Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Project Description

for

Abandoned Clinton Creek Asbestos Mine

Creek Channel Stabilization

Prepared by:
Indian and Northern Affairs Canada
Northern Affairs Program, Yukon Region
Renewable Resources
Waste Management Program
August 2002

Canada

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August 08, 2002

DISTRIBUTION:

Re: Abandoned Clinton Creek Asbestos Mine: Stream Channel Stabilization - Direction Under Section 37 of the *Yukon Waters Act*

On July 23, 2002, Indian and Northern Affairs - Canada (DIAND), Water Resources issued a Direction, pursuant to Section 37 of the *Yukon Waters Act,* to Cassiar Asbestos and/or its successors to undertake actions to prevent the failure of the outlet control at Hudgeon Lake, associated with the Clinton Creek Asbestos Mine.

Cassiar Asbestos and/or its successors have not responded to this Direction, and as such, DIAND will undertake necessary actions to prevent the failure, and subsequently seek to recover costs from Cassiar Asbestos and/or its successors, as provided by the *Act*.

DIAND - Waste Management Program has been identified as Project Authority and will initiate actions immediately to reduce the risks to individuals, property and the downstream environment.

DIAND - Waste Management Program, with advice from other agencies and stakeholders, has developed the attached Project Description. These preventative actions involve the placement of a number of gabion drop structures designed to reduce and disperse the destructive force of the fast-flowing water, and increase the stabilizing mass at the outlet of Hudgeon Lake.

Please review the Project Description, and if you have any comments, questions or concerns, please contact the undersigned.

Sincerely,

Brett Hartshorne, Manager

cc:	Mark Zrum	DIAND - Director - Renewable Resources
	Todd Pilgrim	DIAND - RMO - Klondike District
	Bob Holmes	DIAND - Director - Mineral Resources
	Bengt Pettersson	Government of Yukon - Devolution Coordinator - Dept. of Environment

attachments

Canada

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1.0 Introduction

1.1 OBJECTIVES

DIAND Waste Management is planning to stabilize the creek channel of Clinton Creek at the abandoned Clinton Creek Asbestos Mine. The stabilization of the creek channel will be achieved by constructing *gabion weirs* [1] below the outflow of Hudgeon Lake, a reservoir created by a massive slope failure in 1974.

Concerns with respect to the physical conditions at the site have existed since the closure of mine operations in 1978 and the site and creek channel have been monitored by DIAND Water Resources on a regular basis. Recent investigations (Royal Roads University, 1999; UMA, 1999 and 2000) have confirmed the observations by DIAND Water Resources, that continuing down-cutting of the Clinton Creek channel and erosion of the unstable waste rock may cause the waste rock dam to fail. A sudden breach of the landslide dam and subsequent flooding could expose individuals, property and the downstream environment to various degrees of risk.

The physical instability and environmental issues at the Clinton Creek Mine have been discussed with the Department of Fisheries and Oceans, Yukon Salmon Committee, Tr'on Dëk Hwëch'in, DIAND Land and Water Resources and other stakeholders. The consensus of these consultations was that the stabilization of the outflow channel near the reservoir is a priority to reduce the immediate threat of a breach. The construction of four gabion structures present a cost-effective, short-term solution (UMA, 2002). To remediate the entire length of the stream channel along the waste rock dam, an additional nine gabion structures will be required and waste rock slopes at the creek channel will have to be graded.

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1 *Gabion Structures* are arrays of rock-filled baskets of wire mesh, designed to reduce and disperse the destructive force of fast flowing water.

1.2 BACKGROUND

The abandoned Clinton Creek asbestos mine is located about 100 km northwest of Dawson City, Yukon, 9 km upstream of the confluence of Clinton Creek and the Forty Mile River. The mine site is accessible from Dawson City via the Top of the World Highway, the Clinton Creek road, and an access road from the former Clinton Creek town site. From 1968 to 1978, the Cassiar Asbestos Corporation Ltd. extracted approximately 12 million tonnes of serpentine ore from the bedrock and produced 60 million tonnes of waste rock and 10 million tonnes of tailings. Ore was taken from open pits located on the south side of Clinton Creek and transported via a cable tramway to the mill site on a ridge on the north side of the Clinton Creek valley. The asbestos fibre was then transported by truck to Cassiar, B.C. for further processing. Waste rock and tailings were deposited on valley slopes near the open pits and the mill respectively. The affected mine site area consists of three open pits (Porcupine, Creek and Snowshoe), two waste rock dumps (Porcupine and Clinton Creek) and a tailings pile on the west side of Porcupine creek (**Figure 1**).

A significant slope failure of the Clinton Creek Dump occurred in 1974, blocking the natural drainage of Clinton Creek and creating a land slide dam and a reservoir now referred to as Hudgeon Lake. The surface area of Hudgeon Lake has been estimated at 115 ha, its maximum depth at 27 m, and the volume at 12 million cubic metres of water (Royal Roads University, 1999). Waste rock placement and instabilities also blocked the natural drainage of Porcupine Creek, creating a small reservoir upstream. The tailings deposited near the mill site also failed and two lobes created partial and intermittent blockage of Wolverine Creek. Both Porcupine and Wolverine creeks are tributaries to Clinton Creek.

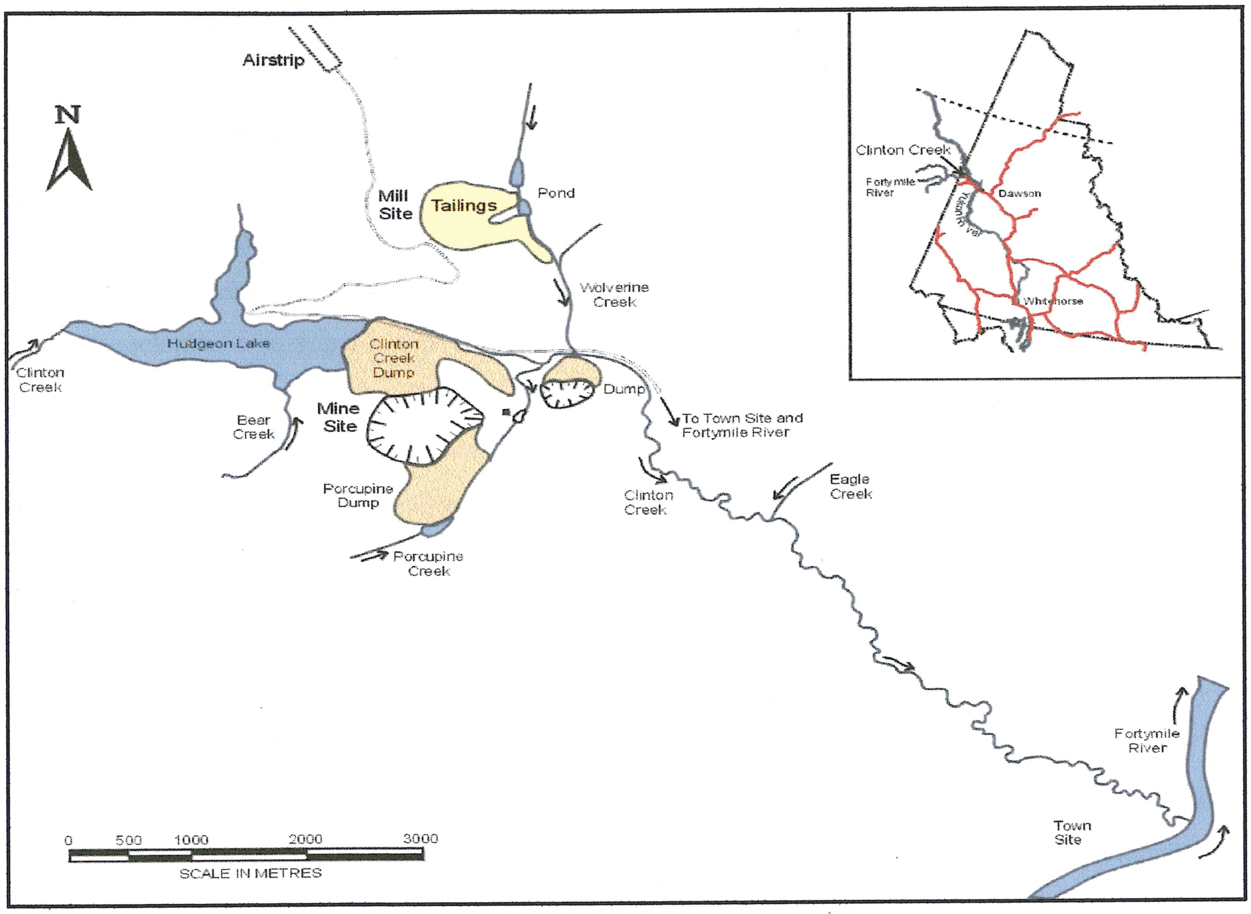


Figure 1: Location Plan (Royal Roads University, 1999)

During 1998/99, DIAND Waste Management initiated an extensive environmental review and a risk assessment (Royal Roads University, 1999 and UMA, 2000). The studies concluded that existing and future conditions at the abandoned Clinton Creek Asbestos Mine have the potential to expose individuals, property and the environment to various degrees of risk associated with downstream flooding, channel sedimentation and chronic redistribution of eroded waste rock and tailings. These risks can be broadly placed into public safety and ecological and health risk categories as presented by DIAND Waste Management and UMA Engineering Ltd. at a public information session in Dawson City, Yukon in 2001:

Public Safety

In terms of public safety, the level of risk downstream of the mine site has been categorized as high, medium or low based on the severity of flooding in each zone. The inherent risk to humans and the potential for loss-of-life is dependent upon the likelihood of exposure (occupancy) within these zones. The potential for loss-of-life is greatest immediately downstream of the mine site in the area potentially inundated by a breach of the waste rock pile, or within the Wolverine Creek valley in the event of a breach of tailings blockage. Farther downstream along Clinton Creek, the risks are reduced, as the high water levels will be confined to the creek valley below the road where human exposure is less likely. The risk is considered low at the next most likely downstream area of occupancy in the vicinity of the Clinton Creek Town-site where the valley widens considerably.

Ecological and Health Risks

Aquatic life and mammals downstream of the mine site are potentially at risk from the redistribution of eroded waste rock and tailings. The largest risk is believed to be from a sudden breach of the waste rock dump resulting in fisheries and habitat loss through downstream smothering and flooding. The impact of asbestos fibres in water on aquatic life has not been ascertained and is not well researched. Available literature does suggest however, that water-borne asbestos has little if any toxicity to aquatic organisms or mammals through the ingestion of water. Chronic risks from the mobilization and release of dissolved metals or other substances to the water appear to be unlikely.
Human health risks associated with possible inhalation of asbestos fibres during occasional site visits have not been quantified although it has been recognized that a crust formed on the surface of the tailings has reduced air-borne transmission of fibres.

Actions by DIAND Waste Management to date have included the direct notification of all known stakeholders and some media coverage. Warning signs are installed at key highway and access road locations to notify travellers and other users in the area of the potential hazard. As the lead agency, DIAND Waste Management has actively worked with other government departments and consultants to investigate possible mitigation methods.

1.3 Waste Rock Movement

The instability of the Clinton Creek waste rock dump has been recognized while the mine was still in operation and records of waste rock movement exist from 1976 until 1986. Routine site inspections and waste rock movement monitoring carried out in 1999, 2000 and 2001 have indicated that the Clinton Creek waste rock dump has still not reached equilibrium conditions (GEO-Engineering Ltd., 2000). Horizontal movements over time are summarized in **Figure 2**.

Over the two year period from July 1999 to June 2001, annual horizontal movements ranging from one to eleven centimetres, or an average annual rate of seven centimetres were observed. Over the same time period, the average rate of vertical settlement appears to be in the order of seven centimetres. The movements confirm previous observations that waste rock pile movements are small (in comparison to movements prior to 1986) and may be referred to as creep movements.

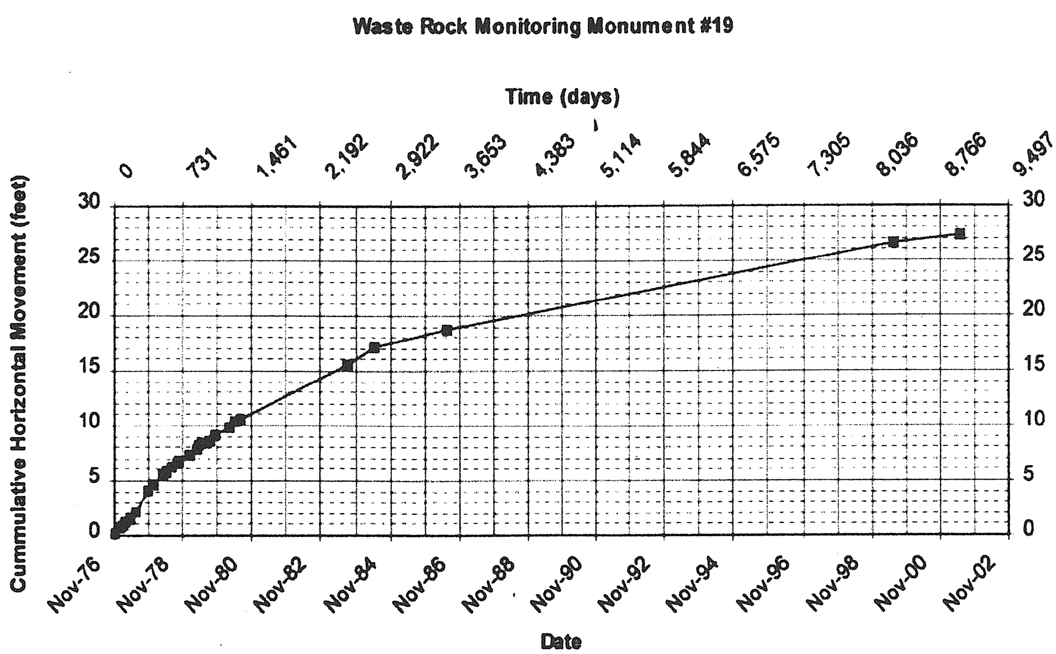


Figure 2: Waste Rock Dump Movements (UMA Engineering Ltd., 2002)

Channel stabilization measures must accommodate anticipated creep movements. The stabilization of the waste rock may however, be deferred until the channel stabilization is complete and additional data for waste rock movement becomes available.

Because the channel stabilization works involve partial infilling of the existing channel, it is possible that the observed horizontal creep movements may be reduced or possibly halted (UMA, 2002).

1.4 Creek Channel

It is believed that the most immediate concern with respect of the potential for a catastrophic breach of the waste rock is the integrity (stability) of the existing creek channel at the Hudgeon Lake outlet. Comparing creek channel profiles in 1986, 1999 and 2001, it is clear that continued channel erosion is deepening (down-cutting) the channel a distance of about 500 m from just downstream of the outlet (**Figure 3**).

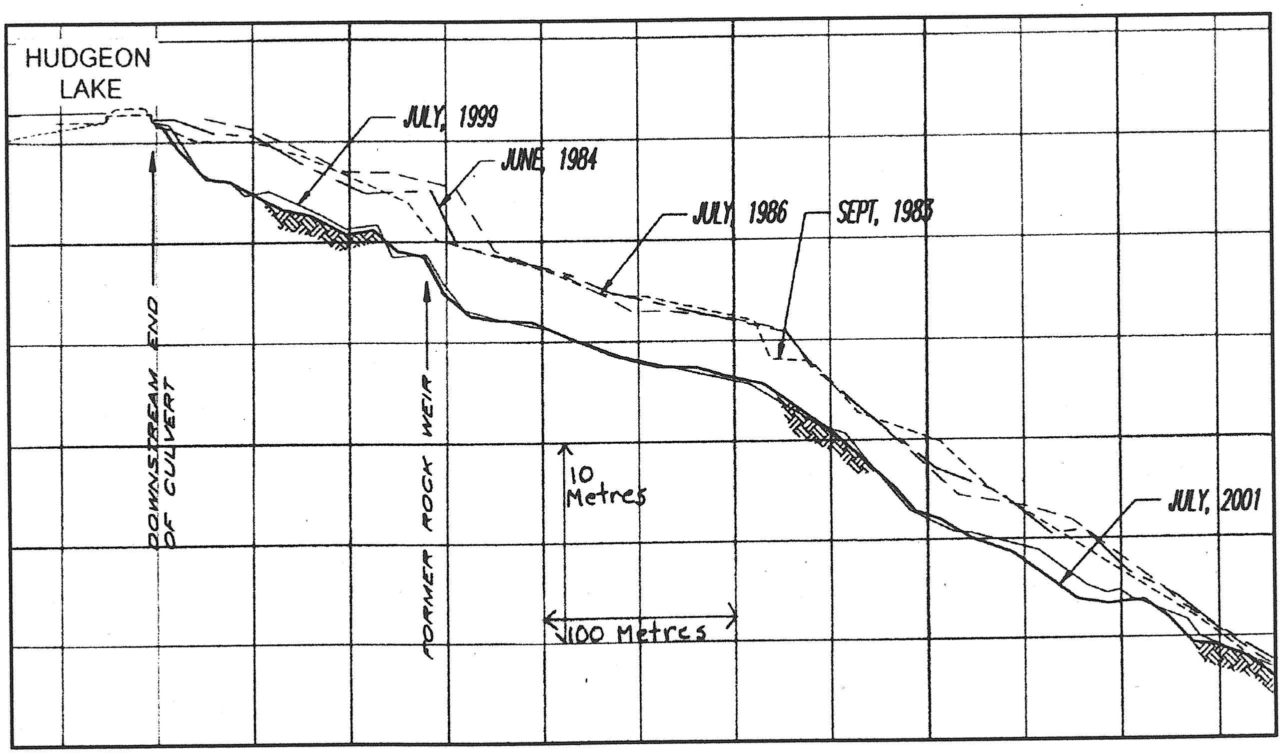


Figure 3: Clinton Creek Channel Profiles (modified from UMA Engineering Ltd., 2002)

The existing channel through the waste rock dump is approximately 800 m long and up to 18 m below the existing road near the middle of the waste rock dump. Side slopes on the waste rock are generally at or steeper than one horizontal to one vertical (1H:1V). The creek has cut its way into the bedrock consisting of clay shale (argillite) from about 350 m downstream of the outlet to the lower reaches of the channel through the waste rock. The waste rock is generally a well graded material consisting of silt, sand, gravel, cobbles and occasional boulders.

As down-cutting continues, the toe of the waste rock pile is undercut and localized slope instabilities develop. The unstable waste rock slumps into the channel, temporarily blocking creek flow. In most instances, this material is quickly overtopped and transported and deposited downstream. As the down-cutting gradually retrogresses towards the outlet however, conditions may quickly develop where normal flow and /or an overtopping event could trigger a full scale breach of the waste rock. The consequences of a breach and rapid draining of Hudgeon Lake are discussed in UMA's Risk Assessment Report (UMA, 2000).

1.5 Land Tenure

The abandoned Clinton Creek Mine Site is on private property with the land title under Cassiar Asbestos (Lot 102, Group 1101). **Figure 4** shows the approximate extent of the property in relation to Hudgeon Lake and the proposed construction area.

Placer claims at the confluence of Wolverine Creek and Clinton Creek have expired and no renewals have been filed with the Dawson mining recorder as of June 27, 2002.

Throughout the property there are a number of quartz claims, mostly held by the Cassiar Mining Corporation. At this time however, there are no mining or exploration activities taking place in the area.

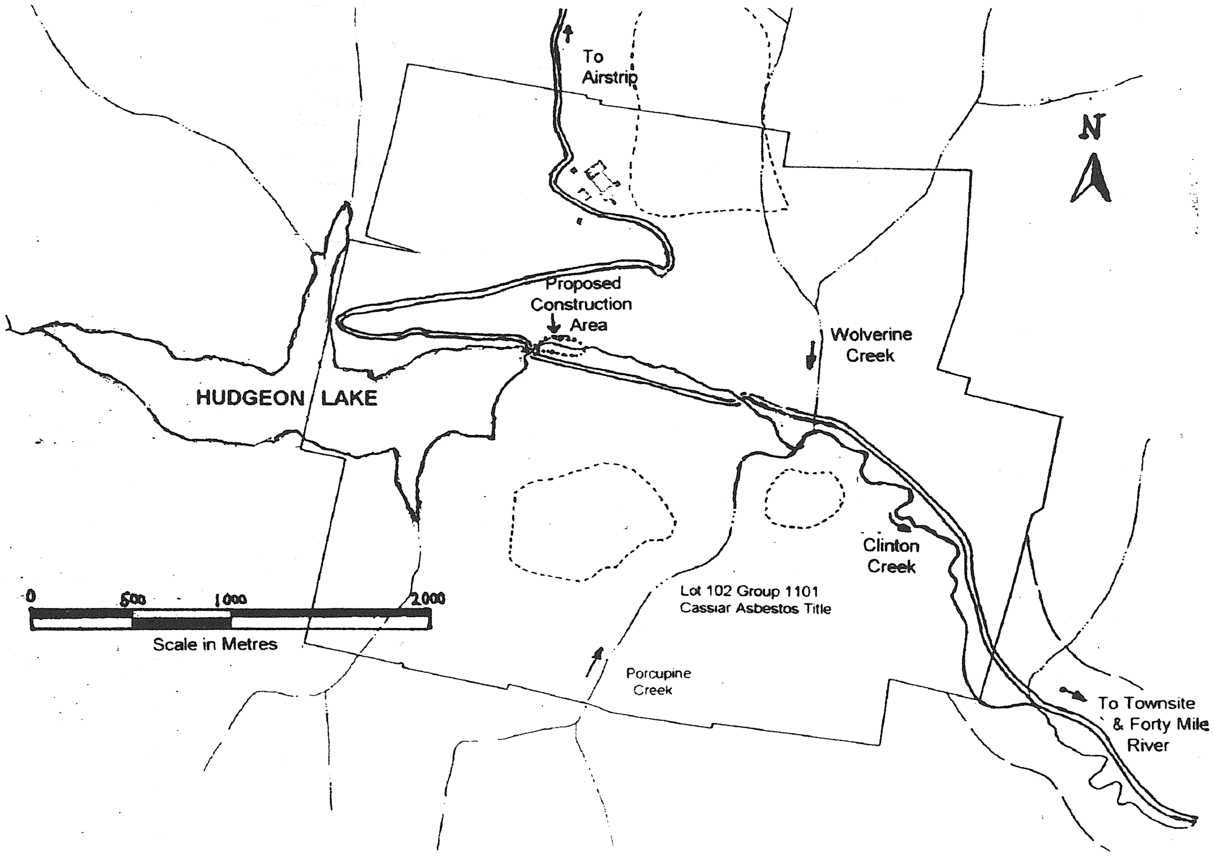


Figure 4: Property line of Lot 102 and location of proposed construction area (DIAND Waste Management, 2002).

2.0 Channel Stabilization

2.1 Hydrology

Based on a regional hydrology study (UMA, 2000), the 100- and 200- year frequency floods for Clinton Creek were estimated from regional unit discharges. The 100- and 200-year floods were plotted in a log-normal graph from which the 50- and 25-floods were estimated by interpolation. The drainage area and estimated discharges are shown in **Table 1**.

Parameter	Clinton Creek
Drainage Area (km^2)	117
25-year flood (m^3/s)	28.9
50-year flood (m^3/s)	33.8
100-year flood (m^3/s)	39.0
200-year flood (m^3/s)	44.5

Table 1: Drainage Area and Discharges for Clinton Creek

To maintain minimum flow from Hudgeon Lake during the construction period, a low-flow estimate for the month of August was obtained from DIAND Water Resources. A water level gauge has been in operation at several locations along Clinton Creek since 1978. The mean unit runoff from Hudgeon Lake for the three lowest flow days for August was calculated based on eight years of data and a lake drainage area of 126.2 km^2. The minimum mean flow amounts to **0.199 m^3/s**.

DIAND Waste Management suggests to maintain the minimum flow from Hudgeon Lake through pumping or siphoning past the construction area in order to maintain aquatic habitats in the downstream portions of Clinton Creek. A rock weir will have to be constructed below the construction area where water from the lake will re-enter the creek channel, in order to avoid erosion and an increase of sedimentation.

2.2 Gabion Weirs

The recommended channel stabilization work involves flattening of the channel grade through the use of gabion drop structures (see **Photograph 1**). Gabion structures are preferred over rigid structures because of their flexibility that allows them to undergo deformation while remaining structurally sound, which is an important consideration given the observed creep movements of the waste rock. Gabion structures are simple to construct with conventional construction equipment, using material available at the mine site. The only materials requiring transportation over a long distance are the gabion baskets and geotextile.

Photograph 1: Gabion Structures - Example

The drop structures would be constructed from 0.5 x 1.0 x 3.0 m gabion baskets placed empty on a geotextile, above gravel bedding. The baskets are tied together with wire and will be machine filled with cobbles. The gabions are placed as steps, which provides energy dissipation between each step as the water travels through the structure. The weir at the top of the structure creates a constriction that reduces the water surface draw-down immediately upstream of the structure to control the channel flow velocity along that length of channel. An end sill prevents a floor jet during high discharges (see **Figures 5a and 5b**). Using as many 0.5 m steps as required creates the desired hydraulic drop of approximately 35 m over the entire stabilized channel.

As the weir and end sill are made of gabions, a part of the channel flow will pass through the gabions rather than over them. As a result, neither the weir nor the end sill will cause any significant ponding of water. In fact, during low flows, the water surface may be below the top of the gabions i.e. between the cobbles. Because there will be a small flow of water through the gabions most of the time, it is important that the gabions sit on a geotextile and gravel bedding layer to prevent the loss of fine grained material below the baskets. Some sand and gravel will be washed through the channel, in particular during spring runoff. The finer material will become trapped between the cobbles in the gabion baskets further stabilizing the structure.

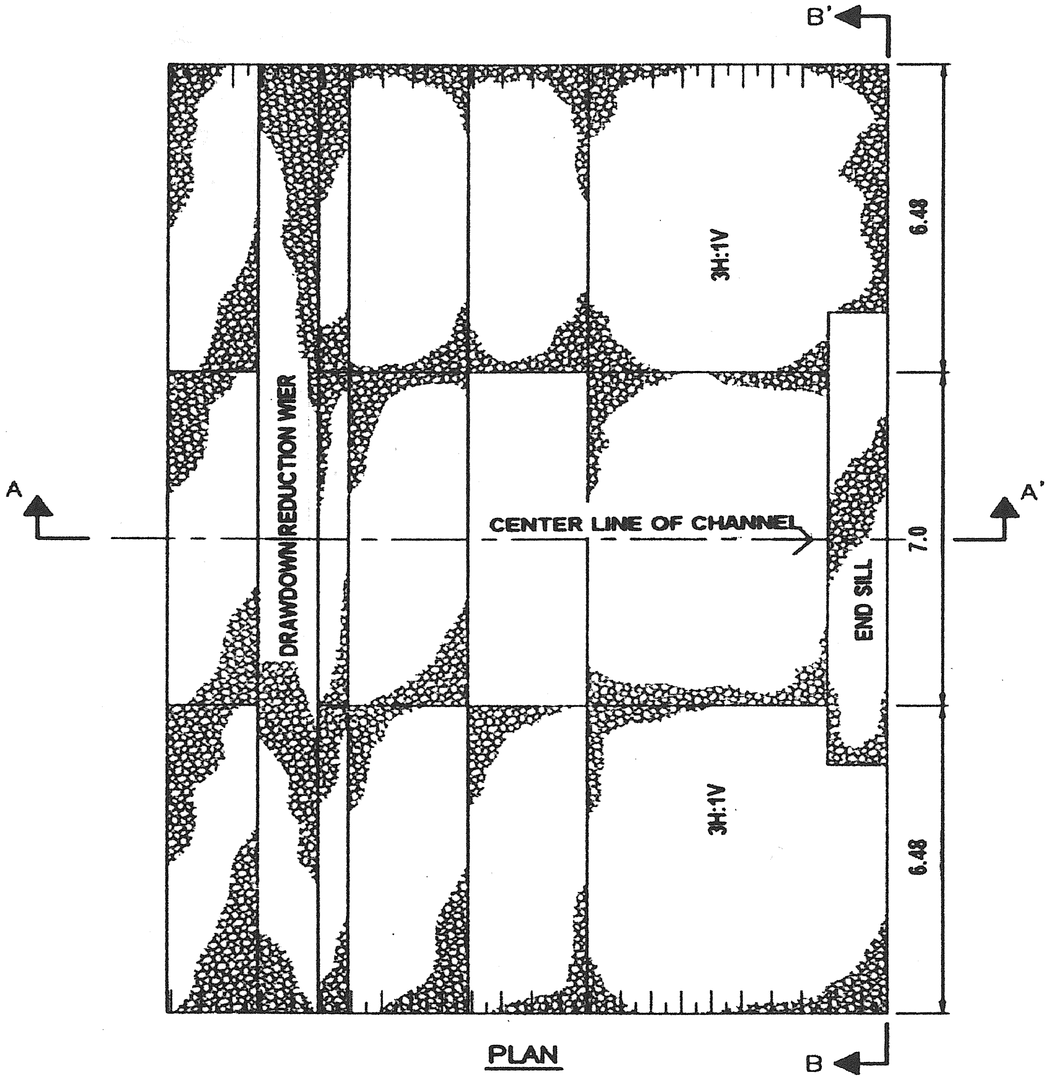
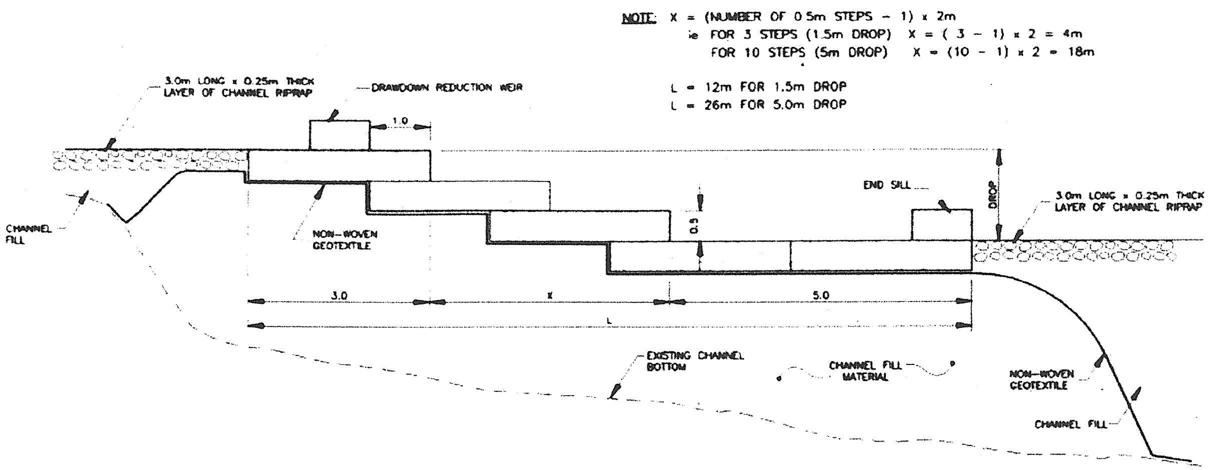
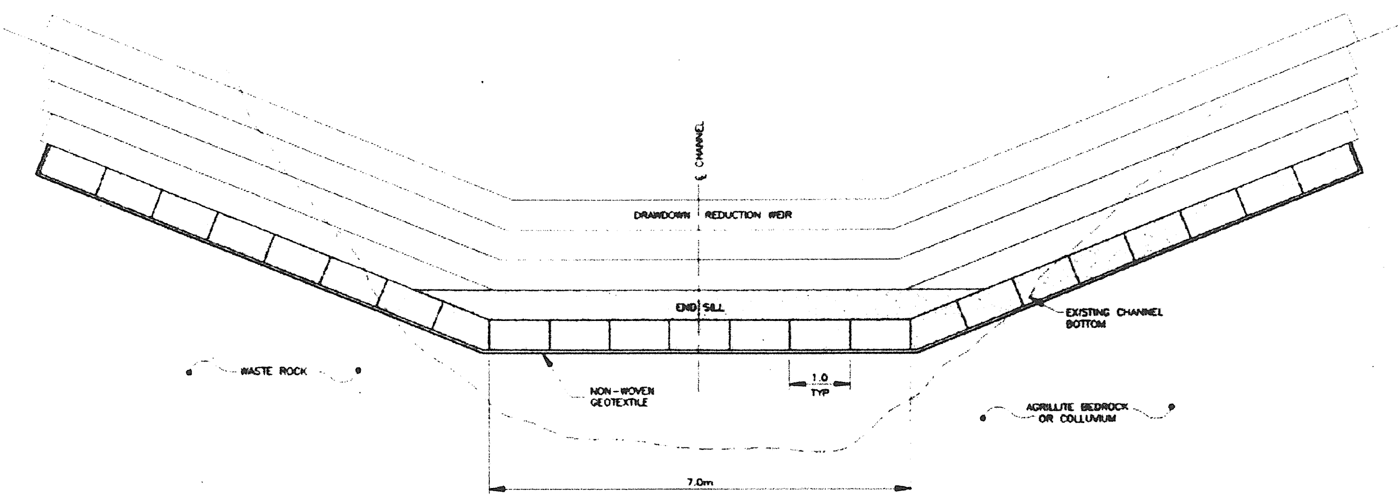


Figure 5a: Top view of a Gabion Structure as designed for Clinton Creek (UMA, 2002)



CENTERLINE PROFILE A–A'



SECTION B–B'

Figure 5b: Profiles of gabion structure as designed for Clinton Creek (UMA, 2002)

2.3 Channel Design

The estimated 25-year flood (28.9 m^3/s) was used for the design of the channel stabilization works for the waste rock pile. However, the discharge of the 25-year flood at the Hudgeon Lake outlet will be smaller due to the flood attenuation caused by Hudgeon Lake, resulting in a higher level of protection. Based on the design discharge and 3H:1V side slopes, the new channel geometry will have a bed width of 7.0 m and depth of flow of 2.0 m for a profile grade of 0.00101 m/m. With the dimensions of the individual gabion baskets used for the grade control structures, the freeboard at the control structures will be approximately 0.2 m or sufficient to confine the 50-year flood within an armoured control section.

To maintain the channel along its existing alignment, reduce the amount of excavation for slope flattening, and maintain road access, the design profile for the stabilized channel through the middle portion of the waste rock dump will be governed by the contact elevation of the intact bedrock. To create the required hydraulic drop a channel profile has been designed that requires 13 drop structures, ranging from 1.5 to 3.0 m in height (**Figure 6**).

The sides of the gabion structures will be tied into the valley slope on the north side and the waste rock on the south side to confine the creek flow within the stabilized channel. Above the armoured portions of the channel, the waste rock side slopes will be flattened to a more stable geometry (1H:1V minimum). Partial infilling of the channel will provide additional toe support for the waste rock pile, possibly helping to reduce future creep movements of the waste rock pile and the potential for instabilities of the valley slope.

Channel revetment in the form of a 0.25 m thick layer of riprap (D_{50} = 150 mm) is required in the transition zones immediately upstream and downstream of the drop structures. This revetment should extend for a distance of 3.0 m upstream and downstream of the drop structures. To provide a higher level of erosion protection in the first 150 m of the channel, it is also recommended that the channel be armoured with riprap between the drop structures and also between the culvert at the Hudgeon Lake outlet and the first drop structure.

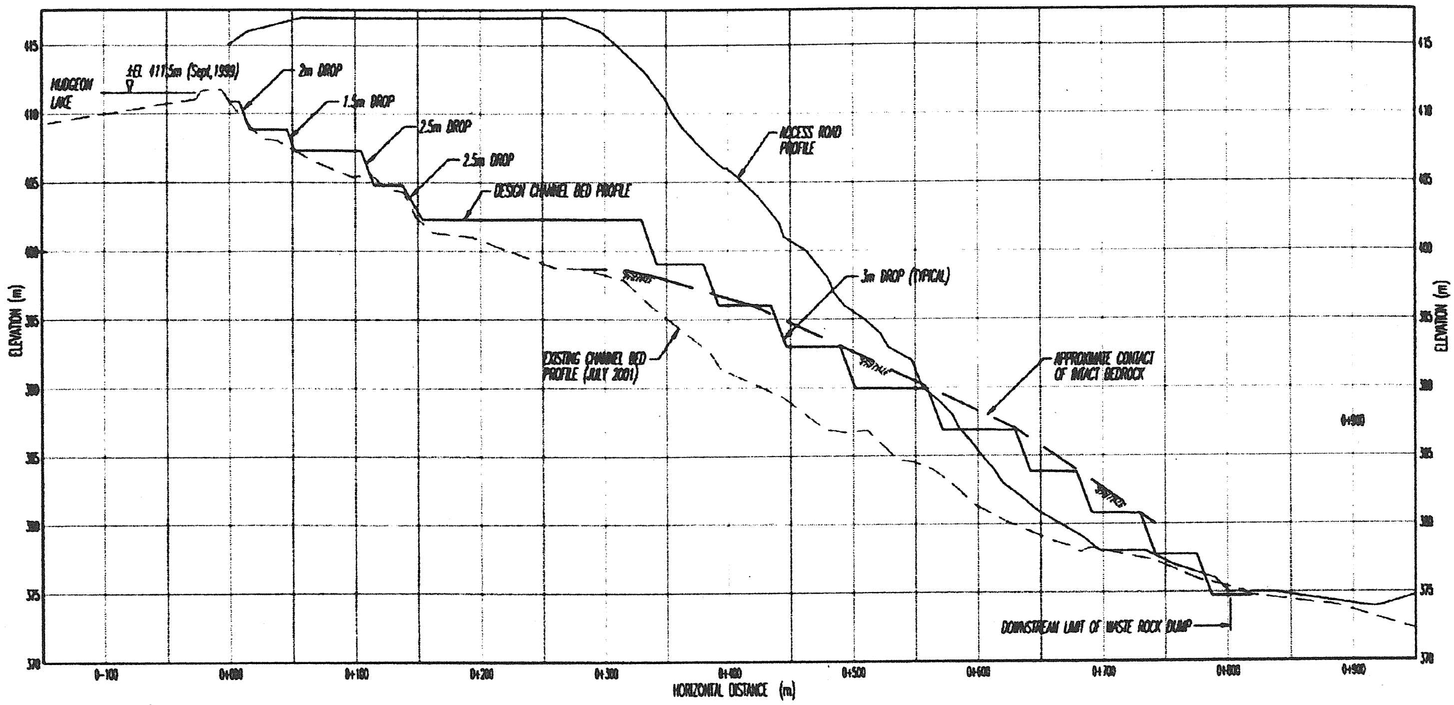


Figure 6: Clinton Creek Channel Profile Design (UMA, 2002)

Any required granular material should be available on site. The adjacent waste rock can be used for channel fill. A gravel source is potentially available along the road up to the former mill site and cobble sized rock for the gabions can be obtained from the weathered outcrop located at the north east corner of the confluence of Wolverine Creek and Clinton Creek.

3.0 Short Term Measures

To provide adequate protection against a breach, the required length of channel stabilization downstream of the outlet is in the order of 150 m. Channel erosion will continue downstream of the gabion structures, possibly at a greater rate due to the reduced sediment load from the stabilized portion of the channel. A longer gabion mat should therefore be placed just downstream of the last drop structure to provide adequate protection to the constructed works. The configuration of the drop structures for the short-term measures is illustrated on **Figure 7**.

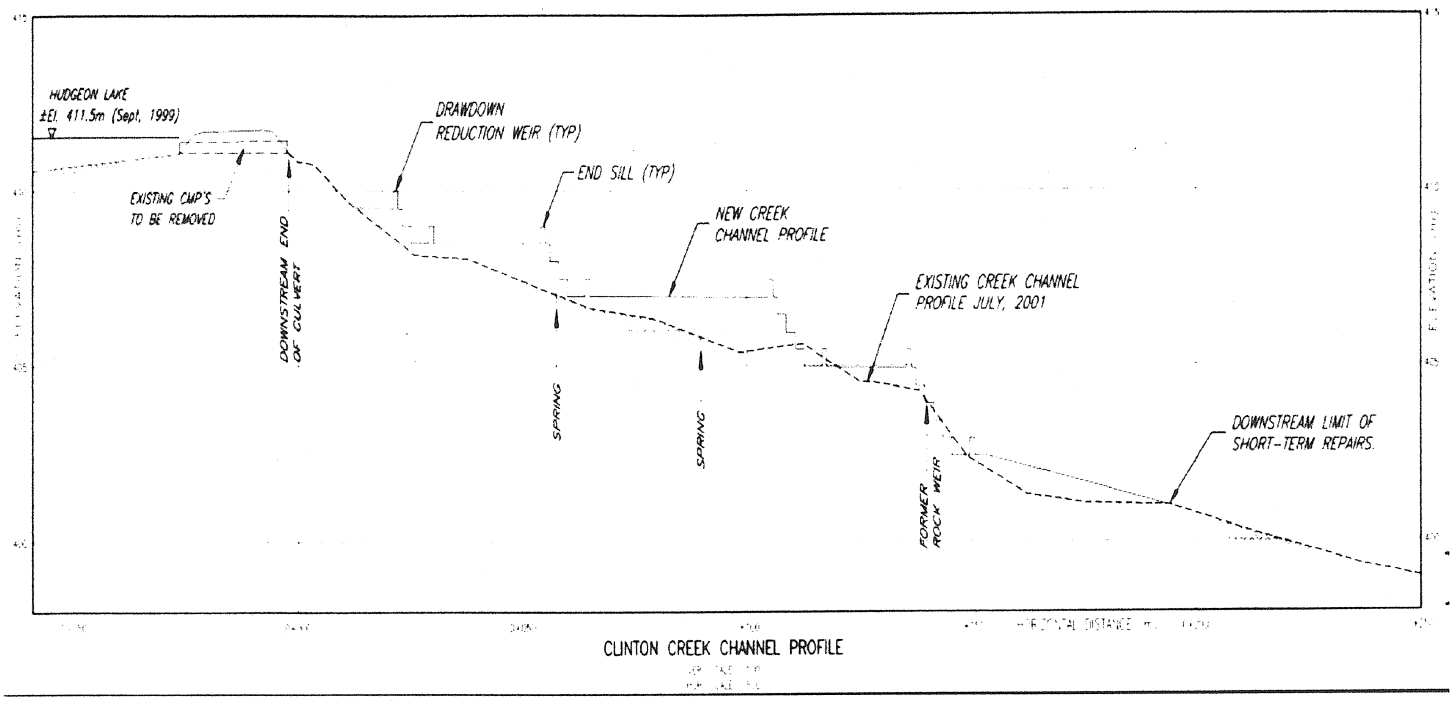


Figure 7: Configuration of Gabion Drop Structures below Hudgeon Lake (UMA, 2002)

3.1 Specifications - UMA, 2002

3.1.1 Channel Preparation

- Clear channel of any debris including trees and large boulders greater than 300 mm in diameter or as directed by the Resident Engineer.
- Fill channel to lines and grades shown on the drawings.
- Side slopes to be regraded as shown on the drawings.
- Existing waste rock material can be used for channel filling. The maximum diameter of the channel fill material is 150 mm.
- Place and compact channel fill in 200 mm lifts. Acceptable compaction effort or number of passes of the compaction equipment will be determined in the field.

3.1.2 Geotextile Placement

- The geotextile shall be of the non-woven type equivalent to ARMTEC 300.
- The geotextile shall be placed in a manner to provide a smooth surface free of tension stress, folds wrinkles and creases.
- The geotextile shall be held in position with weights or pins.
- All overlap seams shall be a minimum of 1000 mm wide. The geotextile panels shall be placed in an upstream direction so that the upstream panel overlaps the downstream panel at the location of the seam.
- Repair rips or tears with a patch to cover a minimum of 1000 mm on each side of the rip or tear.

3.1.3 Channel Erosion Protection

- Geotextile shall be placed over the channel fill and side slopes as shown on the drawings. The geotextile shall be placed such that the overlap seams are perpendicular to the direction of flow.
- The rip rap material shall be placed on the geotextile in a manner that prevents displacement or puncturing of the geotextile.
- The size of the rocks shall range between 80 and 200 mm with the mean diameter being 150 mm. Larger boulders that exist along the channel shall be moved or partly buried so that the faces of the boulders do not project into the channel flow cross-section.

3.1.4 Drop Structure Placement

- Final Location of the gabion drop structures to be located in the field.
- Prepare the base for the structure.

  - In cut, level ridges and fill in low spots and compact the surface until the finished surface is smooth and confirms to design outline.

  - In fill, place the fill material in maximum 200 mm thick lifts and compact to the same degree of compaction as determined for the channel fill. The finished grade shall be smooth and conform to the design outline.

  - Place geotextile on the finished surface as shown on the drawings and in the manner described under geotextile placement section above.

- For assembly of gabion baskets, lacing of baskets and placement of rock in the baskets, see the manufacturer's Installation Guide. Use stainless steel rings, at 80 to 120 mm spacing, for the assembly, interconnection and closing of the gabion baskets.
- Gabion fill material shall have a maximum diameter of 200 mm, a minimum diameter of 80 mm and a D50 of 150 mm.
- Complete the gabion installation and rock placement of the entire tier before proceeding with the installation of the next higher tier.
- For each tier, assemble and place the gabion baskets on the horizontal structure floor first. Install the lowest row of gabion baskets on the side slopes before starting the placement of rocks in the gabion baskets on the structure floor. Complete the filling and closing of the gabion baskets on the side slopes. Fill and close the gabions on the side slopes.
- Pull up the geotextile so it covers the vertical upstream side of the gabion baskets and place compacted backfill for the support of the next higher tier and make the compacted base surface smooth. Place the geotextile on the prepared surface in the manner described under geotextile placement and according to the drawings before proceeding with placing gabion baskets.
- After all the gabions in one tier have been completed and the base for the next higher tier has been prepared, place loose material excavated from the waste rock pile on top of the completed gabions. Manually, strike off the material with a piece of lumber to fill the voids in the filled gabions. Exercise caution in doing so, to not damage the PVC coating on the gabion baskets. Remove larger rocks.

3.2 Approximate Material Quantities

Item	Quantity	Notes
Non-Woven Geotextile	3000 sq. metres	AMOCO 4510, ARMTEC 300
Gabion Baskets	500 baskets	PVC coated, galvanized wire Maccaferri: 0.5 x 1.0 x 3.0 m
Gabion Mat (for outlet)	1	PVC coated, galvanized wire Maccaferri: 0.3 x 3.0 x 30 m
Channel Fill	7200 cu. metres	waste rock and/or fines from making gabion fill
Gabion Fill	750 cu. metres	75 mm to 200 mm with average of 150 mm diameter
Channel Rip Rap	400 cu. metres	75 mm to 200 mm with average of 150 mm diameter
Side Slope Grading	3000 cu. metres	

Table 2: Approximate Material Quantities (UMA, 2002)

3.3 Health and Safety Plan

A Health and Safety Plan for the construction period is in development and will reflect health and safety issues, such as physical instabilities on site, the presence of asbestos fibres in the waste rock that may become air-borne when disturbed, hazards associated with machinery, First Aid, etc.

4.0 References

GEO-Engineering (M.S.T.) Ltd. 2000. *Abandoned Clinton Creek Asbestos Mine - Report on June and July 2000 Site Inspections.* Calgary, AB.

Royal Roads University. 1999. *An Environmental Review of the Clinton Creek Abandoned Asbestos Mine. Yukon, Canada.* Royal Roads University - Applied Research Division. Victoria, BC.

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