded water.

**Site selection**

Back in 1992, a multi site identification and screening process was performed to select the preferred location of the proposed tailings area. Considering that 60% of the tailings was to be returned underground as paste backfill, and allowing for some extra storage capacity, the original design was for 15 Mt (8.8 Mm³ by assuming a dry unit weight for the tailings of 1.7 t/m³).
selected site was located about 9 km to the north west of the plant site. In order to reduce costs and to simplify the construction, it was decided to build this facility in 2 phases or cells (Figure 1 shows the 2 cells – East Cell and West Cell). Only the East Cell has been built so far. This cell has an estimated capacity of about 8 Mt (4.7 Mm³) and did not require a diversion. The West Cell if it is built would require a diversion of a creek flowing North to the Colombière river. This diversion would be done South of the tailings basin (upstream of the current location).

The area consisted in an area of about 1500 m x 900 m natural basin bordered to the south by a continuous ridge of low hills and by isolated rock knobs to the north.

The stratigraphy within the lower portions of this basin consisted in a surficial layer of peat underlain by a 5 to 16 m thick layer of clayey silt to varved silty clay. The undrained shear strength of this material was measured to be 24 to 30 kPa beneath the surficial crust. The clayey materials were noted to be absent from the upper portion of the valley. Loose to compact silts and compact to very dense till varying between 2.5 to 21 m thick were encountered in descending order beneath the clayey materials. The till was found to be quite erratic in nature and could vary from a silt with traces of gravel to a sandy gravel. As a consequence, permeability values were broadly scattered between $1 \times 10^{-6}$ to $2 \times 10^{-3}$ cm/s.

The underlying bedrock was described mainly as a granodiorite. Packer tests showed the bedrock upper meter to be more fractured and pervious than the lower rock with an average measured permeability of $4 \times 10^{-5}$ cm/s in the upper 5.0 m below the surface.

**Dyke design**

The confinement of the 97 ha impoundment area required a total of some 2.5 km of dyke construction along the north-east, north and west sides of the site in order to link the rock knobs one to another and tie them to the southern ridge of hills (see Figure 2). Average dyke height is 9 m with localized segments reaching 18 m in height. Typical dyke geometry is shown on Figure 3. Table 1 provides a description of the general features of the dykes.
Typically, the dykes consist of a 6 m minimum width till core with chimney sand drain along the downstream face. Finger drains were also provided to allow the evacuation of seepage water. The remainder of the dam and berms consist of sandfill. Overall side slopes are 2.5 H:1V upstream and 2H:1V downstream. Side berms varying from 8 to 55 m in width had to be introduced on both sides of the dams to provide adequate safety against basal failure within the clayey materials. Stability analyses were conducted using a minimum factor of safety of 1.4 under static conditions and 1.1 under seismic loading using a 1:1000 year magnitude earthquake.
The stability of the upstream side slope was also checked under rapid drawdown condition and yielded a 1.3 factor of safety.

The seepage analysis of the dyke was conducted through computer modelling and it was determined that 80% of the seepage flow would take place beneath the dyke, the rest consisting of flow through the till core. Anticipated settlements in the most sensitive dyke segments had to be compensated by crowning the crest with an extra 1.0 m height during construction.

The design freeboard was chosen at 2 m and the average water cover was selected at 1 m with a minimum value of 0.5 m. The minimum crest elevation is 3318.0 m expressed in terms of the Mine datum. The maximum elevation for the operating water level is 3316.0 m (providing a minimum freeboard of 2.0 m). The maximum tailings elevation is 3315.0 m.

### Table 1 – Summary of dyke characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Dyke 1</th>
<th>Dyke 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest elevation</td>
<td>3318.0 to 3319.0(^{(1)}) m</td>
<td>3318.0 to 3319.0 m</td>
</tr>
<tr>
<td>Average height</td>
<td>8 m</td>
<td>10 m</td>
</tr>
<tr>
<td>Maximum height</td>
<td>18 m</td>
<td>16 m</td>
</tr>
<tr>
<td>Downstream slope</td>
<td>2.0 H : 1 V</td>
<td>2.0 H : 1 V</td>
</tr>
<tr>
<td>Upstream slope</td>
<td>2.5 H : 1 V</td>
<td>2.5 H : 1 V</td>
</tr>
<tr>
<td>Length</td>
<td>1650 m</td>
<td>880 m</td>
</tr>
<tr>
<td>Foundations</td>
<td>Rock, silty clay and till</td>
<td>Silty clay and till</td>
</tr>
<tr>
<td>Dyke structure</td>
<td>Till core, sand shell on U/S side, coarse sand and gravel on D/S side, rip-rap protection on D/S and with geotextile on U/S, proper drains and filters</td>
<td>Till core, sand shell on U/S side, coarse sand and gravel on D/S side, rip-rap protection on D/S and with geotextile on U/S, proper drains and filters</td>
</tr>
</tbody>
</table>

Note (1): Elevations are related to Mine datum
Figure 2: General view of the tailings area (East Cell) with tailings deposition contours as of spring 2001.
Figure 3: Typical cross section of the confinement dykes
Dyke construction

Dyke construction took place in 1993. Initial topsoil stripping was conducted over the full downstream construction area plus 10 m upstream of the till core. A 5 m width key was excavated beneath the till core to a depth of 1 to 1.5 m within the native clayey materials in order to provide good seal contact with the underlying low permeability material. Alternatively where till and silts were encountered at the foundation level, the key was excavated to a depth of 1.0 m and extended upstream as a horizontal blanket up to 5 m beyond the toe of the dyke. This whole area was then backfilled with compacted till.

Wherever bedrock was encountered within a depth of 2.0 m within the key, rock was mapped and tested for permeability. An extensive grid of Packer tests had to be performed to fully characterize the permeability of the rock and detect zones where grout injection was required. Wherever injection was required, the procedure had to be carried in stages to a maximum depth of 4 m.

Grout volumes and injection pressures were closely monitored during the process. Grout viscosity at a specific location was adjusted depending on the actual volume being injected. After

Figure 4: Typical stratigraphy along part of dyke 1
The first injection boreholes were completed at a 3 m grid, additional boreholes and Packer tests were conducted at tighter spacing to check if further injection was required. Normally, a total of two stages of rock injection proved to be sufficient to attain the required permeability value but some localized zones of heavier rock fracturing required up to three stages.

Sulphate resistant cement had to be used systematically for bedrock preparation and grouting. The risks of high sulphate concentration in the water during operation and closure had to be addressed.

Non organic excavation soils that were found suitable as construction materials, were used for the construction of the upstream berms. The till core, the processed sand used for filter construction and the blasted rock used as rip-rap material were all obtained from borrow areas developed on the property.

Overall some 740 000 m³ of soil and rock were used for dyke construction (see Figures 3 and 4 for typical cross-section and stratigraphy). Full time supervision by qualified personnel was provided during construction to ensure materials characteristics and construction methods were meeting project specifications.

Pore pressure response within the natural clayey deposit was monitored closely during construction using a series of electrical piezometers. Procedures to control the rate of advance had been defined if measured excess pore pressure were detected. Figure 5 shows a close-up view of typical dyke slope.

Figure 5: View of completed dyke 1
**Polishing pond**

The quality of the pounded water within the tailings area met predictions made at the design stage and acid generation from the tailings did not occur. Thiosalts generated during the milling process were however present in the pulp water conveyed to the tailings area. Thiosalts designate a group of sulphur oxide anions that may progressively disintegrate and create some acidity. This phenomenon is usually noted beyond the point of discharge for small basins.

It was observed in 1994, while the tailings area was being filled up with water and no external release had occurred yet, that continued natural oxidation of thiosalts in the impoundment had resulted in acidification of the water.

The original design had provision for a polishing pond to be built if water quality would deteriorate. It was envisioned at that time that regular addition of lime and the provision of a polishing pond would be required during the operational period of the mine to neutralize the water prior to final discharge.

The design and permitting of the polishing pond immediately east of the main tailings area was included as an optional feature in the original 1993 Certificate of Authorization. Construction and commissioning of the facility was therefore conducted without any delay in 1995.

As shown on Figure 6, the pond is adjacent to the main tailings area and is delineated by a 730 m long confinement dyke (Dyke 4). The dyke has a maximum height of 12 m and has an internal structure similar to the one used for the main dyke.

Subsoil conditions are also similar to those encountered at the tailings area. As for the tailings area, rock injection beneath the polishing pond confinement dyke was conducted during the construction period.
Dyke inspection and performance

Inspection of all structures is a key component of the proper management of this site. It is performed on a routine basis by the mine personnel. External site inspection are also performed on an annual basis.

Routine inspections are conducted two times a day by the mill operators and once a week by the environmental team. A more detailed inspection is undertaken three times a year by the environmental site coordinator and technician. The top and toe of the dyke are then inspected. The presence of fissures, depressions, leaks, hot spots (in winter time) is recorded.

A yearly inspection is also performed by an external consultant generally immediately after the snowmelt. Dykes, berms, and natural ground near the toe of dykes are inspected at that time. Unusual site conditions noted during any of these inspections are subjected to a closer follow-up.

Data collected from the instrumentation present on site is reviewed as part of the yearly inspection process and following any sudden changes in the readings.

Corrective actions could be recommended following the yearly inspection. As a minimum, yearly maintenance is performed to maintain the road at dyke crest and remove debris along the upstream side of the dyke.
On-site instrumentation consists of piezometers, settlement monitoring points and V-notches. The electric type piezometers installed and used during the initial dyke construction period for the follow-up of pore pressure build-up and subsequent dissipation are no longer operational.

Active piezometers consist of 5 open ended Casagrande type piezometers and one stand pipe. Two of them are installed around a zone where a resurgence was detected in 1996 and corrected in 1999. V-notch monitoring points (4) were installed in 1996 and 2001 facing Dykes 1A, 1C and 2B to measure seepage flow. These points are monitored weekly during the thaw season and the pH of water is determined.

The quality of the water at these seepage points is adequate and water does not have to be pumped back into the tailings area. The amount of seepage is also steady with time.

Settlement monitoring points (11) exist along the dyke crest. Survey follow-up of these points has shown the actual settlement is less than the maximum anticipated post-construction value of 1.0 m.

Water control structures are installed between the tailings area and the polishing pond as well as the outlet of the polishing pond (see Figure 7). The operation of such water control structures is also controlled during the yearly inspection and was found to be adequate.

![Figure 7: Stop log structure located at the outlet of the polishing pond.](image)

Since its start-up, this facility has met design objectives in terms of performance. Overall seepage flows have been below design criteria. Settlement has occurred in certain sectors in the range expected. To account for settlement, additional freeboard had been provided at the construction stage. Measured water levels in the different piezometers around the site compare well with the predicted levels during and after construction.
Tailings deposition

In order to make full use of the pond capacity, tailings deposition is currently carried out using a series of floating HDPE pipelines (see Figure 12). A bathymetric survey of the impoundment is normally conducted each spring and the deposition scheme for the next 12 months is fine tuned on the basis of this information. Figure 2 shows the state of deposition observed in spring 2002. It could be observed that current tailings contours are higher and more regular in the western half of the basin compared to the eastern half. This follows a more active deposition of tailings in the western zone over the years. The western half is currently used for summer tailings deposition. Shallow water thickness in this area requires frequent displacement of the discharge pipeline to avoid forming tailing accumulations too close to the pond surface. In these areas, moving with a standard craft driven by an outboard motor is no longer adequate. Movement is now made with a hydroplane or airboat (see Figure #8). The hydroplane is also used to grade small islets (tailing high points) accidentally formed during the deposition. To do so the hydroplane is equipped with a home made harrow as shown on Figure #9.

Anchorage of the floating tailings pipeline in the shallow water areas is also a problem. Dead weights (45 gallon drums filled with concrete) left too close to the pond surface can limit the movement on the tailings pond and restrict the future use of dredges. In order to bypass the problem, Louvicourt has designed their own system of retractile anchor rods to attach the tailings pipe line. As shown on Figure #10 and #11, the system consists of a home made flat raft equipped with a hydraulic system to drive in and out the anchor rods.
The deposition method is modified for the winter season. Approximately 5 deposition zones are selected at the end of fall based on the results of the bathymetric survey. These points are selected in the eastern deeper part of the impoundment where water is 3 to 5 m thick. The theoretical capacity and the corresponding operational duration of each low point are determined. The proper length of the discharge pipelines required to reach these low points is then prepared. Such pipes are set up in place before pond freeze-up using dead weights to provide adequate lateral stabilizers. The pipelines are initially empty since pipe connections are water tight and the discharge end points are maintained above the water and ice surface using floats. Each deposition pipeline (see Figure 12) is then operated individually and sequentially throughout the winter for the prescribed time duration. Contingency is built into the system to take into account possible pump failures or shot down periods. When such an event occurs, the active deposition pipeline freezes up and is lost for the remainder of the winter. Deposition resumes through one of the remaining unused pipelines.
In the winter season, the thickness of the ice on the tailings pond is unforeseeable, hot points prevent a safe access to the tailings pond by foot or snow-mobile. The recent acquisition of a hydroplane gives the opportunity to safely move over the ice and access the discharge points. Next winter, a test will be performed by cutting the pipeline at different predetermined locations along the pipeline creating new deposition zones along these cuts.

The deposition in the west half of the basin occasionally results in the formation of more important tailings high points. Such high points are not desirable since tailings would exceed the final elevation objective of 3315 m thus decreasing the water cover thickness. Some of these high points had to be removed by carrying out spreading operations of tailings. Figure 13 & 14 show two different barge mounted dredges used to smoothen the tailings surface when large accumulations are encountered.

![Image of barge mounted dredge](image1.png)

**Figure 13 : Use of a barge mounted dredge to spread shallow tailings**

![Image of rotary device](image2.png)

**Figure 14: Use of rotary device to spread shallow tailings.**
Long term sustainability

The current sub-aqueous deposition technique has proven to be effective over the last 9 years. Project 2.12.1 studying the Louvicourt case was initiated in 1995 as part of the Mine Environment Neutral Drainage Program (MEND). The program was aimed to assess and demonstrate the effectiveness of a shallow water cover in a man-made basin containing sulphide tailings. Two experimental cells (Figure 15) adjacent to the tailings pond were used for this purpose. The synthesis report released in 2002 provided a summary of 5 different studies which confirmed the effectiveness of the water cover (MEND 2.12.1 a through e). Based on these studies and on the information collected during the operation, it can be expected that adequate environmental behavior will continue for extended periods of time. The issue related to dyke stability and water management structures integrity are keys in long term performance. The use of a water cover as post closure strategy obviously requires monitoring and maintenance procedures that are different than for sites operated in a ‘dry’ fashion. In the post closure strategy of the Louvicourt tailings pond, emphasis will be put on inspections and monitoring around the dykes.

![Figure 15: Louvicourt experimental cells](image)

Conclusion

The Louvicourt tailings area has shown adequate behavior during the last 9 years of operation. Dyke seepage is minimal and below the design expected evaluation. Dyke settlement is less than anticipated and water control structures are performing correctly. The sub-aqueous deposition of tailings is efficient in inhibiting acid generation of tailings. Some pH control measures had, however, to be implemented to neutralize the oxidation of thiosalts generated at the mill and contained in the pulp water. Overall, the use of the man-made structure to control acid generation of tailings has proven to be a successful endeavor. This on going tailings reclamation method increases the capital cost at mine start up but will reduce substantially and rapidly the impact on the environment and thus the cost involved for the closure plan.
References


