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REPORT ON

Spillway Design/Construction Report
Stirling Mine Site
Richmond County, Nova Scotia

File No. 24-3594-008-1

Submitted to:

Nova Scotia Department of Natural Resources

Submitted by:

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Project Manager: EIC
Reviewed by: EIC
Date: March 13/96

March 1996

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March 13, 1996 File No. 24-3594-008.1

Nova Scotia Department of
Natural Resources
1701 Hollis Street, 3rd Floor
P.O. Box 698
Halifax, Nova Scotia
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Attention: Dan Khan

RE: Spillway Design/Construction Report
Stirling Mine Site
Richmond County, Nova Scotia

We are pleased to submit two (2) copies of the above-mentioned report.

We trust this information is sufficient for your current needs. If you have any questions or require any additional information, please do not hesitate to contact us at your convenience.

Yours very truly,

ADI Nolan Davis

mmacIntosh

for Edward I. Carey, P.Eng.
Branch Manager

EIC:mrm

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1.0 INTRODUCTION

ADI Nolan Davis has designed and supervised construction of a rock-filled spillway to provide a controlled discharge of water from the tailings pond at the abandoned Stirling Mine Site in Richmond County, NS. The spillway was required to replace an existing discharge structure which was not functioning as designed. The existing structure was a circular shaped galvanized steel culvert with a diameter of 1.5 metres. Runoff water eroded a channel beneath the pipe so that there was no retention in the pond and hence no opportunity for sediment to settle out prior to discharge to the nearby Strachan Brook.

2.0 DESIGN

ADI Nolan Davis chose to design a "down drain" type spillway to be constructed of rock filled gabion mattress sections. It was determined that this type of construction could provide the best combination of hydraulic performance, durability and low maintenance characteristics. These three qualities were very important for this remotely located drainage basin.

Drawing 24-3594-008-001, provided in Appendix A, shows the orientation of the tailings basin with respect to the overall mine site. The tailings basin is approximately 600 metres in length and 150 metres wide. The orientation of the pond is in a west-east direction. The discharge structure is located to the east of the basin. The tailings are contained by a perimeter embankment constructed of glacial till.

In order to design the spillway, a hydrologic assessment of the drainage area of the berm was conducted. The entire watershed of the study area was approximately 26.5 hectares (66 acres). The watershed included a relatively steep wooded slope situated to the north of the tailings basin and the relatively flat lying tailings basin. The tailings basin is generally in an unflooded condition. During rainfall events runoff channels have flowing water and there was some minor ponding near the discharge structure.

It was decided that runoff from the entire watershed would be used for the design of the spillway. A preliminary design concept included an interception ditch to collect the runoff from the north slope. It was determined that the ditch would be expensive to construct and not provide an overall benefit with regard to reduction of inflow versus cost to construct the spillway.

Following NSDOE recommendations, this permanent structure was designed for a 1 in 100 year return storm event. The rainfall event duration of 6 hours was chosen for design. Based on the climatic data obtained from Environment Canada the design rainfall event was 94 mm in 6 hours. This was based on data collected from 1974 to 1994.

The following runoff calculation parameters were used in "normal condition" design calculations. This included an assumption of reduced infiltration during high intensity storm events.

Wooded Area:
- Average Slope = 6%
- Coefficient of Runoff = 0.35

Exposed Tailings Basin:
- Average Slope = 0.5%
- Coefficient of Runoff = 0.25

For winter storm calculations a coefficient of runoff of 0.8 was selected. The calculated peak discharge from the pond was approximately 0.9 m^3/sec (12,000 gallons per minute). The velocity of the flow along the tailings basin was theoretically estimated to be between 2 to 3 metres per second. The required area to discharge the flow would be approximately 0.25 square metres. This would be equivalent to a height of water of 300 mm over a 1.5 metre length. To provide a good opportunity for free flow and to reduce potential for blockage it was decided to increase the span of the intake to 3 metres.

The spillway profile is shown on the design drawing included in this report in Appendix A.

In summary, the spillway consists of rock-filled gabion mattresses manufactured by Maccaferri. The mattresses were designed to rest on a flat surface perpendicular to the intake and then on a 2 to 1 horizontal to vertical side slope of the channel. The channel was designed to be approximately 1 metre deep. Based on discussions with the manufacturer, we anticipated that flow would travel through the 200 mm thick gabion mattress as well as on top of the mattress. The intake to the spillway was constructed using 1 m x 1 m x 3 m gabion basket. These rock-filled baskets were placed to provide scour protection at the inlet. The baskets were further protected by the placement of rip rap material along the face of the inlet with protrusions into the pond at the abutments.

3.0 CONSTRUCTION OF SPILLWAY

Construction of the new spillway commenced on September 26, 1995. Prior to construction a stream crossing permit was obtained from the N.S. Department of Environment. Two temporary wooden bridge structures were set built to cross Strachan Brook to gain access to the spillway site. The locations are shown on drawing No. 24-3594-008-001.

Prior to removal of the existing drainage culvert, a temporary drainage channel was constructed at a location approximately 25 metres to the south of the new structure. This channel worked well during the construction period and was satisfactorily removed following the completion of the new spillway.

The pre-construction conditions at the spillway site and shown on photographs No. 1 and No. 2 provided in Appendix B. The existing galvanized culvert was removed by the contractor. The culvert installation included a large concrete counterweight which was buried in the embankment slope. The occurrence of the counterweight was not expected and considerable effort was required to excavate this concrete block and backfill the void. Locally obtained borrow was used to backfill the excavation. The backfill was placed in lifts and compacted with a vibratory plate.

Following removal of the existing culvert, the embankment was graded to accept the gabion mattresses. The grading included the placement of fill in the eroded area of the downstream slope of the embankment. The fill was a locally borrowed silty sand (till mixture). The fill was placed to provide as shallow a slope as possible on the downstream slope. At completion it was approximately 1 to 1.75, vertical to horizontal.

The "prepared" surface for the spillway is shown in photograph No. 3. The surface was heavily compacted and considered to be not easily erodible. Initially we had considered using a geotextile to separate the embankment soil and the gabion mattresses. However, based on case histories and the manufacturer's recommendation, we deleted the geotextile to reduce the potential for sliding of the mattresses. Instead, sand was sluiced into the rockfill to create a filter and enhance "contact" between the soil and the gabions. A geotextile was placed around the gabion baskets at the intake to reduce the potential for fine material in the tailings basin to migrate through the coarse rockfill. This is shown in photograph No. 4.

The completed spillway structure is shown in figures 5 and 6. The photographs show the rip rap material that was placed at the intake structure and the discharge outlet to prevent scour.

4.0 OPERATING PERFORMANCE

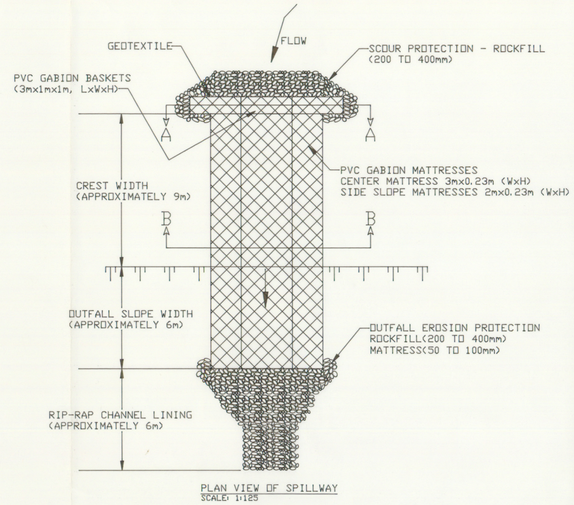
We have made several inspection visits to the site to observe the performance of the structure. These visits were made following heavy rainfall events in October and November of 1995 and February of 1996. The most severe event was the February 17, 1996 rainfall. In that event approximately 60 mm of rain fell during an 11-hour period. The runoff volume was increased by the fact that 150 to 250 mm of snow that was on the ground at the time. The snow was completely melted by the rainfall and warm temperatures.

The inspection on February 18, 1996 showed that the structure was performing satisfactorily. Photographs No. 7 and 8 show the runoff discharge on that date. The water in the tailings basin ponded to a depth of approximately .3 to .4 metres near the discharge and tapered to 0 at approximately 100 to 150 metres into the basin. The discharge was relatively free of suspended sediment. There was no evidence of scour along the structure. As previously noted, the flow tends to travel in the upper level of the gabion mattresses and slightly above.

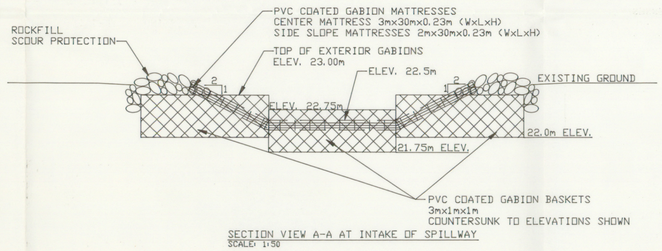
In conclusion, the rockfill gabion spillway is performing satisfactorily. It is recommended that the department make annual inspections of the structure. The buildup of sediment in the area near the discharge should be observed to determine if periodic dredging is required.

APPENDIX A

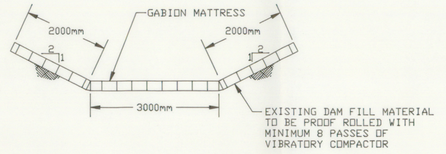
SITE PLAN
SCALE: 1:1250



PLAN VIEW OF SPILLWAY
SCALE: 1:125

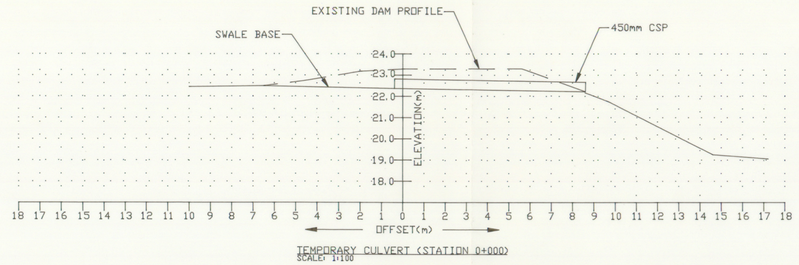


SECTION VIEW A-A AT INTAKE OF SPILLWAY
SCALE: 1:50

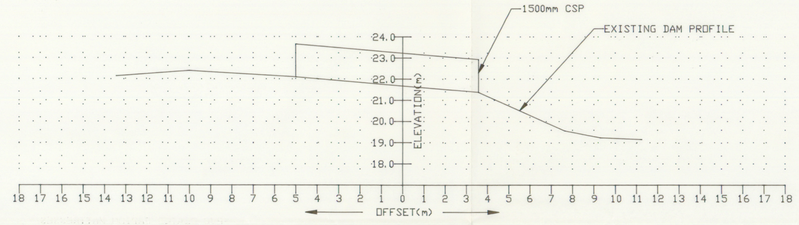


SECTION VIEW B-B THROUGH SPILLWAY
SCALE: 1:50

LOG PLATFORM
SCALE: 1:50



TEMPORARY CULVERT (STATION 0+000)
SCALE: 1:100



EXISTING CULVERT (STATION 0+015)
SCALE: 1:100

SPECIFICATIONS

1.0 SCOPE OF WORK

1.1 This project includes the installation of a new spillway structure through the southwest side of the berm that confines the tailings and adjacent wooded land area watershed. Included in the work is the installation of a temporary 450mm diam. corrugated steel pipe(CSP) to handle flow during construction to the new structure and 2 temporary brook crossings for construction access to the site. These temporary structures are to be removed on completion of the new spillway structure.

2.0 RESPONSIBILITIES

2.1 The contractor shall conduct all work as shown on this drawing and specification and as directed by the consultant.

2.2 The contractor will provide 2 temporary stream crossings for the access to the site in the general location indicated on the drawing. The contractor is to provide costs for both options for the brook crossing as described in Section 4.1. The contractor will supply all materials required for the option selected by the consultant. In addition, the contractor will supply the 450mm diameter CSP for temporary drainage diversion, rockfill for filling of gabion baskets and mattresses, rockfill for erosion and scour protection, and all related machines, labor, and materials required to complete the work.

2.3 The consultant will obtain all necessary permits required to perform the work.

2.4 The consultant will provide on site construction supervision of the project.

3.0 MATERIALS

3.1 Gabion baskets and mattresses to be supplied by the consultant.

3.2 Rockfill for gabion baskets and mattresses to be hard, durable, and abrasion resistant and such that it will not desintegrate from action of wetting and drying, and freezing and thawing cycles. Percent wear not to exceed 35% when tested in L.A. Abrasion apparatus. Samples to be supplied to consultant prior to delivery to site.

3.3 Rockfill Sizes:

3.3.1 Rockfill for gabion baskets to be 100-200mm dimension.

3.3.2 Rockfill for gabion mattresses to be 75-150mm dimension.

3.4 Rockfill for erosion and scour protection:

3.4.1 Rockfill to be angular, hard, durable and abrasion resistant such that it will not desintigrate from action of wetting and drying and freezing and thawing cycles. Samples to be supplied to consultant prior to delivery.

3.4.2 Rockfill to be 200-400mm dimension.

4.0 TEMPORARY STRUCTURES

4.1 Construct 2 temporary brook crossings to provide satisfactory access to the site for the duration of the project. Temporary crossing to be either backfilled CSP or Log Platform Bridge structure. Selection of option to be by the consultant.

4.2 Regrade, compact, or otherwise prepare the surface of the access road to ensure clear access to the site.

4.3 Excavate, proofroll the subgrade and place the temporary 450mm diameter CSP at the location and elevations indicated on the plan and as directed by the consultant.

4.4 Backfill the temporary CSP with excavated soil, compacted in lifts of 450mm to 98% of the soils Maximum Dry Density(ASTM D698) and to the satisfaction of the consultant. Additional soil required for the backfilling may be obtained from an on-site source at the direction and approval of the consultant.

4.5 Construct a cut off berm around the mouth of the existing ellipse shaped culvert. Excavate a swale to divert all flow around the berm to the temporary 450mm diameter CSP.

4.6 On completion of the permanent outfall structure, and on approval by the consultant, remove the temporary berm and 450mm CSP, backfill the temporary swale and restore to match the original grade and drainage pattern.

4.7 Provide pump and portable generator for emergency discharge requirements.

5.0 NEW OUTFALL STRUCTURE

5.1 On completion of the temporary structures, excavate and remove existing ellipse shaped CSP. The contractor will transport the CSP for storage near the tailings dam.

5.2 Excavate, shape, grade and compact the subgrade to the lines and grades indicated on the drawing in preparation for the placement of the gabion baskets and mattresses.

5.3 Secure the baskets and mattresses in place, fill with specified rockfill and secure the basket and mattress tops, to the lines and grades shown on the plan and in accordance with the manufacturers specifications. Additional backfill material will be obtained from on site borrow area. Compaction equipment to be equivalent to diesel powered Bomag BW60 weighing 200Lbs.

5.4 Place rockfill for erosion and scour protection at the intake and the outfall as indicated on the plans. Rockfill at the intake to extend a minimum of 1.5m from the sides of the mattresses and a minimum of 2.0m from the face of the gabion baskets. The rockfill at the outfall to extend to toe of slope and minimum 6.0m beyond the toe.

6.0 RESTORATION

6.1 Remove temporary CSP as described in section 3.6. Pipe to become property of contractor.

6.2 Restore brook crossing, access road, berm and site to original condition. Temporary wooden bridges to become property of the contractor.

PLOTTED BY: N.B.

COMPUTER GENERATED AUTOCAD vs.13 SYSTEM

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No.	Revision	Ckd. By	Date

Drn. By: N. Bach
Dwg. Ckd. By: E. Carey
Calcs. By:
Calcs. Ckd. By:
Date Drn.: August, 1995
Date Issued: September, 1995

Const. North

Project Title: SPILLWAY DESIGN STERLING MINE, NOVA SCOTIA

Dwg. Title: SITE LAYOUT & DETAILS

Project #: 24-3594-008.1
Dwg.: 1 of 1
Scale: NOT TO SCALE
Drawing No.: 24-3594-008-001

APPENDIX B

TAILINGS BASIN SPILLWAY - STIRLING MINE SITE

Photo #1: **Discharge Structure Intake prior to upgrade. Note runoff water flowing under culvert.**

Photo #2: **Discharge Outlet prior to upgrade. Note erosion and seepage to right of pipe. Sediment evident in discharge flow.**

TAILINGS BASIN SPILLWAY - STIRLING MINE SITE

Photo #3: **Gabion Mattresses placed on heavily compacted glacial till berm. Sand placed latter to provide cushion/filter with rockfill.**

Photo #4: **Construction of Spillway Intake. Gabion Baskets countersunk into existing glacial till embankment.**

Photo #5 (above): Completed Spillway. Note ponding of water in tailings basin.

Photo #6 (right): Close-up of Completed Spillway Intake. Rip Rap placed at abutments for scour protection.

TAILINGS BASIN SPILLWAY - STIRLING MINE SITE

Photo #7: **Spillway Intake approximately 12 hours after 60 mm rainfall event on February 17, 1996.**

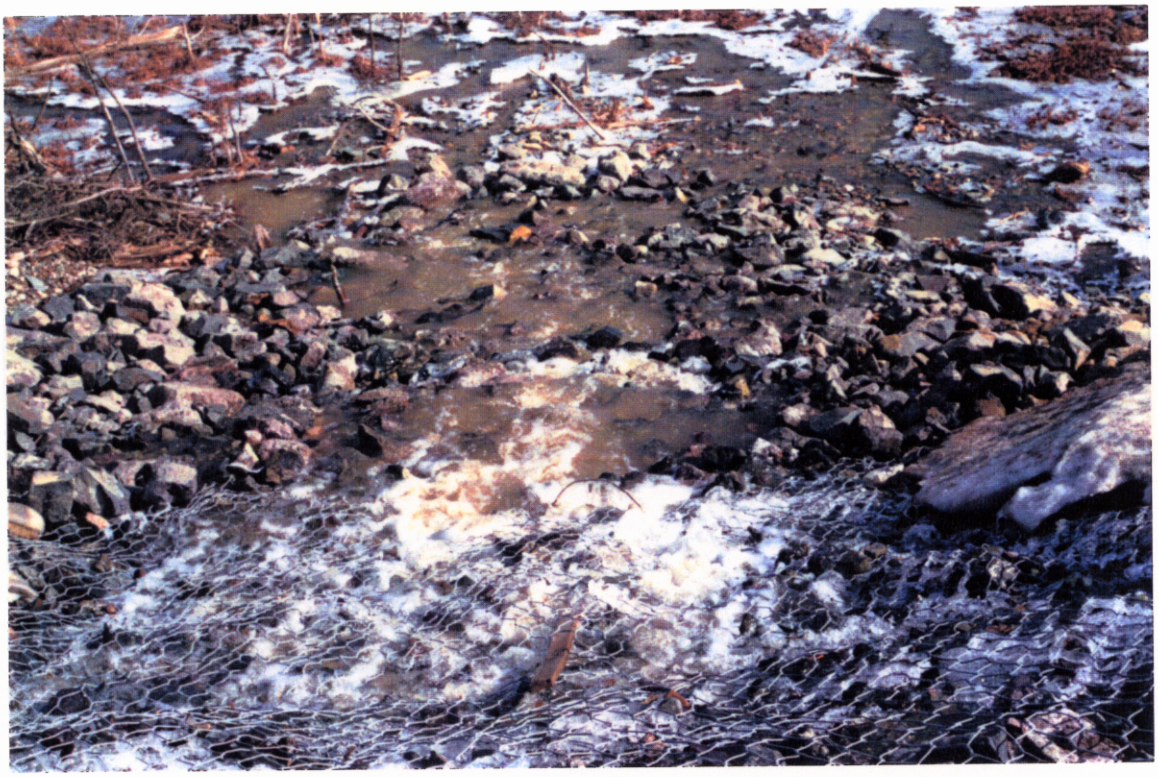

Photo #8: **Spillway Discharge on February 17, 1996. Discharge dissipated at outlet. Sediment loading in discharge water appears to be diminished from pre-construction flow.**