Clinton Creek Mine Options Workshop

Prepared for

Government of Yukon

Prepared by

Project Reference Number
SRK 1CY001.039

February 2010

Clinton Creek Mine
Options Workshop

Government of Yukon

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SRK Project Number 1CY001.039

February 2010

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1 Introduction

A workshop to develop and evaluate possible options for the Clinton Creek Mine located approximately 100 km northwest of Dawson City, Yukon, and 19km from the Alaska border 86 km, was held on January 19 and 20, 2010 at the SRK Offices in Vancouver, BC. From 1968 until depletion of economic reserves in 1978, the Cassiar Mining Corporation (Cassiar) extracted approximately 12 million tonnes of serpentine ore from the three open pits. Over 60 million tonnes of waste rock from the open pits was deposited in the waste rock dumps. The ore was transported by an aerial tramway to the mill site located on a ridge along the west side of Wolverine Creek. Over the same period of time, about 10 million tonnes of asbestos tailings from the milling operation were deposited over the west slope of the Wolverine Creek valley.

This report provides a summary of the workshop activities and key results.

1.1 Workshop Objectives

The objectives of the two-day workshop were to:

- Engage a group of stakeholders in the process of reviewing a all possible options for the future of the Clinton Creek Mine site;
- Determine which options are most worthy of further consideration; and
- Identify critical uncertainties and the associated studies that would be required to ultimately develop a final closure plan for the Clinton Creek Mine site that would be acceptable to stakeholders.

1.2 Workshop Participants

The workshop participants included Federal, Yukon Territorial, and Tr'ondëk Hwëch'in First Nation representatives as well as consultants to the project. Participants were selected to represent a range of technical expertise as well as regulatory and indigenous perspectives to broaden the results of both the divergent and convergent thinking sessions. The workshop was facilitated by Daryl Hockley of SRK. Table 1.1 provides a list of participants and their affiliations.

Table 1.1: Workshop Participants

Attendee Name	Affiliation	General Scope of Interest/Responsibility
Jo-Ann Aldridge	Health Canada	Health Risk Assessment
Rolf Aslund	AECOM Consulting	Hydrology
Karen Ballantyne	INAC	Environmental considerations
Michel Bowman	Minnow Aquatics	Aquatic toxicology
Daryl Hockley	SRK Consulting	Workshop Facilitator
Bill Kendrick	Tr'ondëk Hwëch'in First Nation	Natural Resources
Andrew Liddiard	INAC	Hydrology
Micah Olesh	Tr'ondëk Hwëch'in First Nation	Natural Resources, water quality
Patti Orr	Minnow Aquatics	Aquatic toxicology
Rachel Pugh	Yukon Government	Assessment/Regulatory
Gil Robinson	AECOM Consulting	Geotechnical
Ken Skaftfeld	AECOM Consulting	Geotechnical
Russ Smoler	INAC	Government/Regulatory
Eric Soprovich	Environment Canada	Contaminants/Regulatory
Dirk van Zyl	SRK Consulting	Geotechnical, Closure Planning
Al von Finster	Department of Fisheries and Oceans	Fish habitat

1.3 Workshop Process

1.3.1 Terminology

To help explain workshop activities, some terms used during the workshop and throughout this report are defined as follows:

Method: The term “method” was used to refer to a process or action applied to one or more elements of the site. Construction of a soil cover on the surface of the tailings dam is an example of a “method”.

Scenario: The term “scenario” was used to refer to a combination of methods dealing with elements of the site. An example of a scenario would be use of soil covers on all tailings surfaces, collecting and conveying all surface runoff from these facilities to a central storage facility in the open pit, treating collected seepage and runoff water from tailings management facilities (TMFs), establishing long-term discharge structures to manage excessive storm runoff, removal of all infrastructure from the site, and scarifying and re-vegetating all disturbed areas.

Divergent: The term “divergent was used to refer to workshop activities that were creative, unconstrained and free-flowing. For example the brainstorming processes used to identify all possible “methods”.

Convergent: The term "convergent" was used to describe activities that were analytical, methodical and structured. For example combining a number of possible "methods" into coherent "scenarios".

Mind Maps: "Mind Maps" are a brainstorming tool that can be used by individuals or groups to efficiently generate a large number of ideas related to a central theme.

1.3.2 Workshop Methodology

It is SRK's experience that options planning benefits greatly from a well-defined approach. SRK prefers to use a "top down" approach that recognizes that planning for the long-term conditions of a site is essentially a decision-making process that compares a wide range of options to a set of evaluation criteria.

Figure 1.1 shows the top-down method in schematic form. The numbers on the figure correspond to the major steps:

1) The first step is to use "divergent" thinking to identify all of the "methods" that are potentially applicable.

2) "Convergent" thinking is then used to make a short list of the most attractive methods and assemble them into example "scenarios" that can be evaluated against overall objectives.

3) The uncertainties that prevent a clear selection amongst the "scenarios" are identified, and investigations are undertaken specifically to address those uncertainties. (There can be several iterations in this step).

4) In the fourth step, the preferred methods are assembled into a draft plan, including a transparent and fully defensible explanation of the options that have been considered and the logic behind the final selection.

5) The draft plan is reviewed by a broader group and if necessary revised. If the previous steps have been done well, the revisions at this stage should be on questions of detail only.

The Clinton Creek Mine options workshop was structured to complete the first two steps in the top down method and identify requirements for the third step.

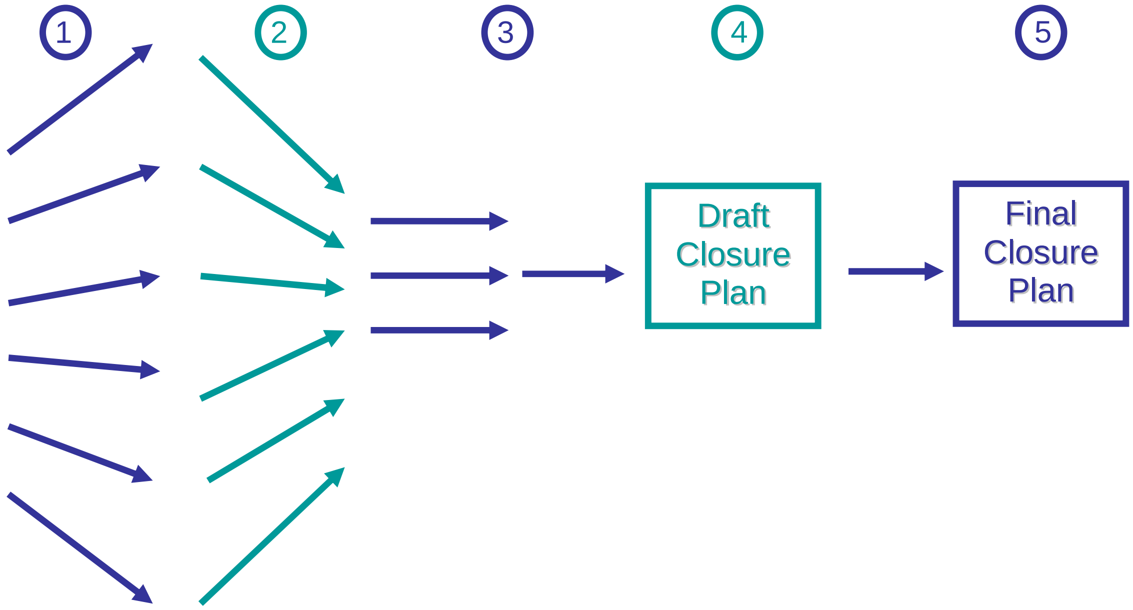


Figure 1.1: Overview of Top-Down Process

1.3.3 Agenda

Table 1.2 presents the detailed workshop agenda. The first day began with a welcome, introductions and a review of the workshop objectives, processes and desired outcomes by the workshop facilitator. Selected individuals then gave brief presentations designed to bring all participants to a common level of understanding about site features and major areas to be considered during the development of methods and closure scenarios. Copies of the presentations are provided in Appendix A. The remainder of the day was spent identifying methods and developing remedial options.

The morning of the second day was occupied a discussion of information needs, study designs and prioritization of information gathering.

Appendix B provides copies of the slides used by the facilitator on both days of the workshop.

Table 1.2: Detailed Agenda

Activity	Time Allocated
Clarify Workshop Objectives Workshop overview and objectives Collaborative introduction activity Discussion about workshop processes and terminology Discussion of workshop deliverables	Tuesday January 19, 2010 morning
Develop Common Understanding Short presentations to develop a common understanding of closure objectives and site condition • Site Overview (Dirk van Zyl, SRK Consulting) • Project Overview (Rachel Pugh, YG) • Waste Rock and Clinton Creek (Ken Skaftfeld, AECOM Consulting) • Tailings and Wolverine Creek (Ken Skaftfeld, AECOM Consulting) • Water Quality and Asbestos (Michelle Bowman, Minnow)	Tuesday January 19, 2010 morning
Brainstorming Methods for Clinton Creek and Wolverine Creek	
Prior Remedial Options • Waste Rock and Clinton Creek (Ken Skaftfeld, AECOM Consulting) • Tailings and Wolverine Creek (Ken Skaftfeld, AECOM Consulting)	
• Historic (Dirk van Zyl, SRK Consulting)	
Develop and Prioritize Remedial Options Discuss and feedback on remedial options in break-out groups Prioritization of remedial options	Tuesday January 19, 2010 afternoon
Information Needs and Prioritization for Gathering Discussion of information needs Study designs Prioritization of information gathering	Wednesday January 20, 2010 morning

2 Common Understanding

Selected individuals provided brief presentations to establish a common understanding of site conditions with respect to the following topics:

- Site Overview
- Project Overview
- Waste Rock and Clinton Creek
- Tailings and Wolverine Creek
- Water Quality and Asbestos

Presentations were made by consultants involved with various aspects of the Clinton Creek Mine site. The presentations provided concise summaries of site conditions, in some cases involving years of investigation. The slides from each presentation are provided in Appendix A.

Remedial options for the Clinton Creek Mine have been proposed since the late 1970's. A review of these were presented and these presentations are also provided in Appendix A.

3 Methods Identification

Workshop participants were led through a series of exercises designed to identify all "methods" that might be applied to different elements of the site. Lists of methods were developed for each of the following site elements:

1. Tailings
2. Wolverine Creek
3. Waste Rock
4. Clinton Creek
5. Access Road
6. Other

A variety of themes were also introduced to assist the divergent thinking process. For example, participants were asked to come up with "faster", "slower", "more expensive", "less expensive", "easier" or "more difficult" methods.

This exercise produced a series of mindmaps which were then consolidated into a comprehensive list of methods for each site element. The lists are presented in Table 3.1.

On the sceond day of teh wporshop, after groups had developed and discussed the complete scenarios, workshop participants were asked to rank the methods using the following system:

- **A** Likely to be on short list;
- **B** Possibly could make short list;
- **C** Probably not applicable but needs a one-paragraph discussion; and
- **X** Certainly not applicable.

The number of participants choosing each ranking is also shown in Table 3.1. Cells are highlighted in different colors to indicate rankings of the methods. The green highlighting indicates options that a clear majority think should get serious consideration. Yellow indicates those that a majority thinks are not likely to go beyond a one-paragraph explanation. Dull green indicates supporting or dissenting minorities.

Table 3.1: Possible Methods for Clinton Creek Permanent Remediation

Tailings	A	B	C	X
Relocate tailings				
Pit or top of valley	0	4	4	2
Cover	0	11	4	0
Revegetate	1	7	7	0
Stabilize with crust	1	4	8	1
Reinforced toe	5	6	2	2
Remove material from top of piles	0	3	12	0
Regrade piles	2	5	8	0
Tunnel through mountain	0	1	5	7
Dredge to restore natural creek	0	1	11	3
Rock drain at toe	11	4	0	0
New creek channel over tailings	0	7	7	1
Flood to keep wet	0	0	3	9
Re-mine	0	0	2	13
Sell it	0	0	3	12
Carbon capture	0	1	9	5
Asbestos capture downstream	3	5	3	4
Do nothing and continue monitoring	3	5	6	1
Wolverine Creek	A	B	C	X
By-pass tailings				
tunnel	0	2	11	1
new channel	0	5	4	6
Convey through tailings				
culvert	0	2	12	1
hanging culvert	0	2	5	5
Erosion Protection				
large rocks	5	9	1	0
maintain/improve vegetation	4	3	8	0
shotcrete	0	0	5	10
surface amendments	0	3	10	1
Remove tailings				0
relocate	0	2	7	6
explosion/wash downstream	0	0	0	15
Fill dredging				
creek over tailings	0	5	10	0
Leave tailings in place				
cover and vegetate	1	5	6	0
adhesive cover 'Elmers'	0	3	6	6
re-shape to stable geometry	0	8	7	0
Downstream				
remove tailings	0	7	6	2
cover (and revegetate)	2	9	3	0
Other				
remove trees/brush from channel	7	3	1	4
restore fish movement	1	6	7	1
carbon capture?	0	0	11	2

Table 3.1: Possible Methods for Clinton Creek Permanent Remediation

	with ongoing maintenance (e.g. downstream	2	3	9	1
Waste Rock		A	B	C	X
Reslope/reshape to a stable state					
	stabilize toe	5	8	2	0
	smooth cross the valley & put channel through the middle	3	10	2	0
Cover					
	revegetate; engage in reveg tests	5	7	3	0
	soil/plastic/grass	1	7	6	1
Relocate					
	to open pit	2	9	4	0
	Hudgeon Lake?	0	6	9	0
Blow up and send downstream		0	0	0	15
Leave to fail		0	2	4	9
Monitor movement		14	1	0	0
Stabilize		9	6	0	0
Remove		0	3	7	5
Notch		0	0	4	0
"Train" movement		0	0	5	10
Clinton Creek		A	B	C	X
Lake:		0	0	0	0
Dewater completely		1	7	3	4
Aerate					
	O2 additives	0	0	9	6
	H2O2	0	0	9	6
	bubblers	0	4	8	7
Drop to intermeditae level		5	6	4	0
Channel:					
Maintain structures					
	as is	3	10	2	0
	after improvement	6	9	0	0
Increase fish passage to lake		9	4	2	0
Maintain habitat		7	8	0	0
Flood abatement (purposeful and controlled)		7	2	2	1
Check dams d/s of mine		0	2	7	6
Long-term monitoring		15	1	0	0
Do nothing		1	3	8	3
Monitor water and biology		12	3	0	0
Access Road		A	B	C	X
Decommission road		0	4	3	8
Upgrade adjacent road		0	5	2	0
Restore access to Wolverine					
	culvert	0	2	9	4
	modified culvert	0	4	7	4

Table 3.1: Possible Methods for Clinton Creek Permanent Remediation

	Bailey Bridge	0	0	7	8
Remove/deconstruct		0	3	1	0
	limit/prevent access	0	8	3	4
	reduce risk and liabilities	4	7	0	0
Block (concrete, boulders, fence, gate)		0	8	6	5
Remove bridge @ Fortymile		0	0	1	10
Stabilize/maintain					
	access for local users	7	7	0	1
Improve					
	surface conditions	0	5	10	0
	winter access	0	0	7	8
	crossing, bridges	0	4	9	2
	culverts (remove for fish)	0	4	2	6
	Restore Wolverine Creek access road	0	4	3	8
Publicize					
	tourist attraction (hunting, fishing, history)	0	0	8	8
	public attraction	0	0	8	7
Signage					
	risks	14	1	0	2
	tourists (guide)	8	0	2	3
Monitor utilization (traffic, pedestrian)		11	2	2	0
Other		A	B	C	X
Access restrictions (human)		4	8	0	0
Access barriers (fish)		4	4	0	0
Remove interpretive signs		5	3	0	0
Increase/improve interpretive signs		0	3	0	5
Research opportunities		4	2	2	0
Tourism opportunities		0	1	2	1
Relocate nearby residents		1	0	0	5
Revegetation					
	natural	4	0	0	0
	seeding and planting	0	4	0	0
Stabilize pit walls		0	0	4	0
Local public consultation		4	0	0	0
Local public involvement and work opportunitie		4	0	0	0

4 Scenario Development and Evaluation

4.1 Scenario Development

Participants were divided into four multi-disciplinary groups to develop complete scenarios for closure of the site. After each group selected their preferred methods, the workshop facilitator requested some changes to ensure that a range of options were covered. The following scenarios reulted:

- Group 1 was asked to consider relocating the waste rock and leave the tailings in place;
- Group 2 was asked to consider an option for Hudgeon Lake outlet and water level lowering and leave the tailings in place;
- Group 3 was asked consider long-term maintenance of the Hudgeon Lake outlet and placing a rock drain at the tailings; and
- Group 4 was asked to consider an alternative channel for the Hudgeon Lake outlet and stabilize the tailings in place.

The groups were given a framework for developing and reporting their scenario. Summaries of each scenario are presented in Table 4.1 and these scenarios are presented in full in Appendix C. The costing component of this exercise was included only to help focus the groups while they scoped out their respective scenarios. The resulting estimates are order of magnitude at best.

4.2 Evaluation Factors

Prior to evaluating the scenarios, each workshop participant completed a mind mapping exercise to generate a list of factors he or she would consider in evaluating the Clinton Mine options. Individual lists were compiled to create the comprehensive list of evaluation factors shown in Figure 4.1.

Table 4.1: Summary of Scenarios

Scenarios	Closure Actions	Cost	Pros and Cons
Scenario 1 **Objectives**: enable traditional land use and reduce risk of catastrophic flood event	**Waste Rock**: relocate top of waste rock to Porcupine and Hudgeon Lake, regrade the waste rock and construct a new channel with fish ladders. **Tailings**: leave as is, construct settling pond on Wolverine Creek	About $30M	**Pros**: site closure, low risk of breach and restore fish passage **Cons**: expensive , not fully rehabilitated
Scenario 2 **Objectives**: retain use of site by people, ensure aquatic productivity	**Waste Rock**: sequential removal of drop structures, reduce lake level **Tailings**: monitor and develop trigger levels for remedial measures, monitor rock-lined channel	About $25M	**Pros**: meets site access objective, meet aquatic objective **Cons**: uncertainty of outcomes, long-term maintenance and monitoring
Scenario 3 **Objectives**: eliminate to the extend possible the potential for catastrophic failure, minimal maintenance	**Waste Rock**: long-term maintenance of gabion structure, incorporate fish passage with first replacement **Tailings**: rock drains at toe, emergency spillway above drain, maintain rock-lined channel	About $20M	**Pros**: low risk of breach of Hudgeon Lake outlet, restore fish passage, robust/redundancy in design for tailings **Cons**: Long-term maintenance requirements
Scenario 4 Objectives: protect human health and safety, protection of fish habitat	**Waste Rock**: stabilize/regrade waste rock, install longer flatter channel over waste rock, maintain current lake level **Tailings**: clean-up North and South lobes, armour face with large rock, channel over top for overflow	About $25M	**Pros**: reduce risk of catastrophic failure, improved fish habitat, reduced human health risk **Cons**: cost, continued limited habitat in Hudgeon Lake, no improvements to habitat in Wolverine Creek

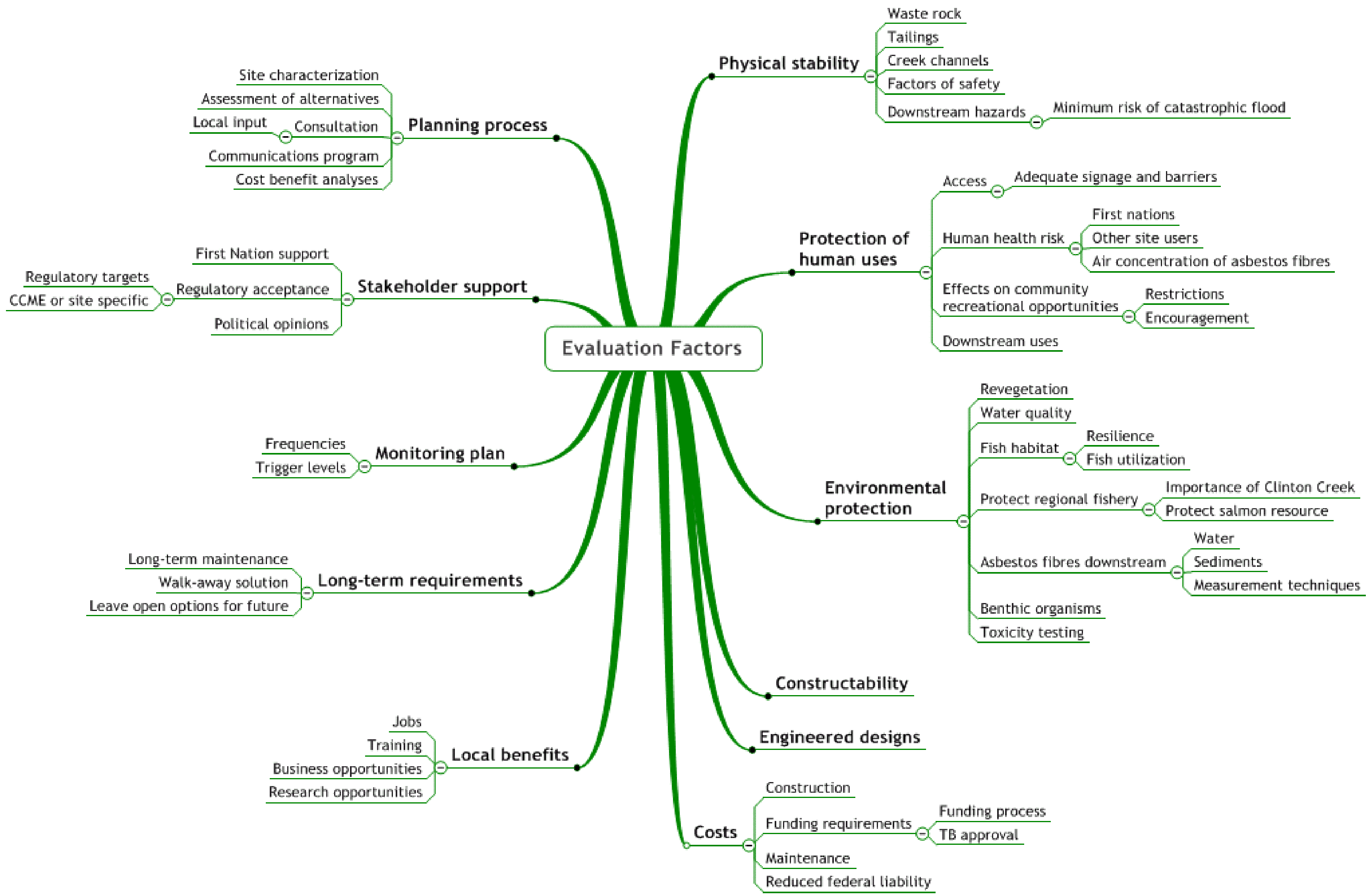


Figure 4.1: Options Evaluation Factors

4.3 Scenario Ranking

Participants were then asked to use the evaluation factors to rank the scenarios. Each individual was given a set of four coloured "post it notes" and instructed to place them on the scenarios with each color indicating a ranking of preference.

The results of these rankings are shown in Table 4.2.

Table 4.2: Results of Scenario Evaluation by Workshop Participants

Waste Rock & Clinton Creek				
	1st	2nd	3rd	4th
Group 1	2	1	9	2
Group 2	6	2	1	7
Group 3	5	4	2	3
Group 4	1	8	4	2
Tailings & Wolverine Creek				
	1st	2nd	3rd	4th
Group 1	3	4	5	4
Group 2	1	3	3	7
Group 3	5	5	6	0
Group 4	7	3	0	5

There was then discussion about the factors that contributed to the rankings. For example, the remoteness of the project site, permanent remediation vs. ongoing maintenance, and the uncertainties of the impacts of asbestos on aquatic resources. Participants were reminded by the facilitator that the exercise was not intended to indicate a final preference, but rather to identify the key questions that would need to be answered before a clear choice could be made.

5 Information Gaps and Investigation Needs

5.1 Information Gaps

Upon conclusion of the scenario evaluation, groups were asked to itemize the areas of uncertainty that prevented them from immediately selecting a preferred option. Twenty information gaps were identified as shown on the mindmap on Figure 5.1.

5.2 Study Designs

Participants were then split into groups of individuals having similar areas of expertise and asked to develop work scopes to fill the identified information gaps. Each group selected areas that were best aligned with their collective areas of expertise or experience. The resulting study designs are shown on **Error! Reference source not found.** through 5.x. The developed work scopes and associated costing were then presented to the workshop. The total estimated cost for the studies was $2.4M.

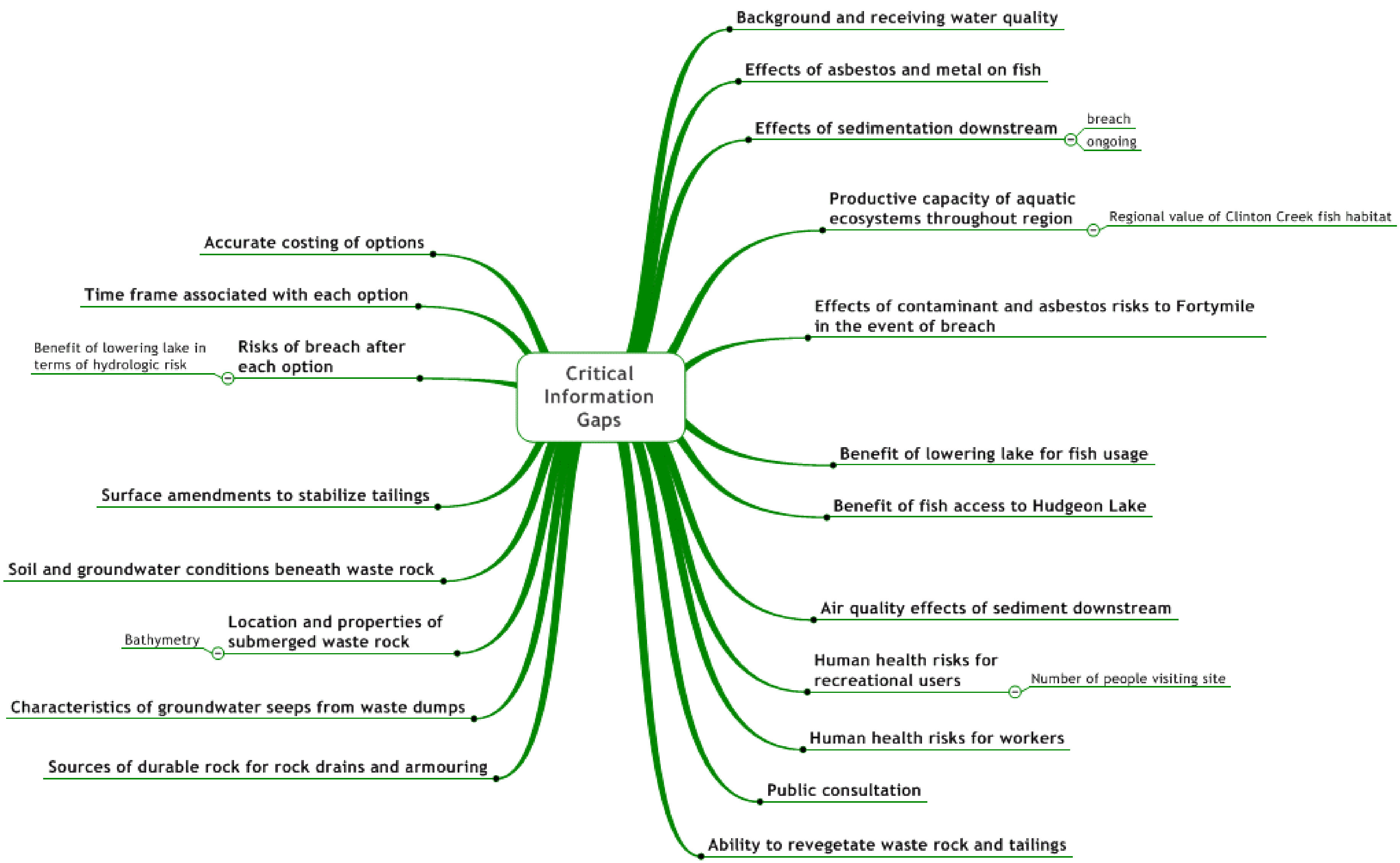


Figure 5.1: Information Gaps

Table 5.1: Work Plans

Reclamation Area	Time/Duration Post Closure	Estimated Cost
Field Investigations		
Subsurface Conditions – Tailings		
Plan drill program	2 weeks	$10,000
Health and safety plan	3 months	$50,000
Field Program (drill instrumentation	2-4 weeks	$200,000
Monitoring	1 year	$50,000
Lab testing	2 months	$25,000
Report	1 month	$25,000
Total	**1.5 years**	**$360,000**
Subsurface Conditions – Waste Rock		
Plan drill program	2 weeks	$10,000
Health and safety plan	1 week	$5,000
Field Program (drill instrumentation	2-4 weeks	$300,000
Monitoring	1 year	$50,000
Lab testing (soil and water)	4 months	$50,000
Report	1 month	$25,000
Total	**1.5 years**	**$440,000**
Hudgeon Lake bathymetry		
Confirm waste rock/valley slope topo below lake level (entire lake)		
Plan/arrange survey	1-2 months	$50,000
CADD work/models	1 month	$10,000
Total	**3 months**	**$60,000**
Groundwater Seeps		
Characterize Seeps (10c)		
Site inspection	1 week	$10,000
Lab testing (water)	4 weeks	$5,000
Report	2-4 weeks	$5,000
Total	**6-8 weeks**	**$20,000**
Durable Rock Source		
Office and filed investigations to locate durable rock for rock drain.		
Office/desktop review	1 month	$25,000
Field recon and sampling	1 week	$25,000
Lab testing	1 month	$10,000
Report	1 month	$10,000
Total	**3-4 months**	**$70,000**
Options Study		
Costing of options		
Construction timeframes		
Lake: risk of breach; benefit of lowering lake; sediment and breach modeling		
Develop plans: geometry, qty's, const. sequencing, stability modeling geotech	4 months	$100,000
Hydraulic input	4 months	$80,000
Total	**6 months**	**$180,000**
Surface Amendments to Stabilize Tailings		
Investigate amendments to reduce air and water erosion of tailings (at feasibility level)		
Literature review	1 month	$15,000
Physical & chemical characterization of tailings	2 months	$25,000
Evaluation and bench scale testing	6 months	$50,000
Report	1 month	$15,000
Total	**9 months**	**$105,000**

Clinton Creek Fish Productivity		
Objective: determine current and potential fish productivity for Clinton Creek		
Current productivity		
Estimated current productivity		
Bio mass and pop[N] abundance/div[Y] (fish and inverts)		
Life stage utilization		
Potential productivity		
Assess benefit to fish comm[Y] of providing access to Hugeon Lake seasonal vs. year round		
Benefit of lowering lake for fish passage	3+ years	$400K - $500K
Current and Potential Impacs		
Objective: complete our understanding of current and potential effects on receiving env. from release (acute or chronic) of potential contamiants.		
Spatial char[N] of sediment chem. & toxicity		
Reference and exposure areas		
Field sampling and lab program[Y]	1 year	$100K - $150K
Acute and chronic predictions		
Tie into modeling of catastrophic breach (dam – break or sm.)		
Aspect of chronic release of tailings on rec. env.	0.5 years	$50K
Water Quality assessment		
T & D metals		
Nutrients		
Immediate		
Asbestos fibres		
Seasonal var[Y] (H/L Q)		
Background/reference, rec. streams, source	2 years	$300K
Regional Use/Value of Clinton Creek Fish Resource		
Objective: Desktop exercise with inputs from fish studies program[M]	0.5 years	$50K
Revegetation		
Feasibility of revegetating waste rock and tailings		
Literature Review	1 month	$
Test plots	6 months	$
Lab Studies	3 months	$
Final Report	1 week	$
Total	**10 months**	**$40,000**
Public Consultation		
Information Exchange		
Contact key stakeholders	Ongoing	$50,000
Site use survey		$
Integrate feedback into planning		$
Total		**$**
Human Health Risk Assessmen		
Objective: supplement currently available data and re-assess		
Literature review of current asbestos air quality/health effects	2 months	$10,000
Identify data gap	1 week	$5,000
Sampling program design/implement (30+ samples & weather monitoring [static & personal modeling)	1 month	$30,000
Report	1 week	$5,000
Total	**3.5 months**	**$50,000**

5.3 Study Prioritization

Participants returned to multi-disciplinary groups and were then asked to prioritize the recommended studies. Each group was given $600,000 of “play money” and asked to assign amounts to the studies that they believed were most important. In order to force participants to be critical of the study plans, the allocated total amount was chosen to be about one-fourth the sum of the estimated total study costs.

Results of group allocations are shown on **Error! Reference source not found.**. There was consensus that the following studies are priorities:

- Options study – further engineering, feasibility and cost assessment of options for the waste rock – Clinton Creek system and the tailings – Wolverine Creek system;
- Current and potential impacts – characterize the current effects of sediment asbestos and metals on aquatic resources, and develop an ability to assess the impacts of possible future releases from the site; and
- Public consultation – Present the range of possible options to stakeholders and ask for feedback.

Three other study areas received at least partial support from three of the four groups. Subsequent discussions indicated that the groups supported only limited efforts:

- Subsurface conditions waste rock – Assessment of available information and possibly a minimum drilling program to assess whether subsurface conditions in the waste rock would preclude any of the proposed Clinton Creek options.
- Durable rock sources – Office-based review of possible sources of rock for use in riprap channel or rock drains.
- Human health risk assessment – Review of prior work and gap analysis.

There wa sinitialloy no consesus on the need for further bathymetry of Hudgeon Lake. In subsequent discussios it was agreed that it would be useful to know the bathymetry immediately offshore from the waste rock and channel intake. Underwater slopes in that area will drive the development of risk management measures for the Hudgeon Lake outlet.

There was also consensus that many of the proposed studies were not priorities: Further stuides of the tailings geotechnical conditions and revegetation were not favoured by any of the groups. Studies of groundwater seeps, Clinton Creek fish productivity and the regional value of Clinton Creek habitat were each supported by only one group.

Table 5.2: Studies Developed by Specialty Groups and Prioritized by Multi-Discipline Groups

Study	Initial Cost Estimate	Allocation Recommended by Multi-Disciplinary Groups			
		Group 1	Group 2	Group 3	Group 4
Engineering					
Subsurface conditions tailings	360				
Subsurface conditions waste rock	440	150	200		200
Hudgeon lake bathymetry	60	50	50		
Groundwater seeps	20	25			
Durable rock sources	70		25	50	50
Options study	180	175	150	150	150
Surface amendments to tailings	105				
Aquatic					
Clinton Creek fish productivity	500			25	
Current and potential impacts	500	150	125	300	125
Regional value of CC fish habitat	50			25	
Environmental					
Revegetation	40				
Human health risk assessment	50		25	25	50
Public consultation	25	50	25	25	25
Totals	**2400**	**600**	**600**	**600**	**600**

6 Conclusions

The workshop successfully met its three main objectives:

- Review options for the Clinton Creek Mine site;
- Determine which methods are the most worthy of further consideration; and
- Identify critical uncertainties and develop plans for resolving them.

The list of closure methods (Table 3.1) provide a comprehensive basis for further work. The Yukon Government and consultants involved in the Clinton Creek Mine can proceed with the understanding that reasonable options for permanent remediation have been identified. The initial assessments eliminate some methods and clearly indicate which ones the group believes are worthy of further investigation.

The scenarios developed in the workshop and presented in Section 4 were not intended to be a definitive set. However, they do form a set of representative options for discussion with other stakeholders. Development and assessment of the scenarios helped to identify uncertainties that need to be resolved before definitive selection plans can be made.

The investigation plans developed to address those uncertainties provide guidance for the next steps in the project. The plans presented in Section 5 reflect input from a broad group of people familiar with the prior work in each area. The "play money" budgets presented in **Error! Reference source not found.** indicate the priority that the group assigned to each area. The investigation plans are not intended for immediate implementation, but rather will need to be scheduled to fit with ongoing studies.

The workshop process allowed many different perspectives to be represented, and allowed all parties to become familiar with the whole spectrum of issues that need to be considered as the Clinton Creek Mine final remediation planning process moves forward.

This report, "**Clinton Creek Mine Options Workshop"**, has been prepared by SRK Consulting (Canada) Inc.

Prepared by

Dirk van Zyl
Associate Consultant

Reviewed by

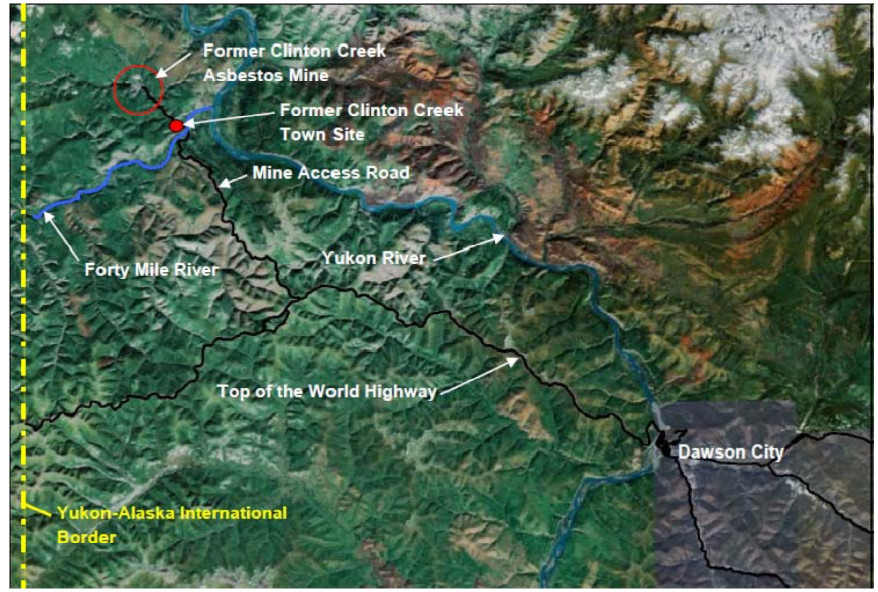
Daryl Hockley
Principal

Appendix A
Common Understanding and Prior Remedial Options Presentations

Appendix A1
Site Overview

Clinton Creek Options Workshop
Site Overview

Dirk van Zyl



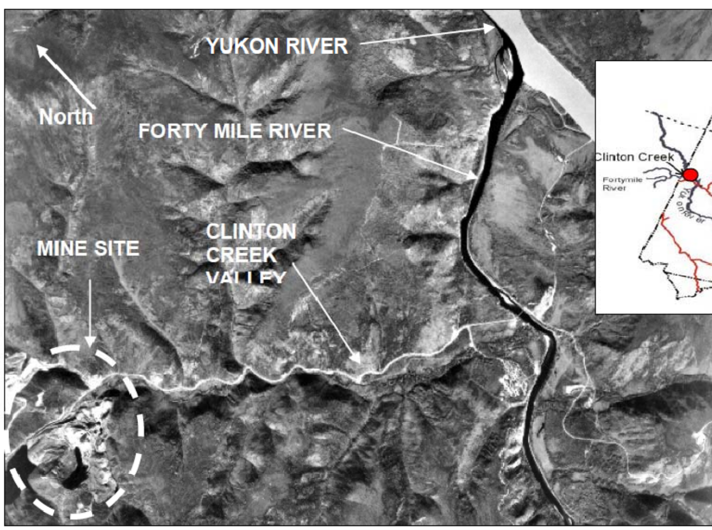
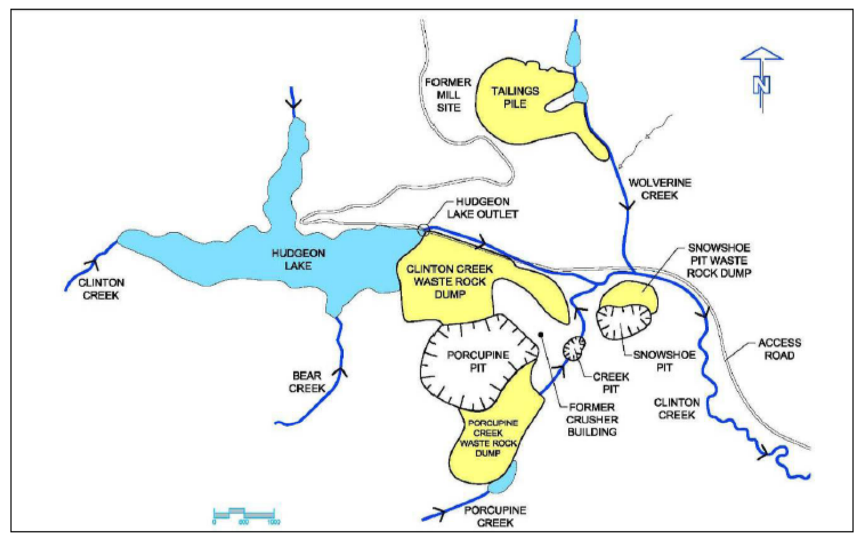
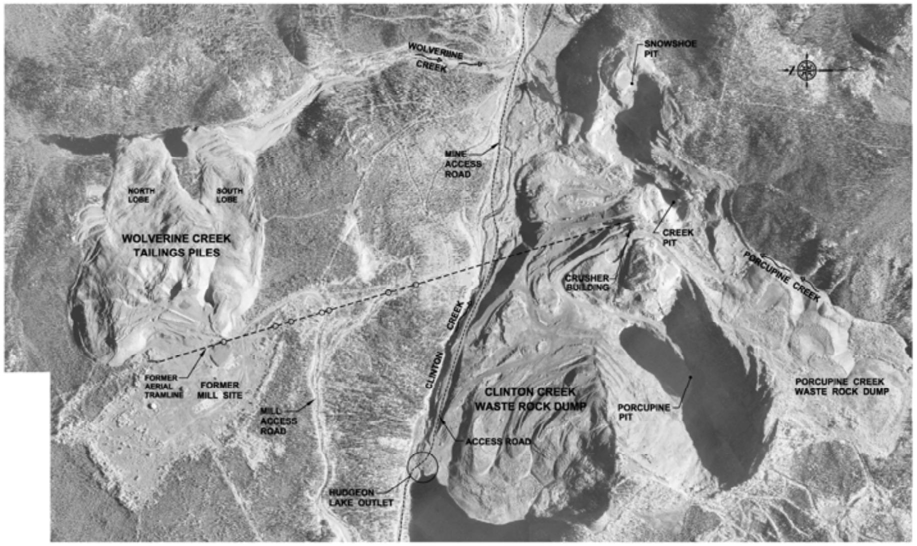


Figure 01
Location Plan




WOLVERINE CREEK
SNOWSHOE PIT
MINE ACCESS ROAD
NORTH LOBE
SOUTH LOBE
WOLVERINE CREEK TAILINGS PILES
CREEK PIT
PORCUPINE CREEK
CRUSHER BUILDING
CLINTON CREEK
FORMER AERIAL TRAMLINE
FORMER MILL SITE
MILL ACCESS ROAD
CLINTON CREEK WASTE ROCK DUMP
PORCUPINE PIT
PORCUPINE CREEK WASTE ROCK DUMP
ACCESS ROAD
HUDGEON LAKE OUTLET




Appendix A2
Project Overview

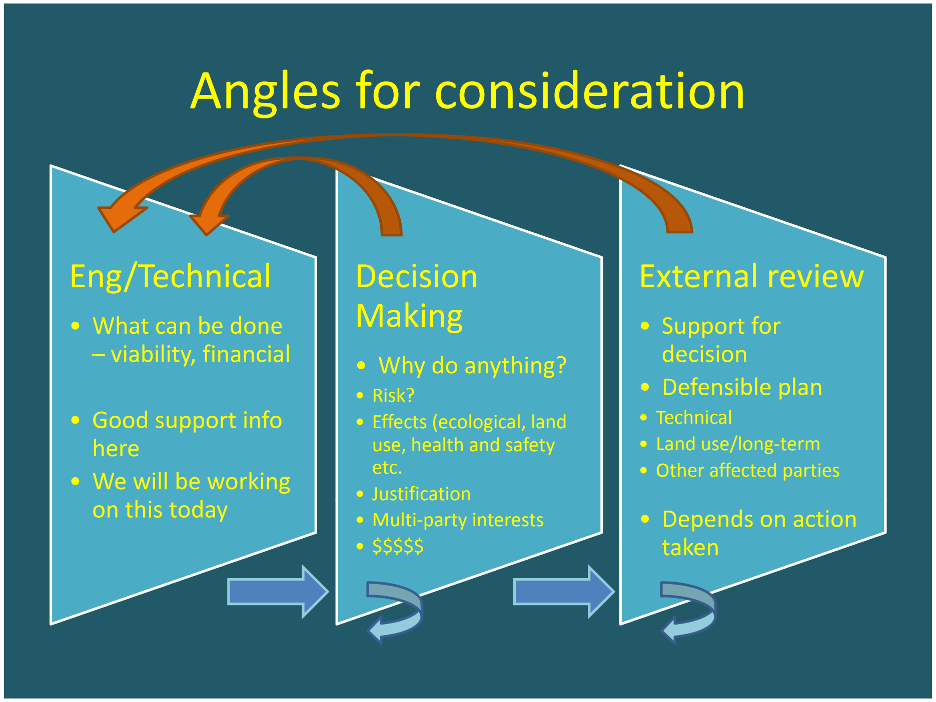
Project History

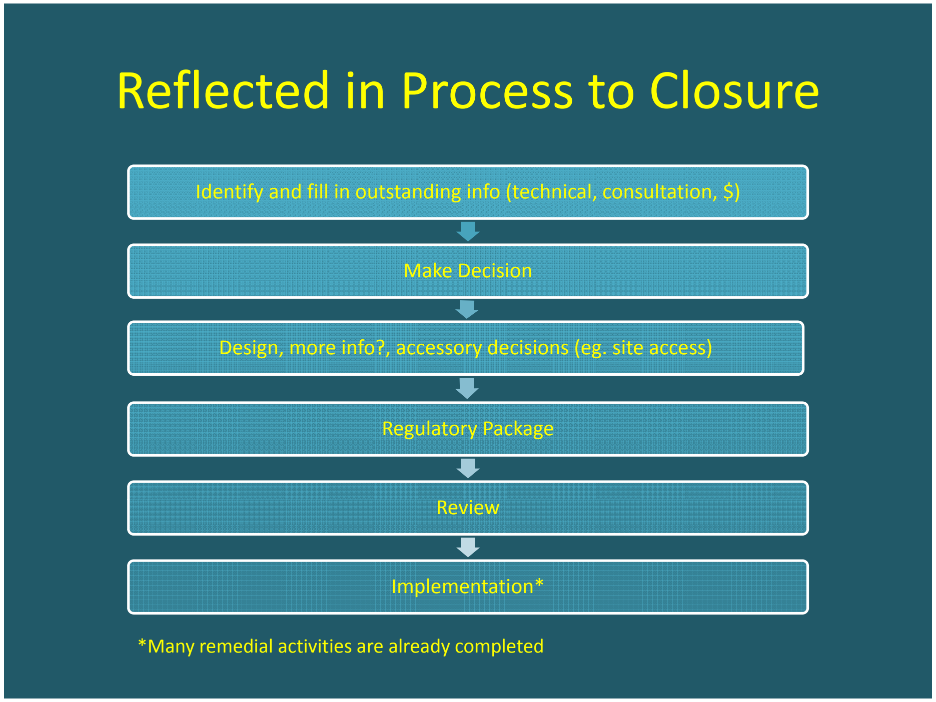
- Active Mine 1968-1978
- Company responsible for site remediation 1978-1992
- Company left site in 1992
- Regular DIAND Inspections by Geo-Engineering
- 1997 – large flood event destroyed Clinton Creek channel work, culverts, bridge etc.
- 1998 – DIAND started site assessments (UMA, RRU)

What's left?

- Tailings
- Waste Rock
- (road? pits?)

Have we done all we can, or is there more to do?


Angles for consideration
Eng/Technical
What can be done – viability, financial
Good support info here
We will be working on this today
Decision Making
Why do anything?
Risk?
Effects (ecological, land use, health and safety etc.
Justification
Multi-party interests
$$$$$
External review
Support for decision
Defensible plan
Technical
Land use/long-term
Other affected parties
Depends on action taken


Reflected in Process to Closure
Identify and fill in outstanding info (technical, consultation, $)
Make Decision
Design, more info?, accessory decisions (eg. site access)
Regulatory Package
Review
Implementation*
*Many remedial activities are already completed

Appendix A3

Waste Rock and Clinton Creek, Tailings and Wolverine Creek

Former Clinton Creek Asbestos Mine

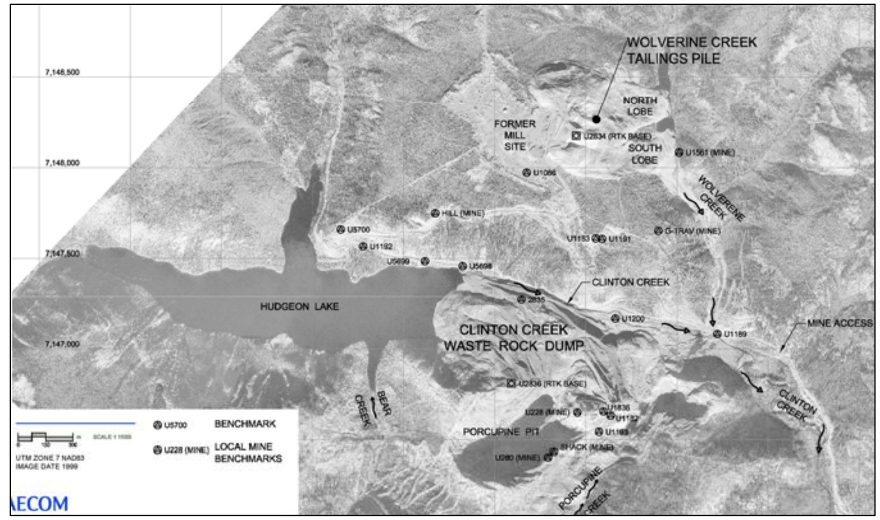
OPTIONS WORKSHOP

Vancouver, BC

January 19 & 20, 2010

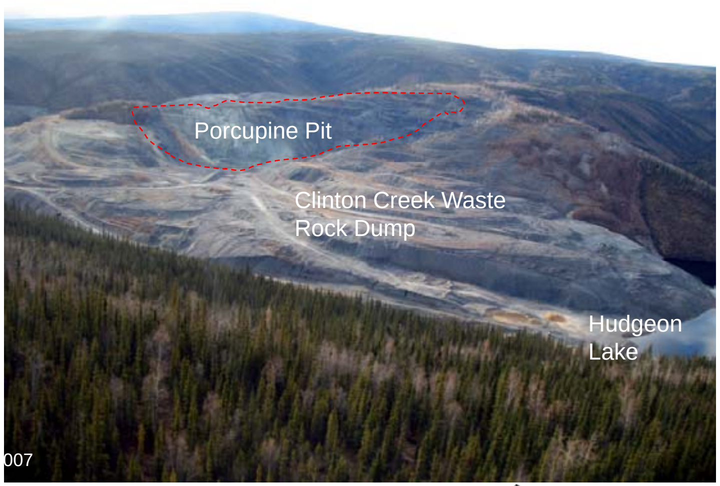
Yukon Energy, Mines and Resources AECOM

Overall Site Plan



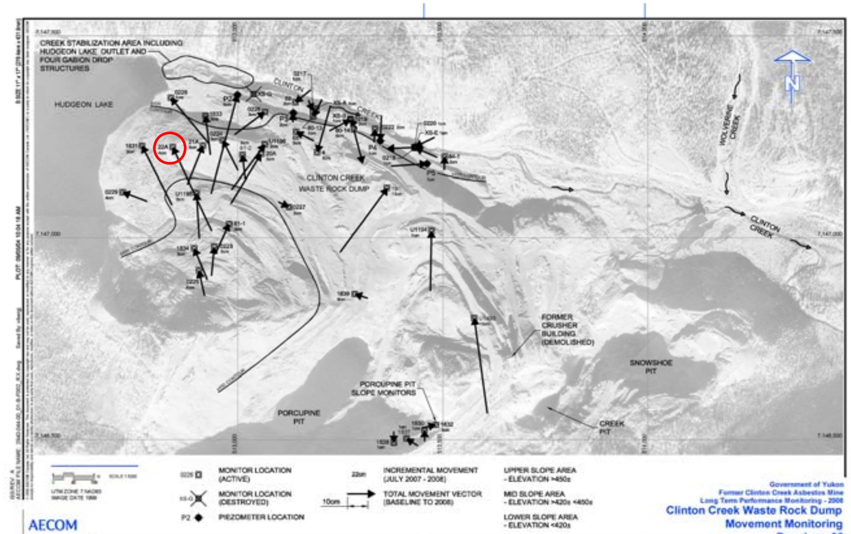
Yukon Energy, Mines and Resources AECOM

Clinton Creek Waste Rock Dump and Porcupine Pit

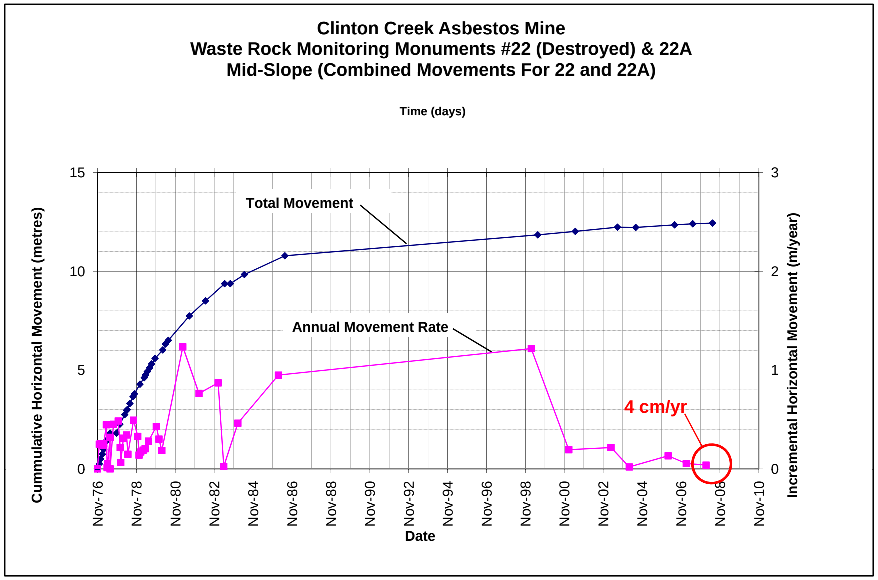


Yukon Energy, Mines and Resources AECOM

Waste Rock Movement Monitoring Results (2008)



Yukon Energy, Mines and Resources AECOM



Gabion Drop Structure Closure Measurements

Measurement Location #1 - Across Drawdown Weir

Drop Structure	Date 16-Jul-09	Incremental Change (m) Sept 2008 to July 2009	Average Annual Rate Of Movement (m/yr) Sept 2008 to July 2009	Total Change (m)	Comment
1	19.40	-0.08	-0.09	-0.22	survey tags 1 & 2
2	19.41	-0.05	-0.06	-0.08	survey tags 5 & 6
3	19.00	-0.08	-0.09	-0.44	survey tags 9 & 10
4	19.35	-0.05	-0.06	-0.26	survey tags 13 & 14

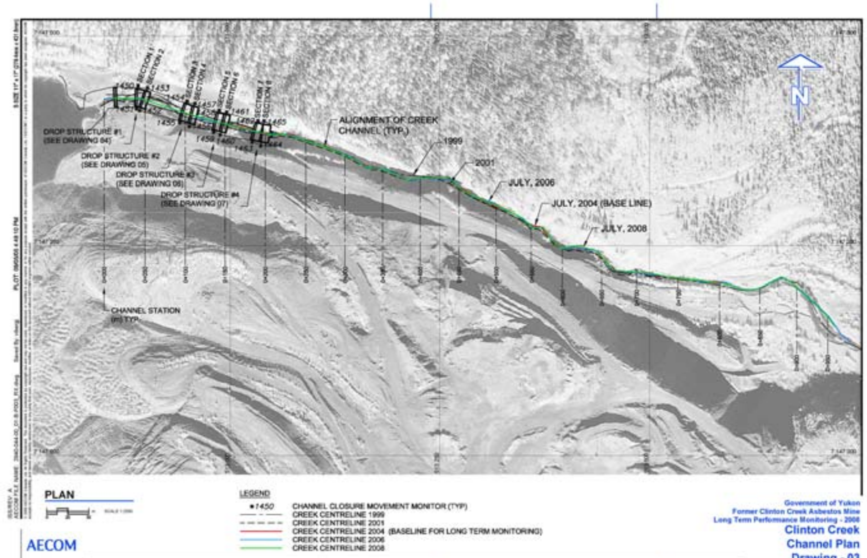
Measurement Location #2 - Across Lower Tier In-Line With End Sill

Drop Structure	Date 16-Jul-09	Incremental Change (m) Sept 2008 to July 2009	Average Annual Rate Of Movement (m/yr) Sept 2008 to July 2009	Total Change (m)	Comment
1	20.66	-0.11	-0.13	-0.34	survey tags 3 & 4
2	20.90	-0.05	-0.06	-0.25	survey tags 7 & 8
3	21.09	-0.08	-0.09	-0.41	survey tags 11 & 12
4	21.27	-0.03	-0.04	-0.21	survey tags 15 & 16

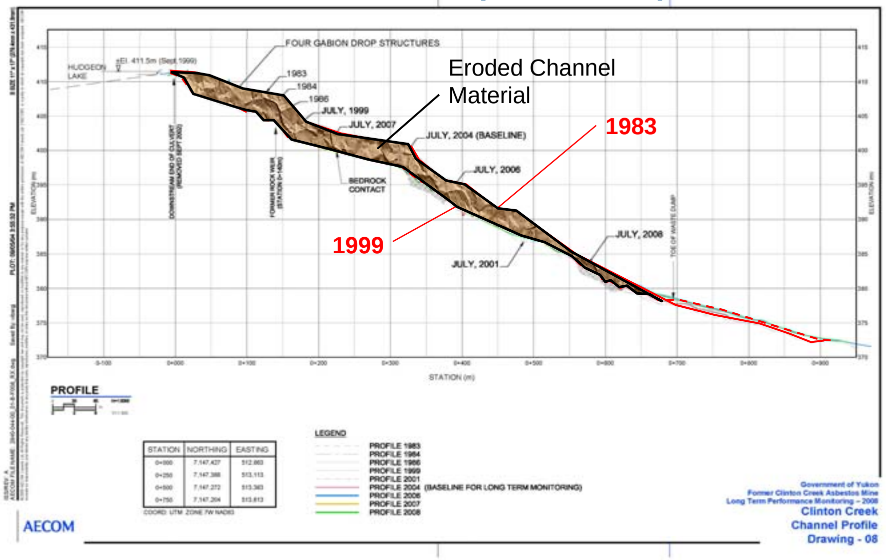
Average	**-0.07**	**-0.08**	**-0.28**
Minimum	**-0.03**	**-0.04**	**-0.08**
Maximum	**-0.11**	**-0.13**	**-0.44**

Clinton Creek Channel D/S of Gabion Structures

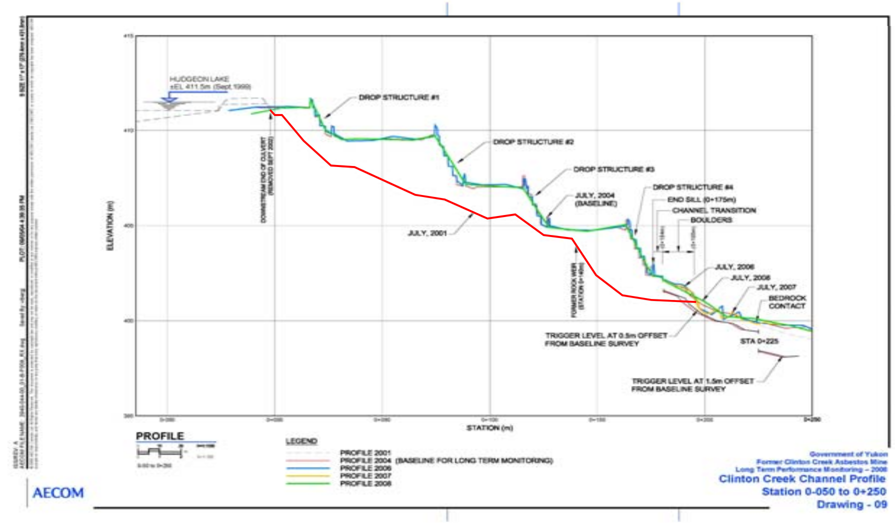
Clinton Creek Channel



Clinton Creek Channel Profile (1983 – 2008)



Clinton Creek Channel Profile at Hudgeon Lake Outlet



Clinton Creek Options Workshop January 19 & 20, 2010

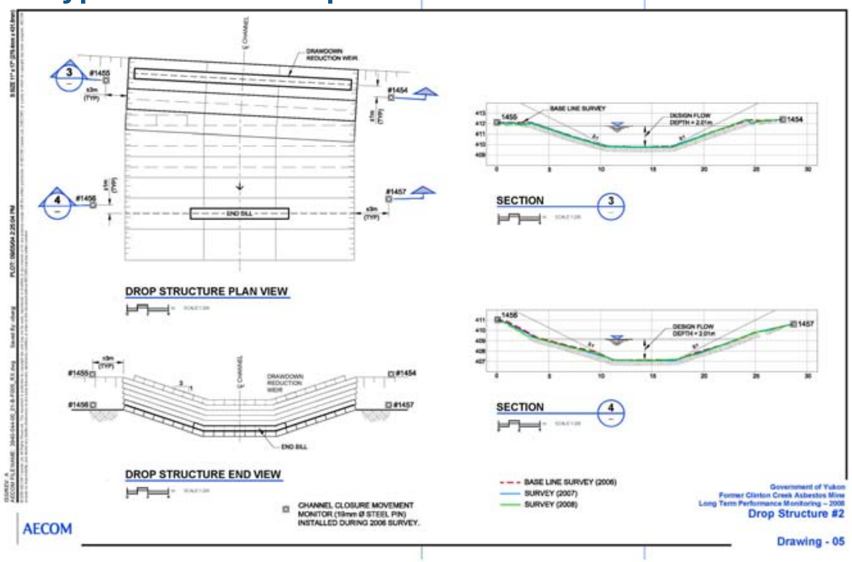
Gabion Drop Structures at Hudgeon Lake Outlet (2005)

Clinton Creek Options Workshop January 19 & 20, 2010

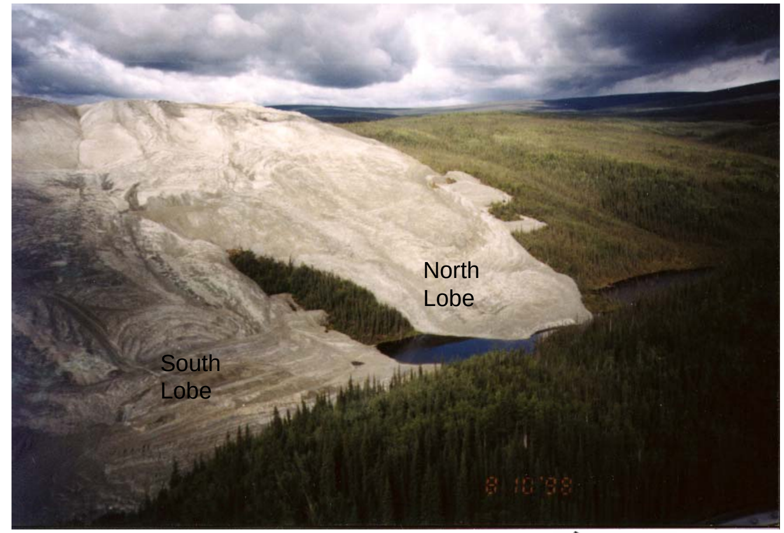
Gabion Drop Structure Repairs – Fall 2009

Clinton Creek Options Workshop January 19 & 20, 2010

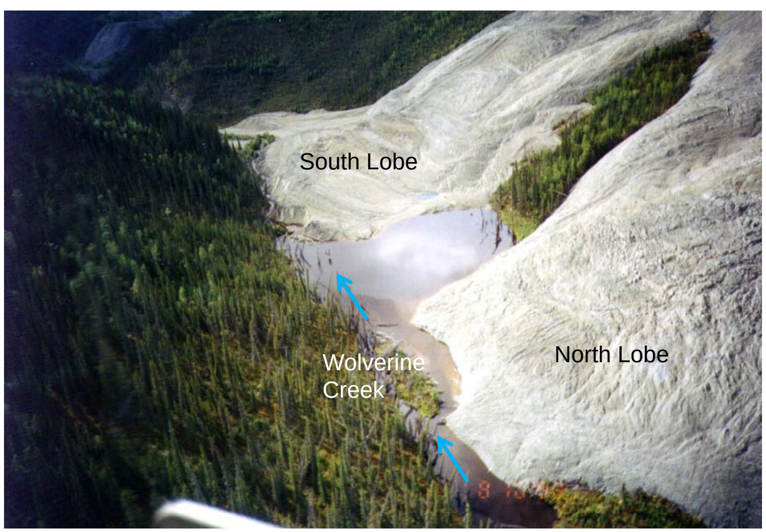
Typical Gabion Drop Structure



Wolverine Creek Tailings Pile (1998)

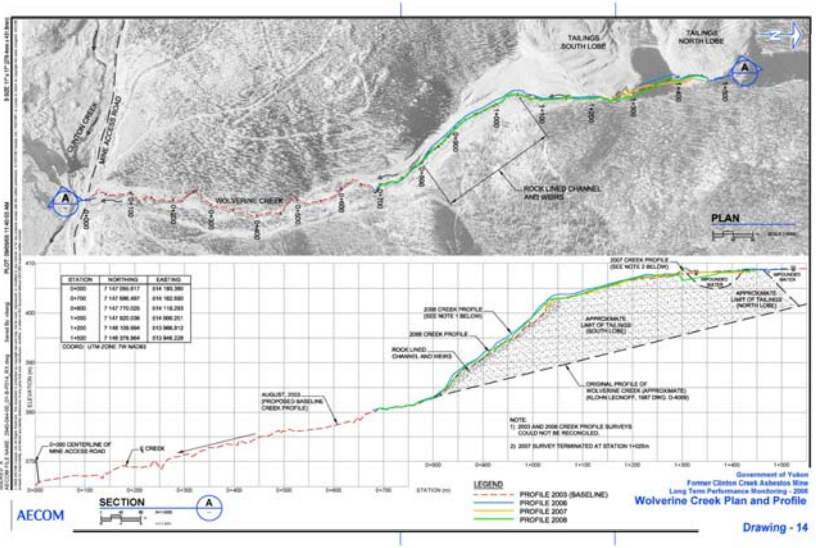


Toe of Tailings Lobes at Wolverine Creek (1998)

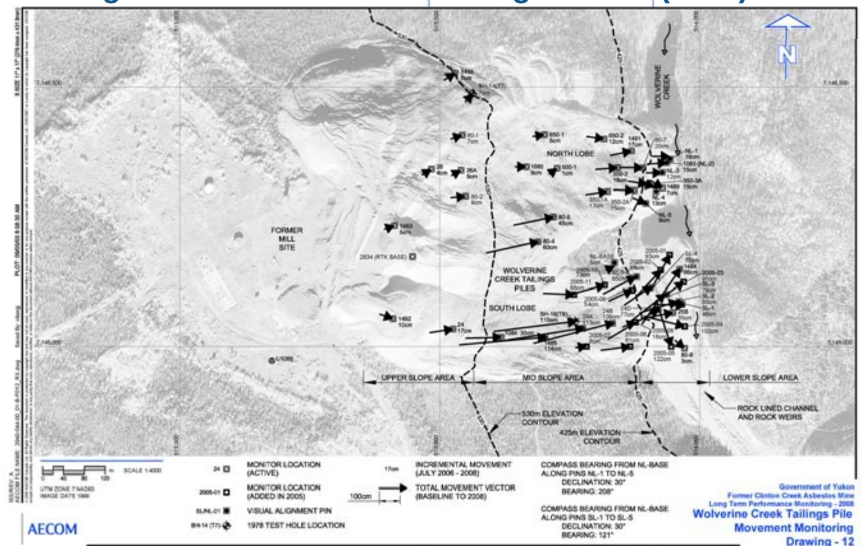


Rock Lined Channel & Weirs Along Wolverine Creek

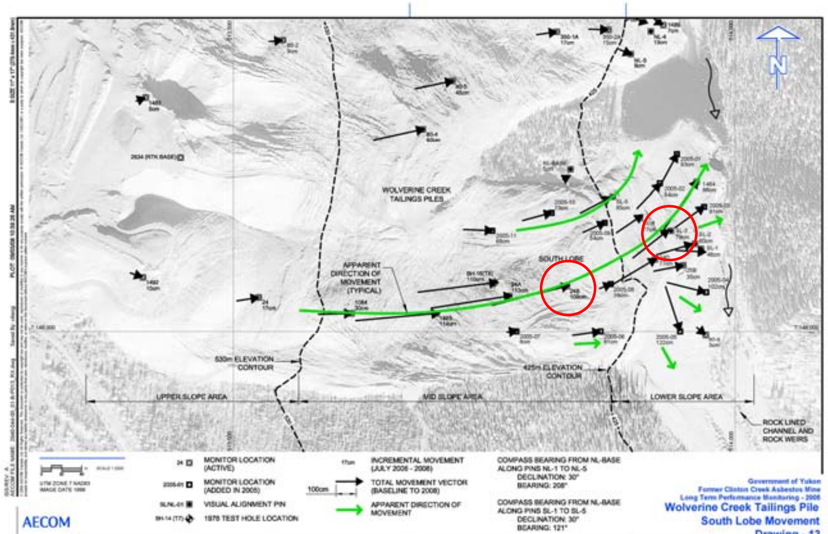
Wolverine Creek Plan and Profile (2003 to 2008)

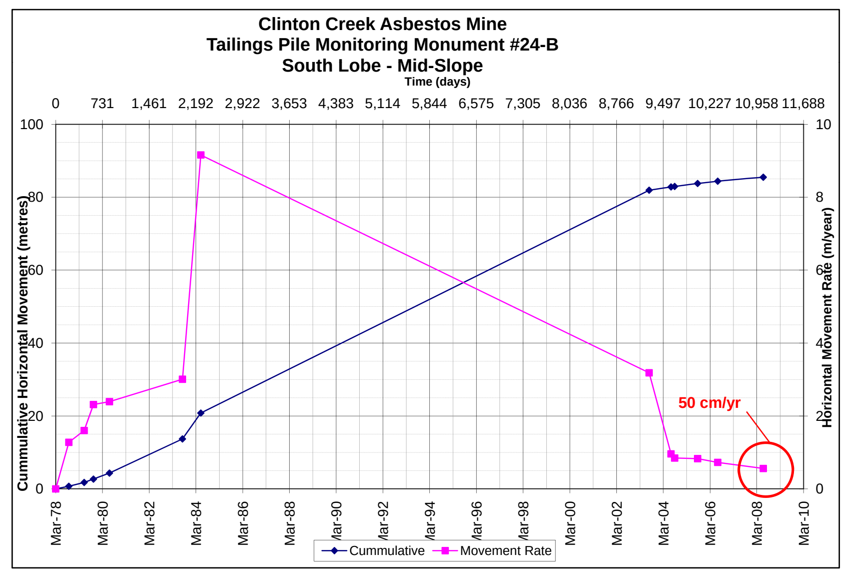


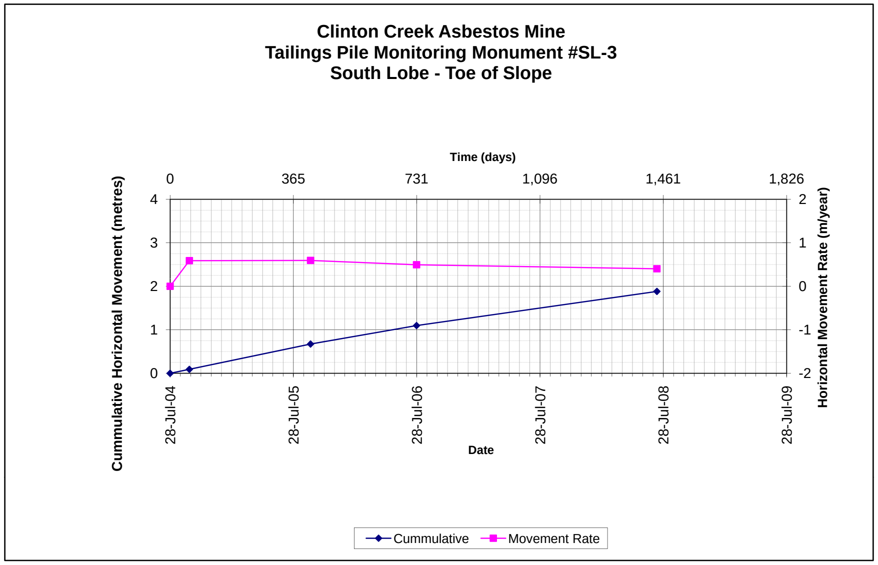
Tailings Pile Movement Monitoring Results (2008)



Tailings Pile – South Lobe Movement (2008)







Clinton Creek Options Workshop January 19 & 20, 2010

Appendix A4

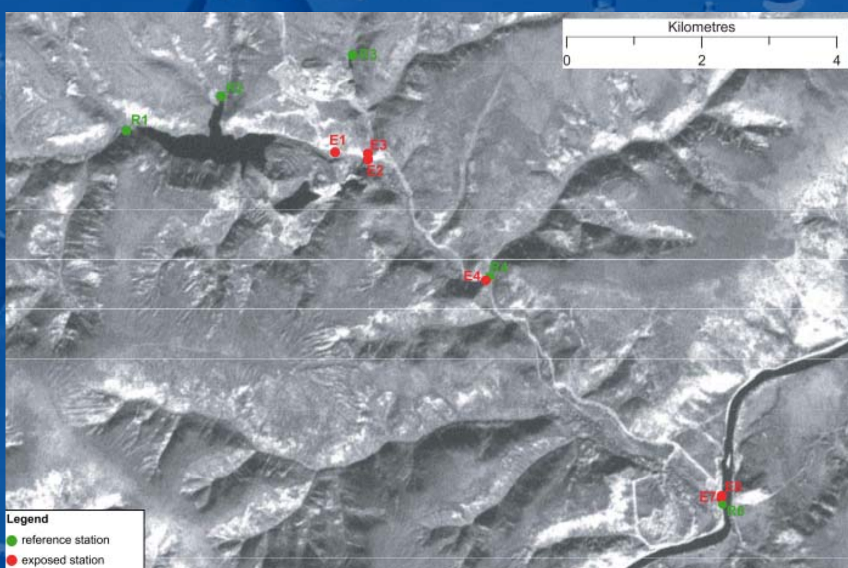
Water Quality and Asbestos

Effects of the Clinton Creek Mine on Chemical and Biological Stream Quality

Michelle Bowman, Patti Orr, and Jocelyn Kelly
Minnow Environmental Inc.

Overview

- Brief description of historical conditions
- Preliminary results on current conditions
- Preliminary conclusions and recommendations



Asbestos Toxicity

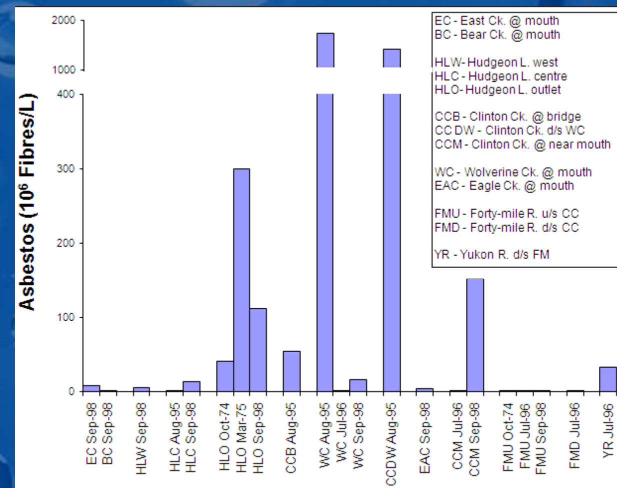
Common Name	Life stage at initiation	Exposure time	Minimum Effect Concentration	Observed Toxic Effects
Planktonic algae	-	48 hours	1-1.5 x 10^6 fibers/L	cell clumping
Duckweed	-	7-21 days	0.5-5.0 μg/mL (<30 um fibers)	biochemical changes
Brine shrimp	2-3 days old	22 - 26 hours, with turbulence	2 x 10^2 mg/L (short fiber)	increased mortality
Asiatic clam	adult	48 hrs - 30 days	10^2 - 10^8 fibers/L	depressed siphoning, reduced growth, changes to gill microstructure, less larvae released, increased larval mortality
Clam	juvenile	30 days	10^2 - 10^8 fibers/L	depressed siphoning, reduced growth, increased water content in body tissue, changes to gill microstructure
Amazon molly	2 months	6 months	0.1-1.0 mg/L (coarse fiber)	kidney, gill, and heart damage
Coho salmon	larvae	13-40 days	1.5-3.0 x 10^6 fibers/L	mortality, abnormalites in tissue and behaviour
Green sunfish	juvenile	52-67 days	1.5-3.0 x 10^6 fibers/L	loss of scales and skin tissues, abnormal swimming behaviour
Japanese Medaka	egg-adult	13 days - 20 weeks	10^4-10^{10} fibers/L	increased days to hatch, decreased growth, increased mortality, abnormal epidermis, lower spawning frequency

Historic Chemical and Biological Quality

Year	Title	Reference	Data Type[a]
1978	An Environmental Assessment of the Effects of Cassiar Asbestos Corporation on Clinton Creek, Yukon Territory	Landucci 1978	Asb, WQ, F
1998	Abandoned Clinton Creek Asbestos Mine	Roach 1998	Asb, F
1999	An Environmental Review of the Clinton Creek Abandoned Asbestos Mine, Yukon, Canada	Royal Roads University 1999	Asb, WQ, F
2003	Human Health Screening Level Risk Assessment for Clinton Creek Abandoned Asbestos Mine	SENES 2003	WQ
2004	Report on Operations Under License to Collect Fish Number 04-17	Copeland 2004	F
2005	Inspection, July 6-7, 2005	von Finster 2005a	F
2005	Inspection, July 6-7, 2005	von Finster 2005b	F
2005	Overflight, August 9, 2005	von Finster 2005c	F
2005	Clinton Creek, tributary to the Fortymile River, Yukon River North Mainstem sub basin - record of 2005 sampling	von Finster 2005d	F
2006	Clinton Creek, tributary to the Fortymile River, Yukon River North Mainstem sub basin - record of 2006 sampling	von Finster 2006	F
2007	Clinton Creek, tributary to the Fortymile River, Yukon River North Mainstem sub basin - record of 2007 sampling	von Finster 2007	F
2007	Rearing and Overwintering Access Restoration	Smart 2007	F
2008	Clinton Creek Mine Site Fisheries and Benthic Invertebrate Assessment Monitoring, 2007	White Mountain Environmental Consulting 2008	BMI, F
2009	Clinton Creek, tributary to the Fortymile River, Yukon River North Mainstem sub basin - record of 2008 sampling	von Finster 2009	F

[a] Asb = asbestos, WQ = water quality, BMI = benthic macroinvertebrates, F = fish

Historic Asbestos Levels



- outdated
- variable but in toxic range
- once / year

Historic Chemical and Biological Quality

Indicator	Data available	Limitations
Asbestos	Asbestos concentrations in water potentially toxic	Outdated, variable, low frequency
Water	Several variables exceeded guidelines (Cr, Fe, Mn, Se)	Poor detection (esp. ref.), low frequency

Historic Chemical and Biological Quality

Indicator	Data available	Limitations
Asbestos	Asbestos concentrations in water potentially toxic	Outdated, variable, low frequency
Water	Several variables exceeded guidelines (Cr, Fe, Mn, Se)	Poor detection (esp. ref.), low frequency
Sediment	Elevated chromium in Wolverine Ck. d/s tailings	Data spatially limited, outdated

Historic Chemical and Biological Quality

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Invertebrates	Artificial substrate sampling attempted	Unreliable due to variable drying

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Historic Chemical and Biological Quality

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Sediment	Elevated chromium in Wolverine Ck. d/s tailings	Data spatially limited, outdated
Invertebrates	Artificial substrate sampling attempted	Unreliable due to variable drying
Fish	Spatial and temporal records	Variable methods/ effort, no condition, toxicity or reference data

Area	Arctic grayling	Chinook salmon	Lake Whitefish	Round Whitefish	Slimy sculpin	Longnose sucker	Lake chub	Sources
Tributary to upper Clinton Creek								White Mountain Environmental Consulting, 2008
Clinton Creek upstream of Hudgeon Lake								Landucci, 1978; White Mountain Environmental Consulting, 2008
Hudgeon Lake	P							Royal Roads University, 1999; EVS 1980 data; DFO Dec 6, 2005; DFO Oct 31, 2006; White Mountain Environmental Consulting, 2008
Bear Creek								White Mountain Environmental Consulting, 2008
East (or Easter) Creek								White Mountain Environmental Consulting, 2008
Clinton Creek upstream and within gabion baskets	P	P				P		Roach et al., 2003; DFO Oct 31, 2006; DFO Dec 23, 2007; DFO Jan 16, 2009
Clinton Creek downstream of gabions and within/near gabion areas prior to their construction	P	P		P	P	P	P	Landucci, 1978; Roach and Ricks, 2003; Roach et al., 2003; DFO July 14, 2005; DFO Aug 2, 2005; DFO Dec 23, 2007; White Mountain Environmental Consulting, 2008; DFO Dec 23, 2007; DFO Jan 16, 2009
Clinton Creek near Wolverine Creek (including road crossing)	P	P			P	P	P	Landucci, 1978; EVS 1980 data; Royal Roads University, 1999; Roach and Ricks, 2003; DFO July 14, 2005; DFO Aug 2, 2005; DFO Dec 6, 2005; DFO Oct 31, 2006; DFO Dec 23, 2007; DFO Jan 16, 2009
Clinton Creek near confluence of Eagle Creek	P	P			P	P		Landucci, 1978; EVS 1980 data; Royal Roads University, 1999; DFO July 14, 2005; DFO Aug 2, 2005; DFO Jan 16, 2009
Clinton Creek near confluence with Fortymile River	P	P	P	P	P	P		Landucci, 1978; EVS 1980 data; Royal Roads University, 1999; DFO Dec 6, 2005; DFO Oct 31, 2006; DFO Dec 23, 2007; Smart
Wolverine Creek								Landucci, 1978; White Mountain Environmental Consulting, 2008
Fortymile River	P	P			P	P		Landucci, 1978

Historic Chemical and Biological Quality

Indicator	Data available	Limitations
Asbestos	Asbestos concentrations in water potentially toxic	Outdated, variable, low frequency
Water	Several variables exceeded guidelines (Cr, Fe, Mn, Se)	Poor detection (esp. ref.), low frequency
Sediment	Elevated chromium in Wolverine Ck. d/s tailings	Data spatially limited, outdated
Invertebrates	Artificial substrate sampling attempted	Unreliable due to variable drying
Fish	Spatial and temporal records	Variable methods/ effort, no condition, toxicity, or reference data

2009 Recommendations

- Monthly water quality monitoring (targeting low and high flows)
- Sediment characterization
- Assess invertebrate health relative to reference
- Assess fish health relative to reference

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Overview

- Brief description of historical conditions
- Preliminary results on current conditions
- Preliminary conclusions and recommendations

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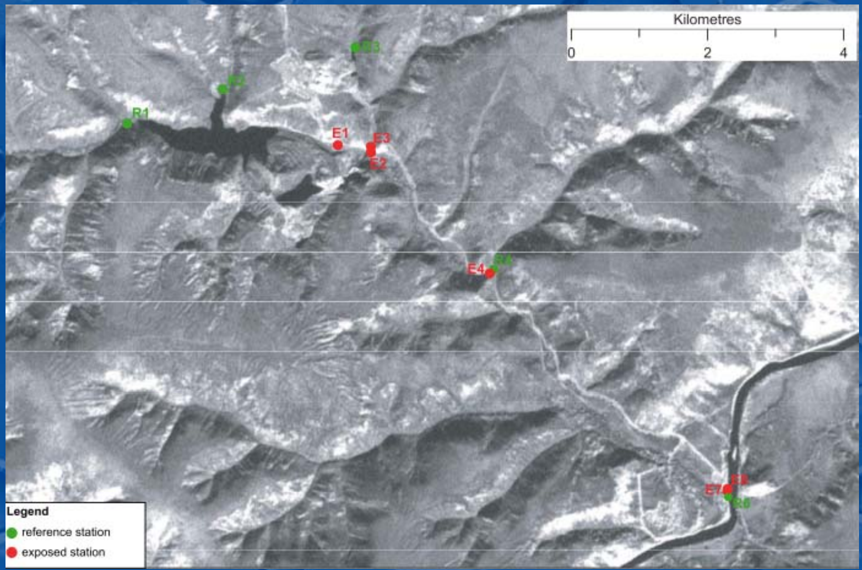
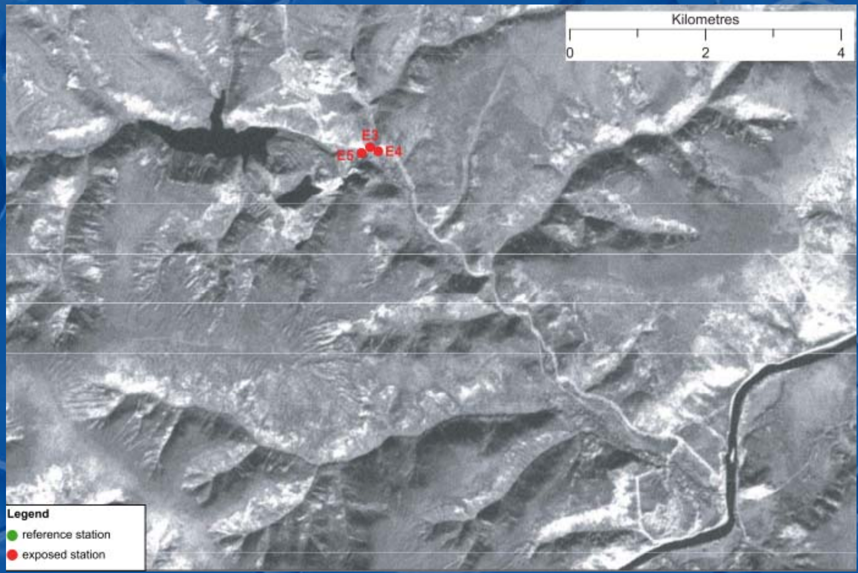
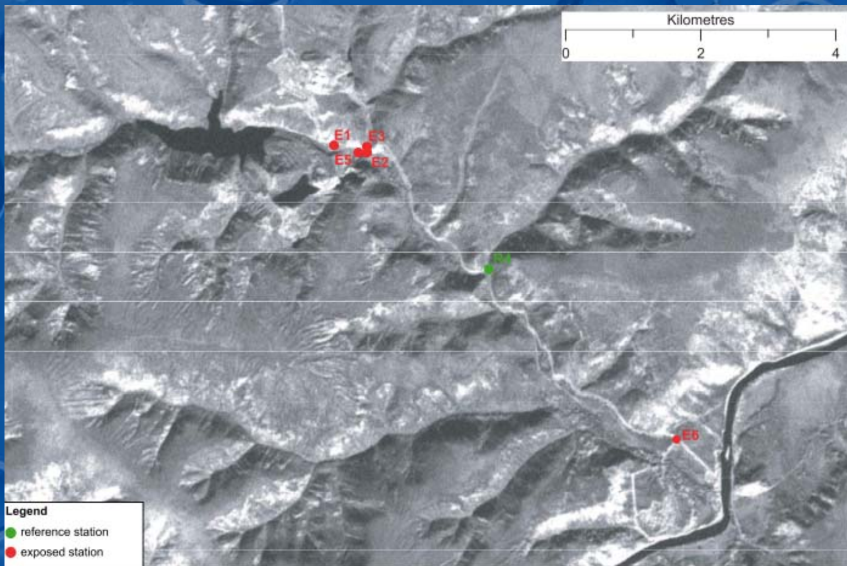
Water and Invertebrate Sampling



Sediment Sampling



Fish Sampling



Preliminary Asbestos Results

Wolverine Creek d/s tailings	Current (Autumn 2009)	Historic (Autumn 1995-99)
WATER	10^{12}	10^{6}-10^{9} (1995-98)
SEDIMENT	15-20%	10% (1999, dam)

Preliminary Water Chemistry - relative to reference

Variables	CC d/s gabions	Porcupine Pit	Porcupine Pond	CC d/s Porcupine	Wolverine d/s tailings	CC d/s Wolverine	CC u/s town ford	CC u/s mouth	Fortymile d/s CC
	E1		E5	E2	E3	E4	E6	E7	E8
	n=1	n=2	n=2	n=5	n=5	n=4	n=1	n=3	n=2
Non-metals									
Kjeldahl Nitrogen		-	-		X		-	X	X
Dissolved Sulfate (SO4)		-	-	X	X	X	-	X	
Total Hardness		-	-	X	X	X	-	X	
Conductivity (field)		-	-	X	X	X	-	X	
Electrical Conductivity (lab)		-	-	X	X	X	-	X	
Total Metals									
Antimony		X	X		X	X			
Arsenic		X	X	X	X	X			
Beryllium					X	X			X
Boron		X	X	X	X	X	X	X	X
Cadmium						X			
Calcium		X	X	X		X		X	
Chromium					X	X		X	X
Cobalt				X		X		X	X
Lithium		X	X	X		X	X	X	X
Magnesium		X	X	X	X	X		X	
Manganese				X		X	X	X	X
Molybdenum		X	X	X	X	X		X	
Nickel	X	X	X	X	X	X	X	X	X
Phosphorus (ICP scan)		X	X	X	X				
Potassium		X	X	X	X	X		X	
Selenium		X	X						
Silver			X	X					
Sodium		X	X	X	X	X		X	
Strontium		X	X	X		X		X	
Sulfur		X	X	X	X	X		X	
Thallium	X		X	X					
Tin		X	X	X					
Uranium		X							

Preliminary Water Chemistry - relative to reference + guidelines

Variables	CC d/s gabions	Porcupine Pit	Porcupine Pond	CC d/s Porcupine	Wolverine d/s tailings	CC d/s Wolverine	CC u/s town ford	CC u/s mouth	Fortymile d/s CC
	E1		E5	E2	E3	E4	E6	E7	E8
	n=1	n=2	n=2	n=5	n=5	n=4	n=1	n=3	n=2
Non-metals									
Dissolved Sulfate (SO4)		-	-	X	X	X	-	X	
Total Metals									
Arsenic		X	X	X	X				
Boron		X							
Cadmium						X			
Chromium					X	X		X	X
Nickel			X						
Phosphorus (ICP scan)		X	X	X	X				
Selenium		X	X						
Silver			X	X					

Sediment Chemistry

Parameter (mg/kg)	ISQG[a]	PEL[b]	E5 (PC-04) Porcupine Creek Beaver Pond	E3 (WC-05) Wolverine Creek u/s of culvert	- Clinton Creek d/s of Wolverine
Arsenic	5.9	17.0	28.4	8.6	11.6
Cadmium	0.6	3.5	2.28	0.15	0.19
Chromium	37.3	90.0	331	1180	1170
Copper	35.7	197	45	8	8
Mercury	0.17	0.486	0.24	0.02	0.03
Nickel	16	75	590	1660	1600
Selenium	2		6.7	0.6	0.6
Zinc	123	315	148	35	39

value exceeds ISQG

value exceeds ISQG and PEL

[a] ISQG - Interim Sediment Quality Guideline

[b] PEL - Probable Effect Level

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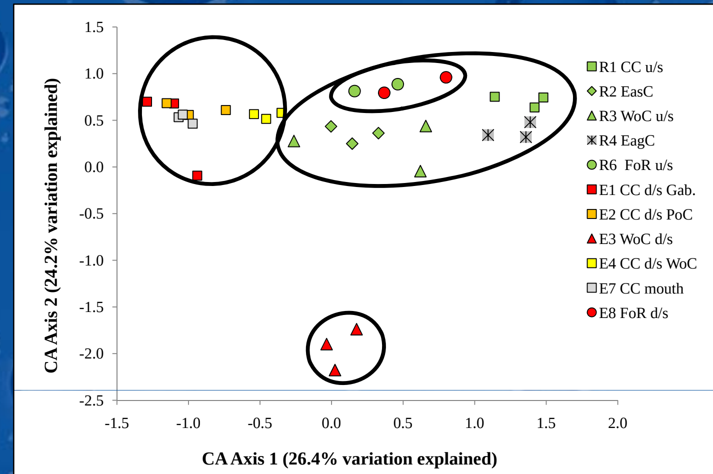
Benthic Invertebrate Communities



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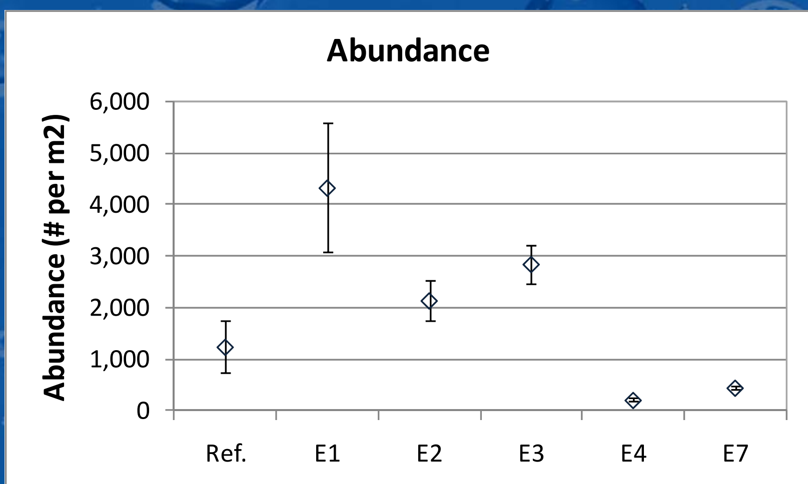
Benthic Invertebrate Metrics



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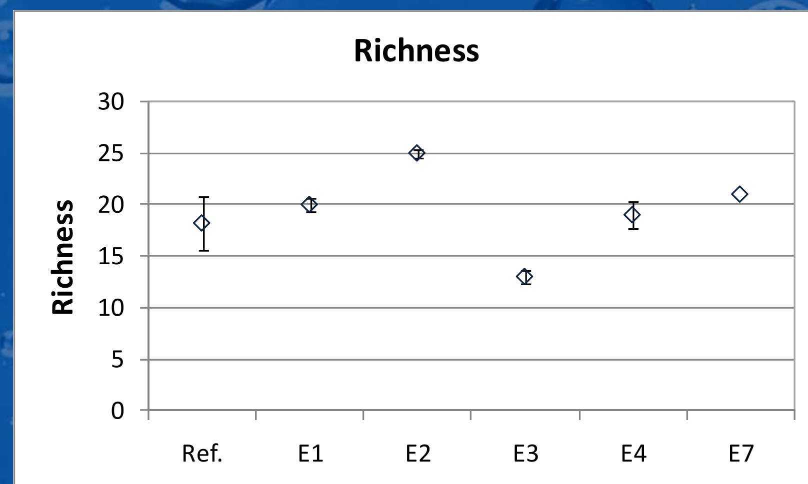
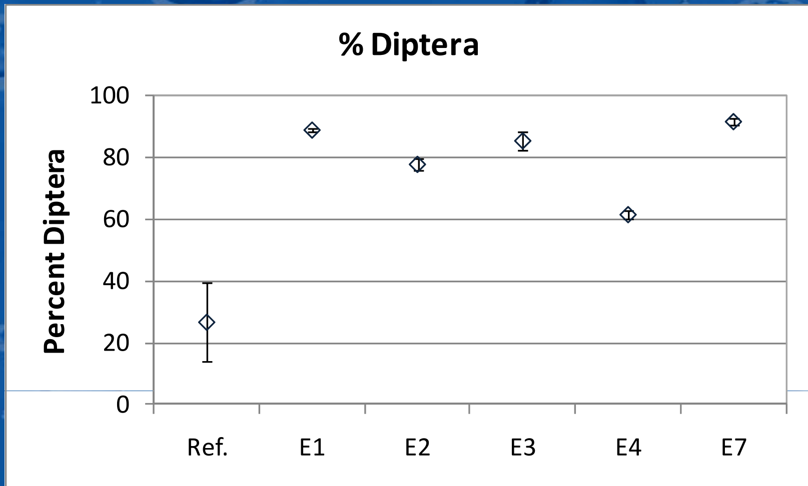
Benthic Invertebrate Metrics



minnow environmental inc.

Benthic Invertebrate Metrics



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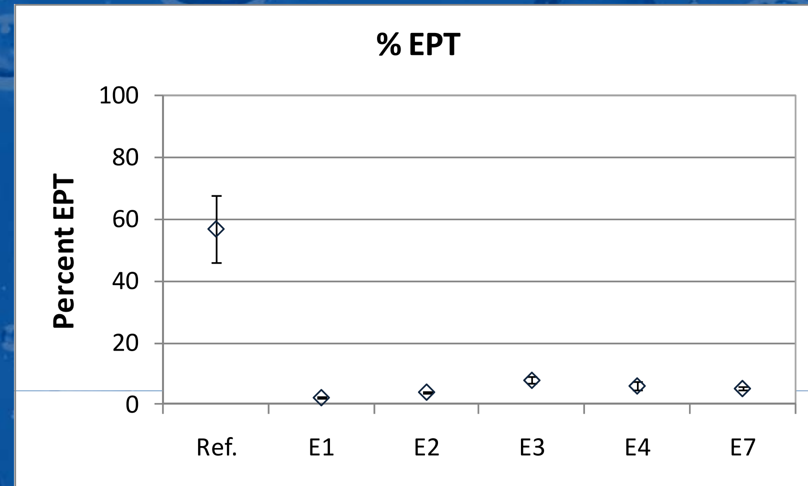
Benthic Invertebrate Metrics



minnow environmental inc.

Benthic Invertebrate Metrics - Fortymile River

	Forty Mile River u/s CC	Forty Mile River d/s CC	P value from t-test
Mean abundance	255	231	0.92
Mean richness	17	18	0.75
Mean % Diptera	15	16	0.94
Mean % EPT	60	76	0.48

minnow environmental inc.

Total Fish Abundance

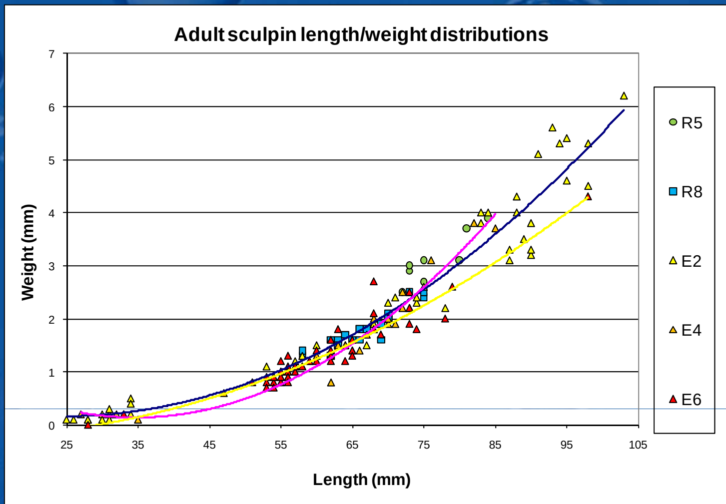
from angling, electrofishing & minnow trapping

Area		Arctic Grayling	Chinook Salmon	Slimy Sculpin
R4	Eagle Ck	-	-	-
R5	Mickey Ck	3	23	8
R7	Maiden Ck	1	-	-
R8	Marten Ck	3	-	20
E1	CC d/s gabions	15	-	-
E2	CC d/s Porcupine	8	46	158
E3	Wolverine d/s tailings	0	-	-
E4	CC d/s Wolverine	1	-	28
E6	CC u/s town ford	2	3	93

- Dominant species in assemblage consistent with previous surveys

minnow environmental inc.

Preliminary Fish Condition



minnow environmental inc.

Overview

- Brief description of historical conditions
- Preliminary results on current conditions
- Preliminary conclusions and recommendations

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Historic Chemical and Biological Quality

Indicator	Data available	Limitations
Asbestos	Asbestos concentrations in water potentially toxic	~~Outdated~~, variable, low frequency

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Historic Chemical and Biological Quality

Indicator	Data available	Limitations
Asbestos	Asbestos concentrations in water potentially toxic	~~Outdated~~, variable, low frequency
Water	Many reference but few ref.+guideline exceedances	~~Poor detection (esp. ref.)~~, low frequency

minnow environmental inc.

Historic Chemical and Biological Quality

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Asbestos	Asbestos concentrations in water potentially toxic	~~Outdated~~, variable, low frequency
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Sediment	Cr and Ni elevated d/s of mine	Data spatially limited, ~~outdated~~

Historic Chemical and Biological Quality

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Sediment	Cr and Ni elevated d/s of mine	Data spatially limited, ~~outdated~~
Invertebrates	Significant effects of the mine on benthos	~~Unreliable~~

Historic Chemical and Biological Quality

Indicator	Data available	Limitations
Asbestos	Asbestos concentrations in water potentially toxic	~~Outdated~~, variable, low frequency
Water	Many reference but few ref.+guideline exceedances	~~Poor detection (esp. ref.)~~, low frequency
Sediment	Cr and Ni elevated d/s of mine	Data spatially limited, ~~outdated~~
Invertebrates	Significant effects of the mine on benthos	~~Unreliable~~
Fish	No evidence of effects of the mine on fish health	~~Variable methods/ effort~~, no ~~condition~~, toxicity, or reference data

Preliminary Recommendations

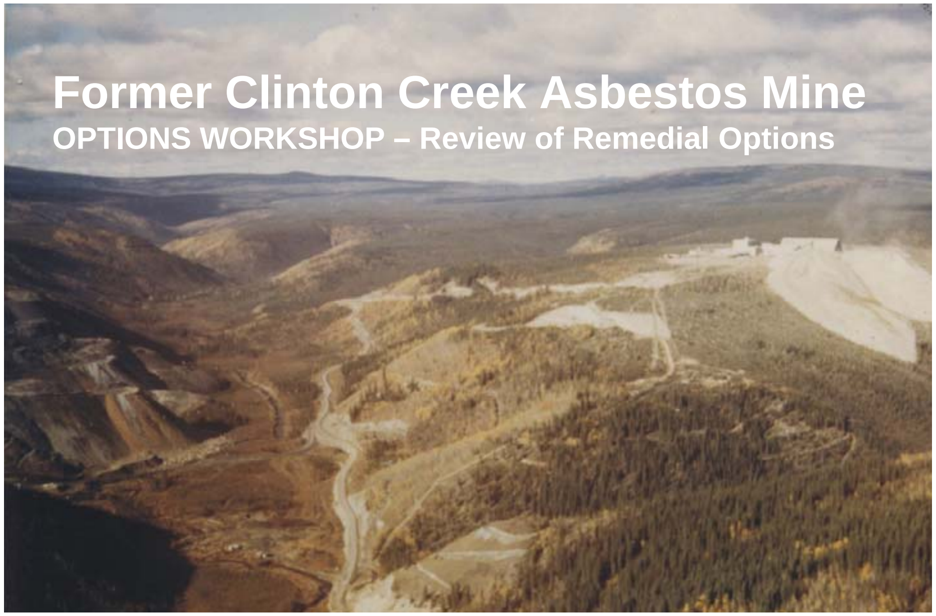
- Monthly water quality monitoring, winter access?
- Further spatial sediment characterization
- Laboratory toxicity tests (water and sediment)
- Confirm BMI health relative to reference?
- Assess fish health relative to reference?
- Evaluate desired outcomes regarding fish habitat in context of local & regional importance

Appendix A5

Prior Remedial Options for Clinton Creek and Wolverine Creek

Former Clinton Creek Asbestos Mine

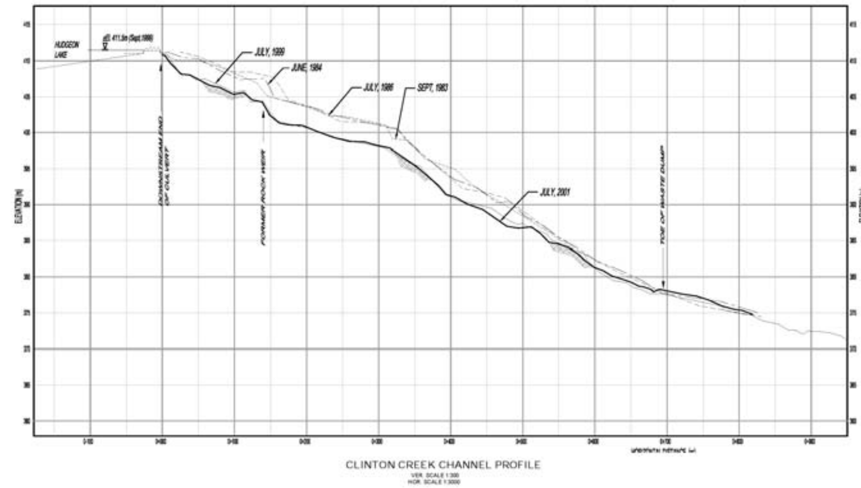
OPTIONS WORKSHOP – Review of Remedial Options



January 19 & 20, 2010

Conceptual Design Options – CC Waste Rock Dump

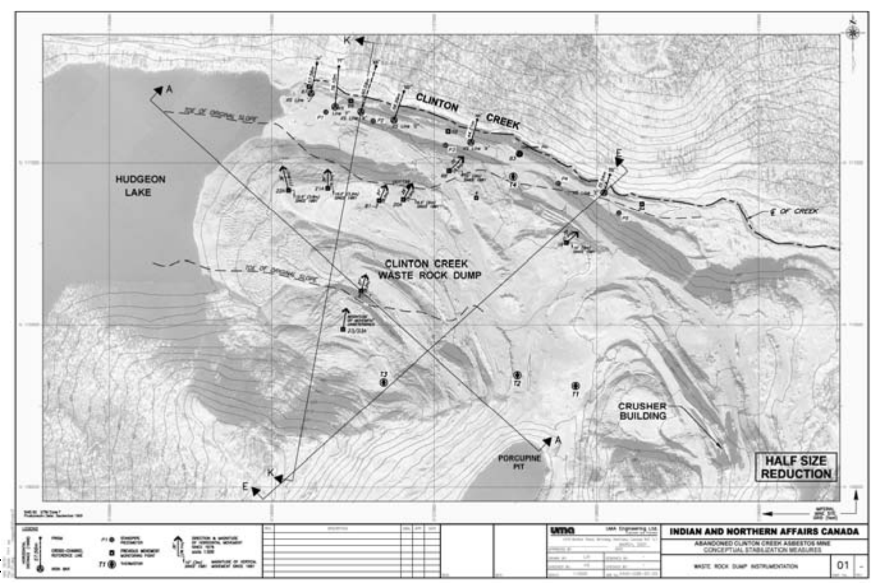
Objective: Minimize the potential for a breach scenario



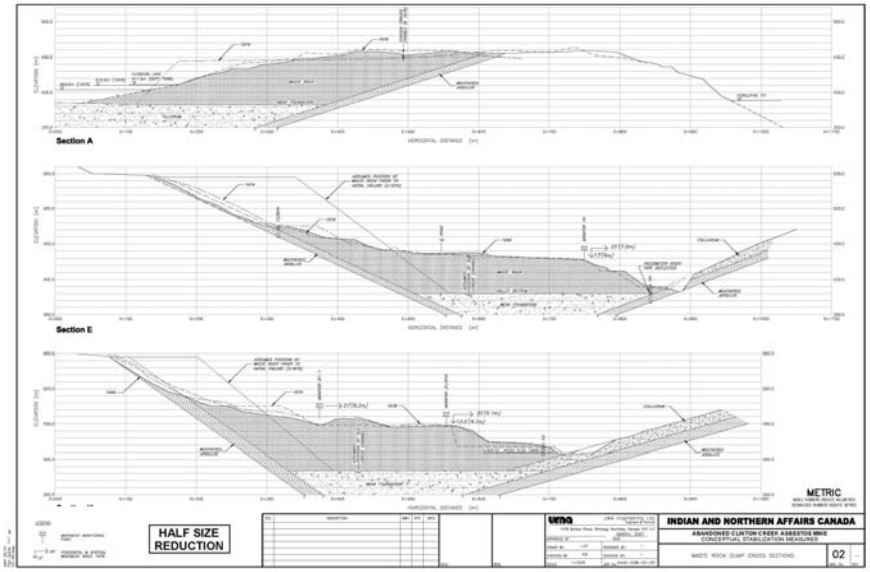
Conceptual Design Options – CC Waste Rock Dump

- Restore natural creek drainage
  - Remove majority of waste rock
- Convey water over waste rock
  - Stabilize channel
  - Stabilize waste rock:
    - Existing creek alignment
    - Alternate creek alignment
- Convey water around the waste rock (tunnel)

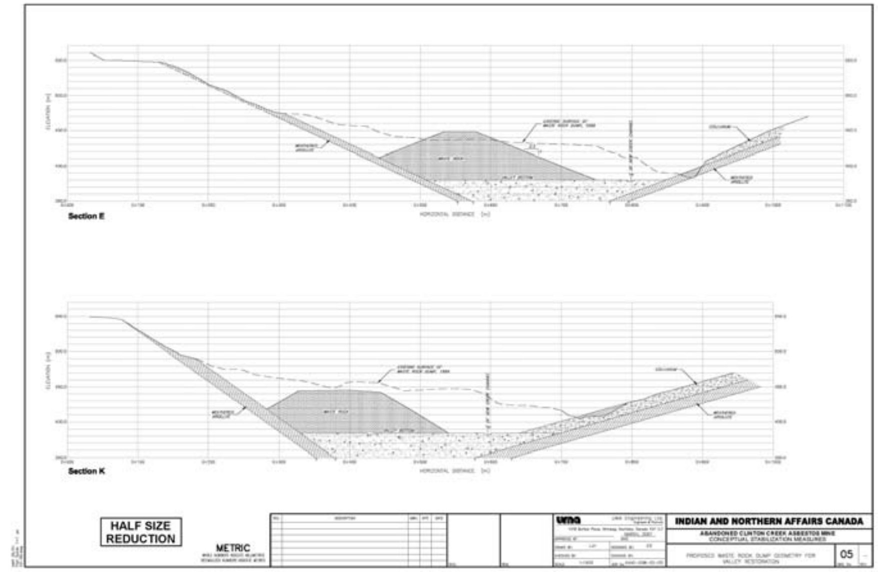
Conceptual Design Options – CC Waste Rock Dump



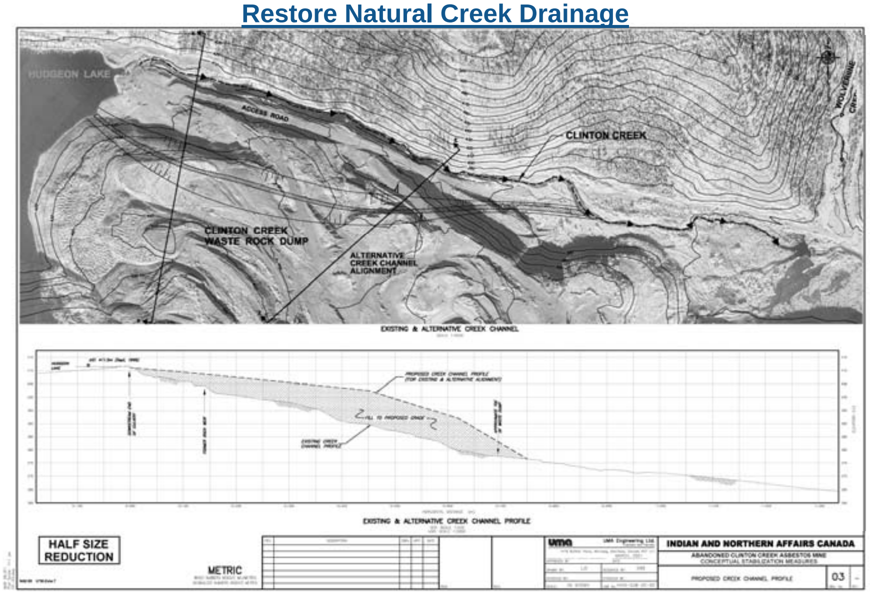
Conceptual Design Options – CC Waste Rock Dump
Cross-Sections



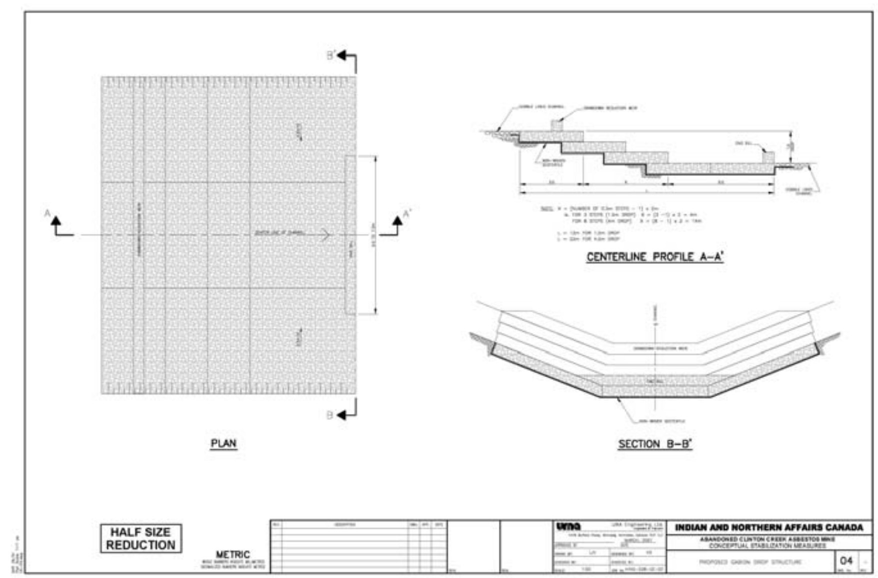
Conceptual Design Options – CC Waste Rock Dump
Restore Natural Creek Drainage



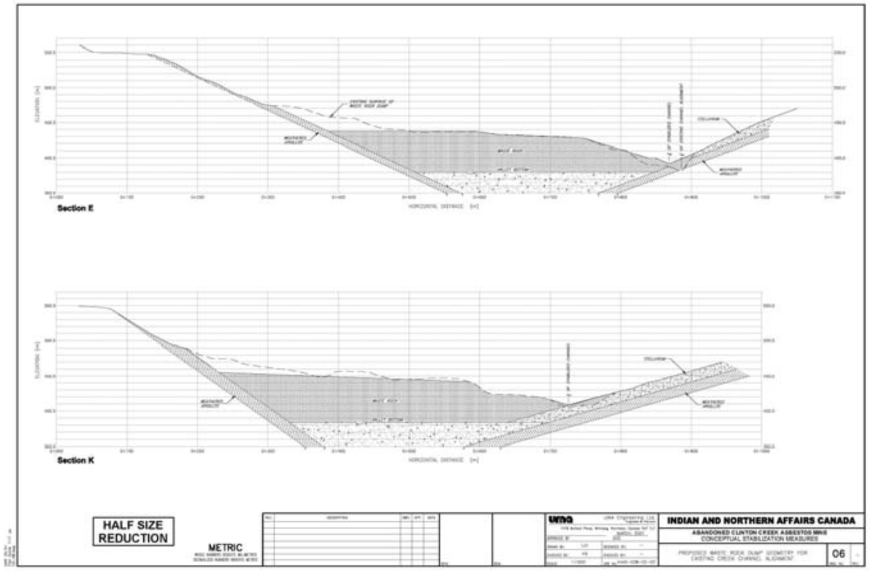
Conceptual Design Options – CC Waste Rock Dump
Restore Natural Creek Drainage



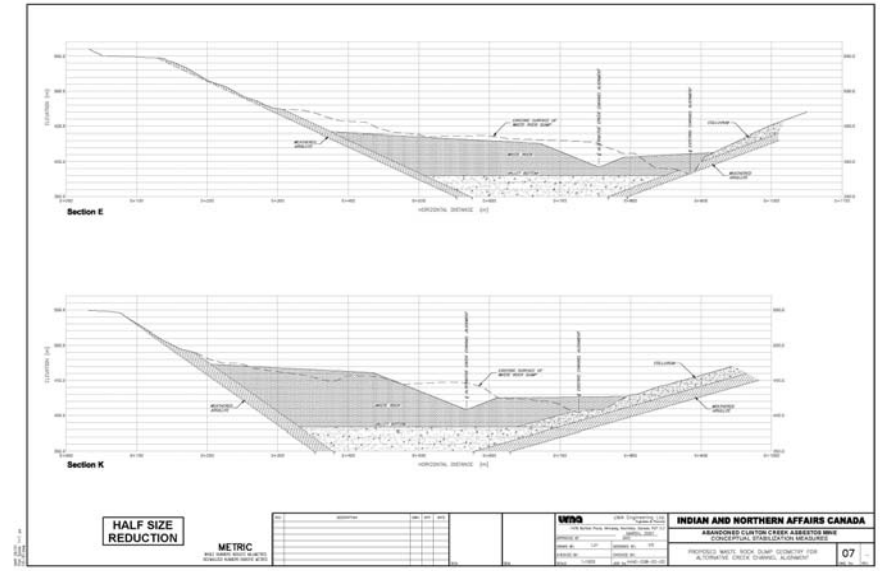
Conceptual Design Options – CC Waste Rock Dump
Restore Natural Creek Drainage



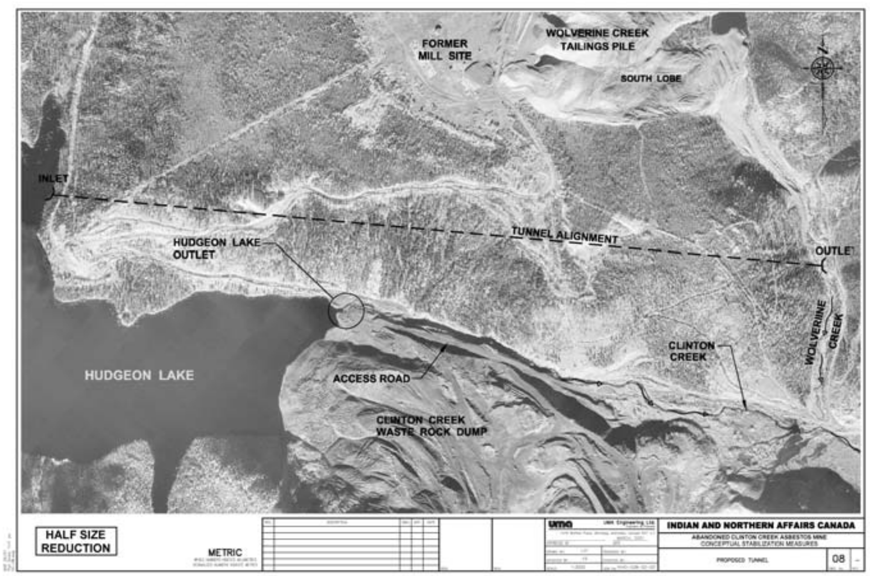
Conceptual Design Options – CC Waste Rock Dump
Convey Water Along Existing Creek Alignment



Conceptual Design Options – CC Waste Rock Dump
Convey Water Along Alternate Creek Alignment



Conceptual Design Options – CC Waste Rock Dump
Convey Water Around Waste Rock



Conceptual Design Options – CC Waste Rock Dump

Cost Estimates

Option	2000	2010
Restore Valley	$28.6 M	$75 M
Convey Along Existing Creek	$6.8 M*	$16 M*
New Creek Alignment	$14.3 M*	$36 M*
Tunnel	$20.3 M*	$38 M*

* Long term maintenance costs not included

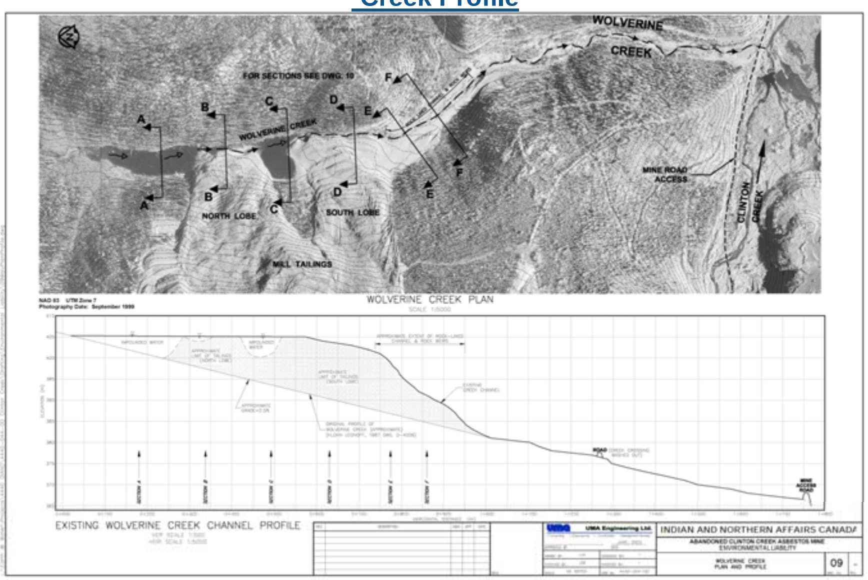
Yukon Energy, Mines and Resources AECOM

Conceptual Design Options – Wolverine Creek Tailings

- Restore natural creek drainage
  - Remove some of the tailings
- Convey water over tailings – Case A and B
  - Stabilize channel
  - Stabilize tailings pile
- Convey water around the tailings (tunnel)

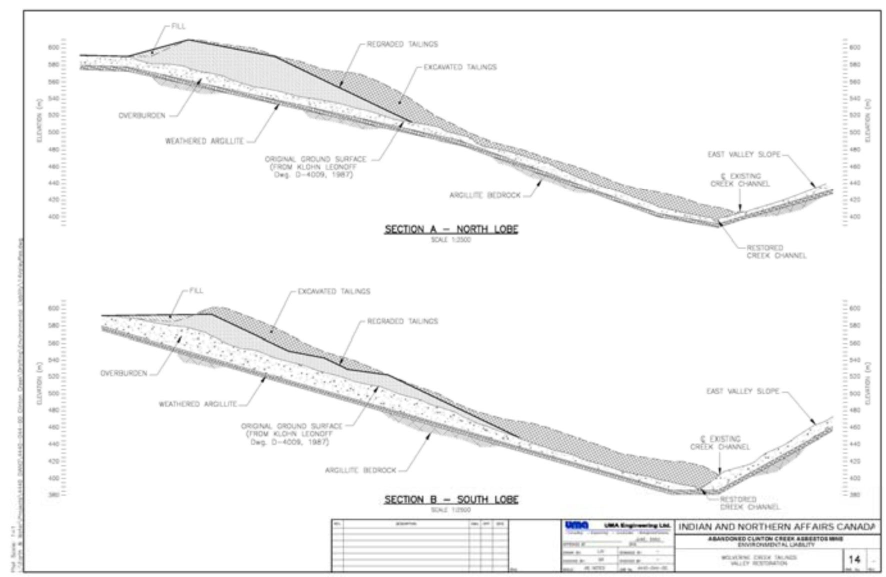
Conceptual Design Options – Wolverine Creek Tailings

Creek Profile



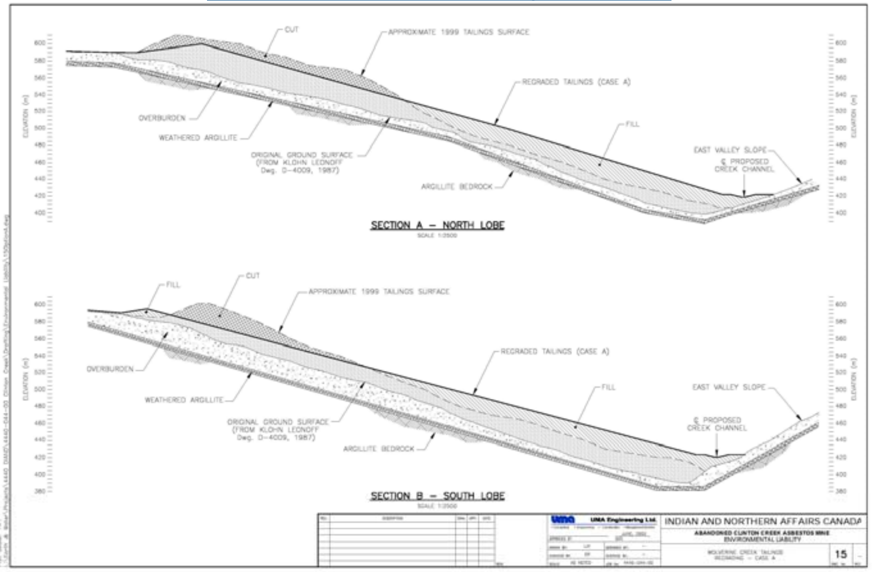
Conceptual Design Options – Wolverine Creek Tailings

Restore Natural Creek Drainage



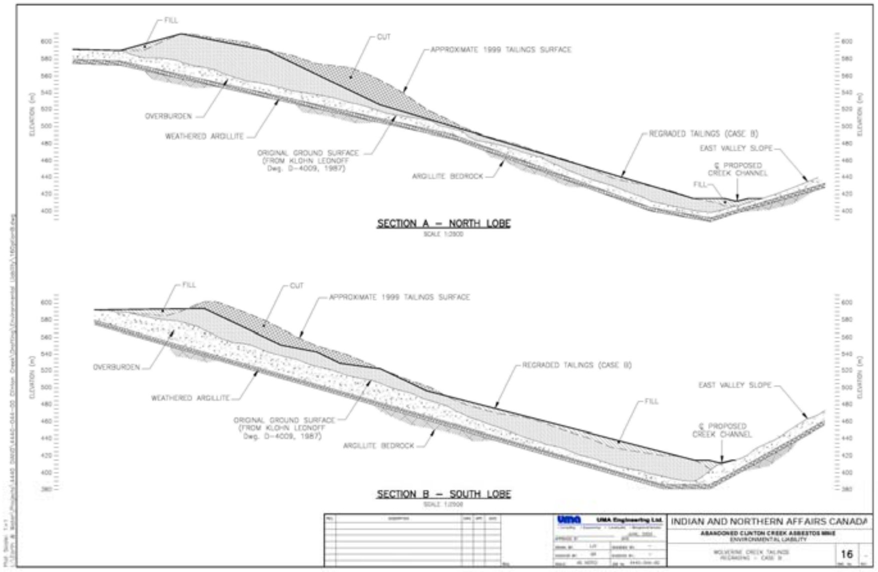
Conceptual Design Options – Wolverine Creek Tailings

Convey Water Over Tailings – Case A



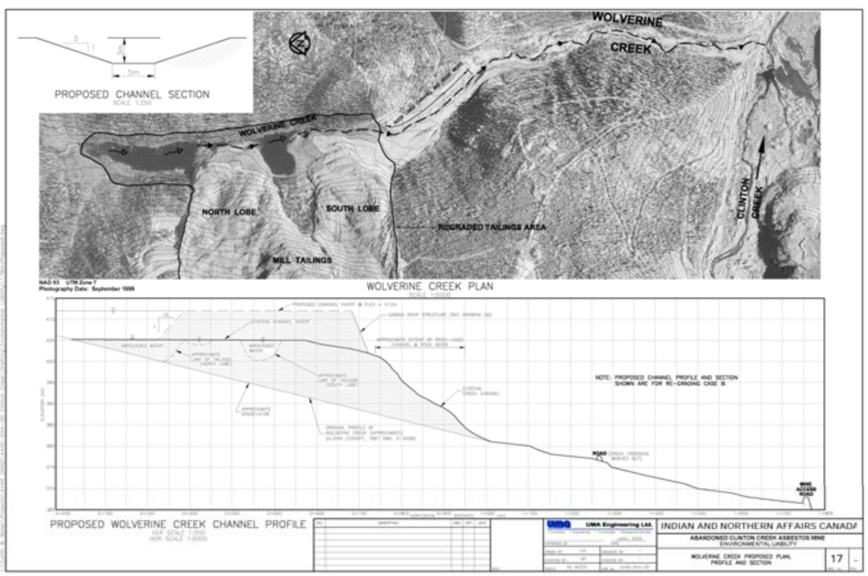
Conceptual Design Options – Wolverine Creek Tailings

Convey Water Over Tailings – Case B



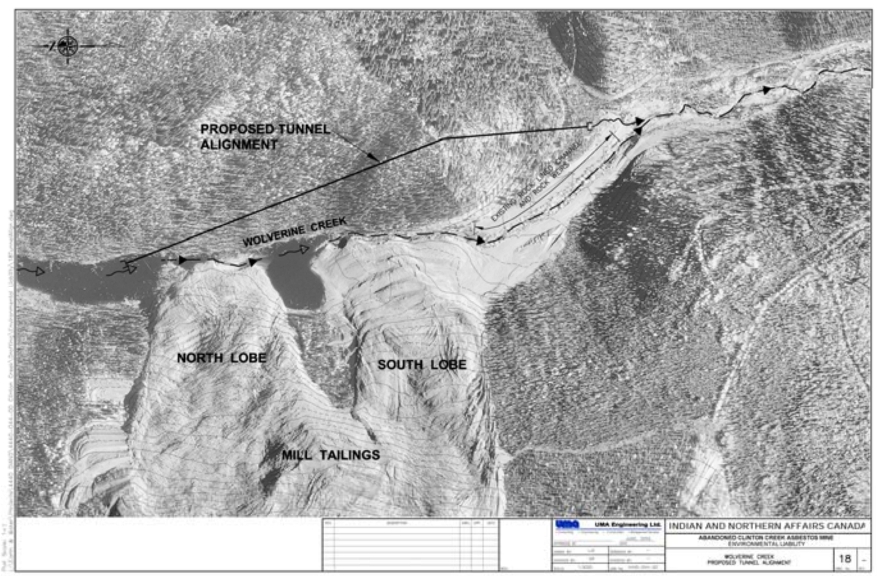
Conceptual Design Options – Wolverine Creek Tailings

Convey Water Over Tailings



Conceptual Design Options – Wolverine Creek Tailings

Convey Water Around Tailings - Tunnel



Conceptual Design Options – Wolverine Creek Tailings

Cost Estimates

Option	2003	2010
Restore Valley	$28.6 M	$90 M
Convey Over Tailings – Case A	$5.8 M*	$30 M*
Convey Over Tailings – Case B	$5.4 M*	$28 M*
Tunnel	$10.3 M*	$18 M*
Rock Drain	n/a	$6 M*

* Long term maintenance costs not included

Appendix A6
Historic Remediation Proposals

Clinton Creek Options Workshop Historic Remedial Options

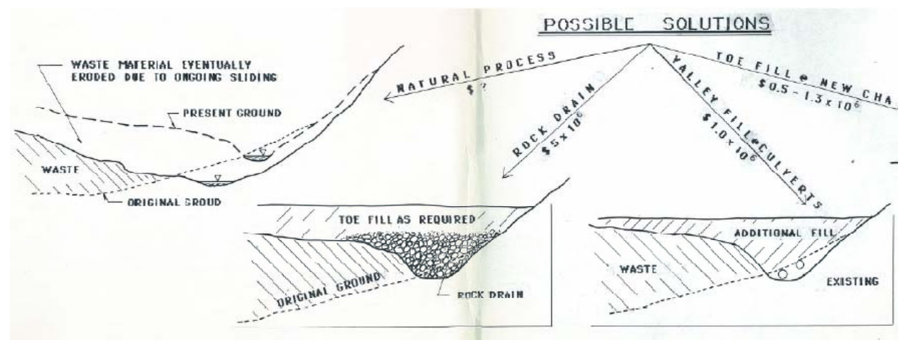
Dirk van Zyl

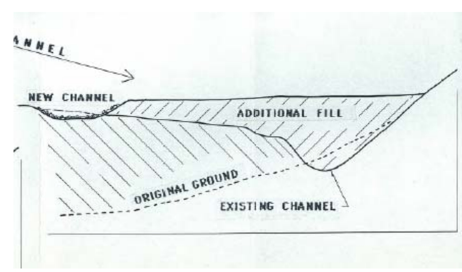
Historic Note

- A series of remedial options were suggested by various consultants since the late 1970's
- Some options were suggested and immediately rejected before further evaluation
- A few options were taken to the conceptual level
- Major reasons for rejecting the options were cost and durability

Some Historic Options for Clinton Creek

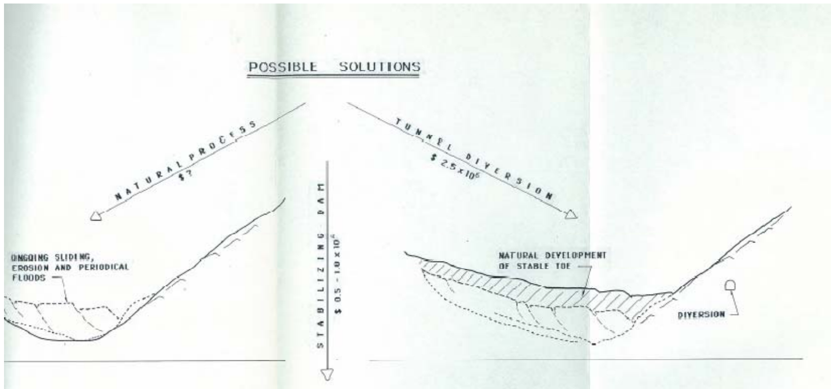
- Diversion through waste dump to Porcupine Pit
- Culvert underneath the waste rock
- Concrete energy dissipation structures
- Rock lining of the channel
- Coarse rock drain
- Culvert and valley fill
- Valley fill, spillway and armoured channel
- Sedimentation ponds

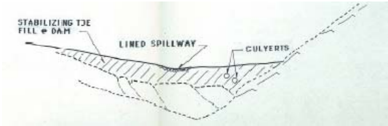




Some Historic Options for Wolverine Creek

- Retaining embankment for downward sliding tailings
- Downstream dam to collect sediment
- Diversion through culvert or open channel at higher elevation
- Coarse rock drain
- Tunnel diversion
- Culvert and valley fill
- Relocation of tailings





Appendix B
Workshop Facilitator Notes

Clinton Creek Options Workshop

January 19-20, 2010

Workshop Overview

Workshop Overview

- Objectives
- Agenda overview
- Introductions
- Terminology
- Processes

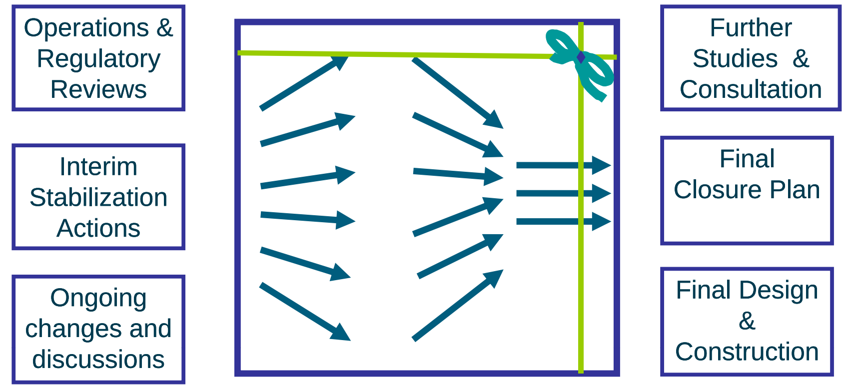
Workshop Objectives

- Seek input into possible plans for the Clinton Creek mine
- Develop options that can be taken through more detailed assessments and consultation

Specific Goals

- Review all possible options
- Identify the options most worthy of further consideration
- Prioritize investigations and activities for next few months

Workshop Context



Workshop Processes

- Basis
  - Decision analysis
  - Community consultation
  - “Top-down” project planning
  - Group creativity methods

Agenda Overview

- Tuesday
  - Common understanding
  - Identify possible methods
  - Develop complete scenarios
- Wednesday
  - Review scenarios
  - Identify critical information gaps
  - Define and prioritize steps to resolve them

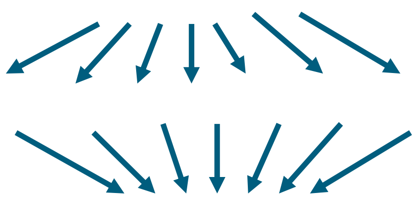
Workshop Processes

- Roles
  - Facilitator
  - Active participants
    - Group sessions
    - Report backs
  - Document results as we go

Introductions

Workshop Processes

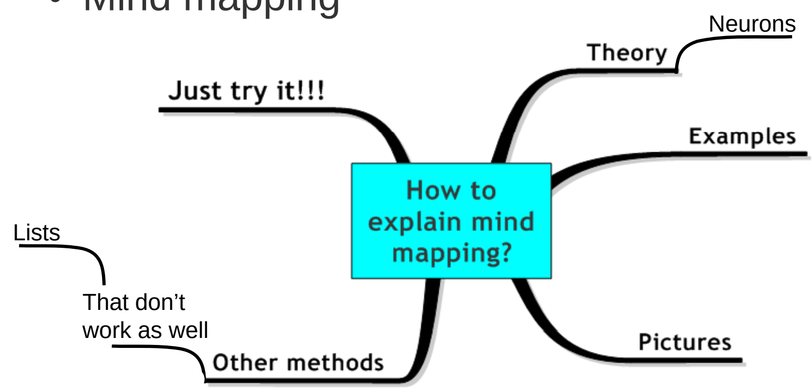
Divergent thinking

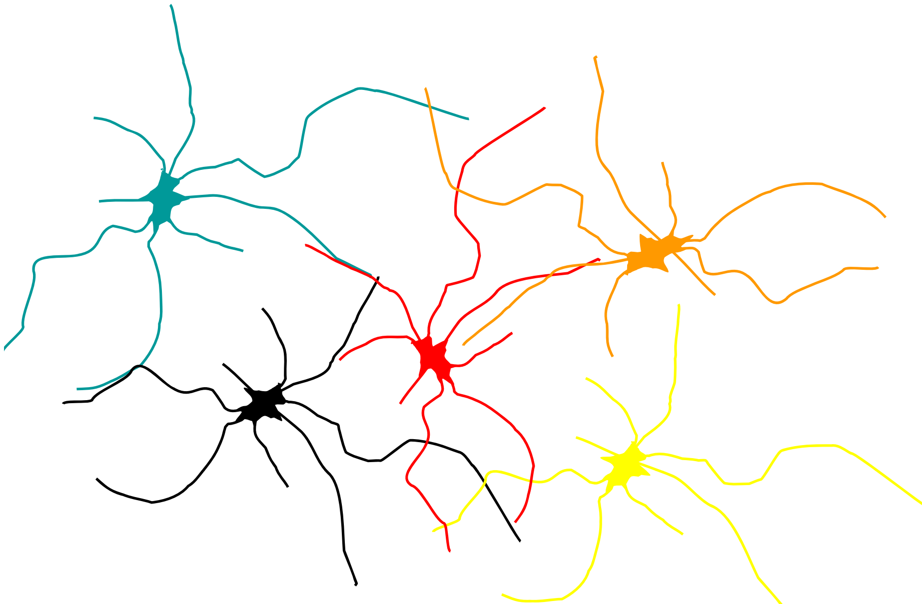


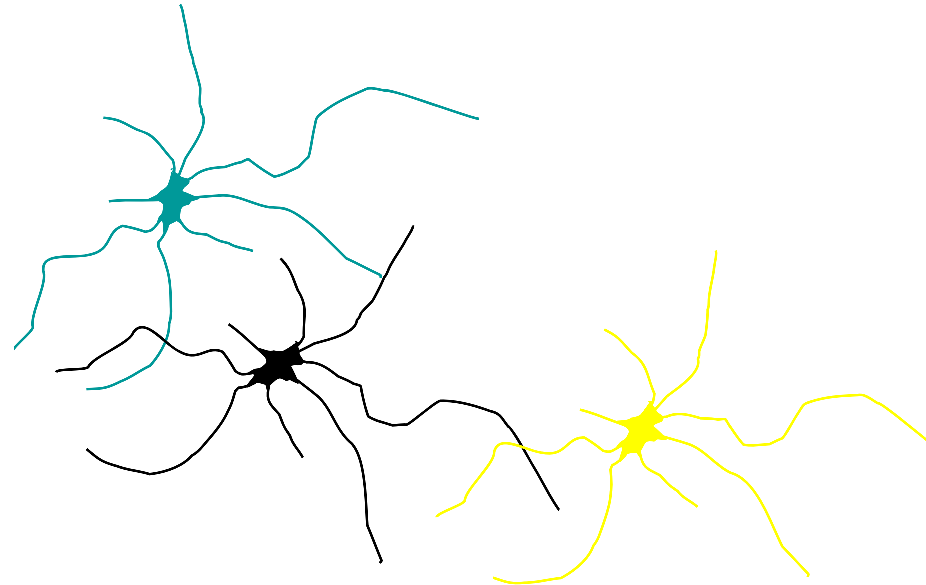
Convergent thinking

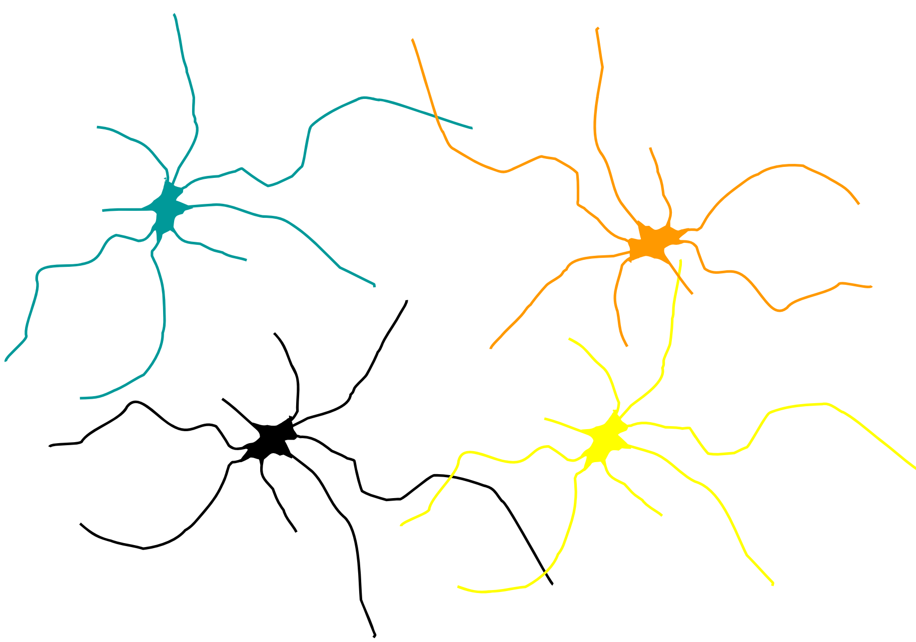
Workshop Processes

- Mind mapping



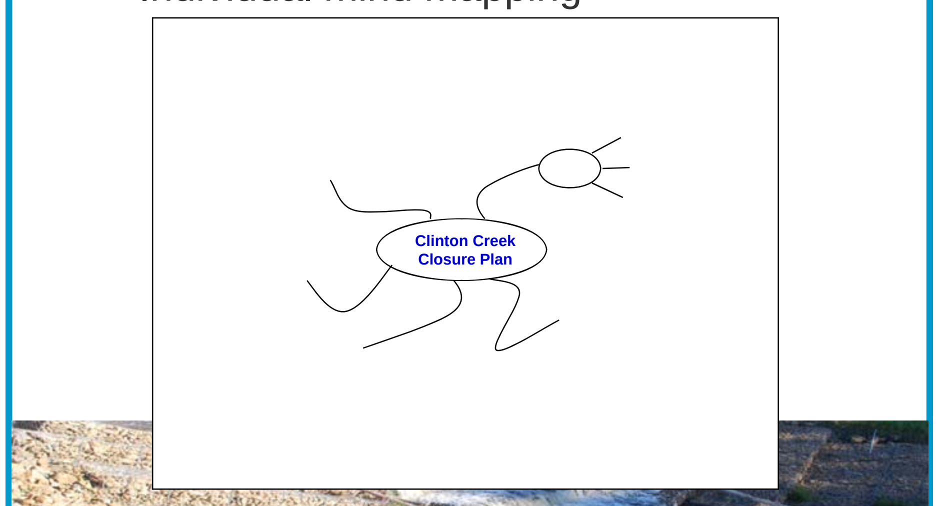






Workshop Processes

- Individual mind mapping



Workshop Terminology

- "Method" means an individual process or action that applies to one component of the project, e.g.:
  - Cover tailings with soil
  - Reslope waste rock to stable landform

Workshop Terminology

- "Scenario" means a combination of methods dealing with all components :
  - Tailings area closure methods
  - Mine area closure methods
  - Other closure requirements
    - Access roads
    - Pit walls
    - Post-closure monitoring
    - Etc.

Workshop Deliverables

- Comprehensive list of potentially applicable methods
- Defensible selection of options most worthy of further consideration
- Initial analysis of major options
- Scopes of work for resolving remaining uncertainties

Common Understanding

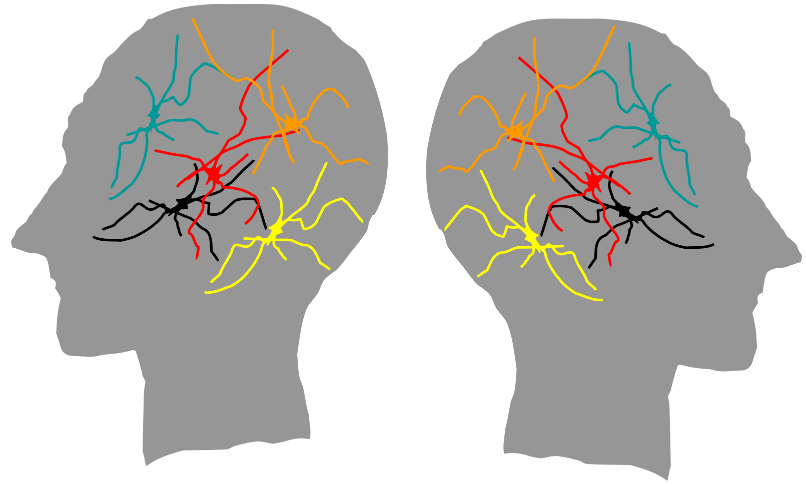
- Presentations
  - Five short presentations
    - Site overview – Dirk
    - Project overview – Rachel
    - Waste rock & Clinton Creek – Ken
    - Tailings & Wolverine Creek - Ken
    - Water quality & asbestos - Michelle

Identify Methods

- "Method" means an individual process or action that applies to one component of the project, e.g.:
  - Cover tailings with soil
  - Reslope waste rock to stable landform

Identify Methods

- Group mind mapping



Group Mind Mapping

- Evaluation Factors
  - What will you be looking for when the draft Clinton Creek Closure Plan appears on your desk?

Identify Methods

- Tailings
- Wolverine Creek
- Waste rock
- Clinton Creek
- Access road
- Other

Identify Methods

- Convergent thinking
  - Same methods
  - Similar methods
  - Variants of another method
  - Different but with same effects

Workshop Terminology

- "Scenario" means a combination of methods dealing with all components :
  - Tailings area closure methods
  - Mine area closure methods
  - Other closure requirements
    - Access roads
    - Pit walls
    - Post-closure monitoring
  - Post-closure requirements

Develop Scenarios

- Four groups
  - Each group will develop one scenario

Develop Scenarios

- Four scenarios
  - Cover the range of outcomes
  - Include variety of methods

Develop Scenarios

- All steps – record reasoning
- Fill out 3M sheets
  - Scenario Name
  - Objectives
  - Scoping level description
  - Costs
  - Consultation, assessment & licensing needed
  - Expected performance
    - Pro's & con's

Develop Scenarios

1. Select objectives
2. Select methods
3. Complete scoping level descriptions
4. Assess costs
5. Evaluate your own scenario

Develop Scenarios

Step 1 - Select objectives

- Consider
  - Post-closure land use
  - Level of post closure management
  - Scenario <u>must</u>
    - Meet reasonable standards of environmental protection
- Choose a catchy name for your scenario

Develop Scenarios

Step 2 – Select methods

- Choose methods appropriate for your theme
  - Refer to lists compiled this morning
  - Use the group’s expertise
  - Record reasoning

Develop Scenarios

Step 3 – Complete scoping level description

- Closure actions
  - Tailings & Wolverine Creek
  - Waste rock & Clinton Creek
  - Other
- Post-closure actions
  - Monitoring
  - Maintenance
  - Water management
  - Site management

Develop Scenarios

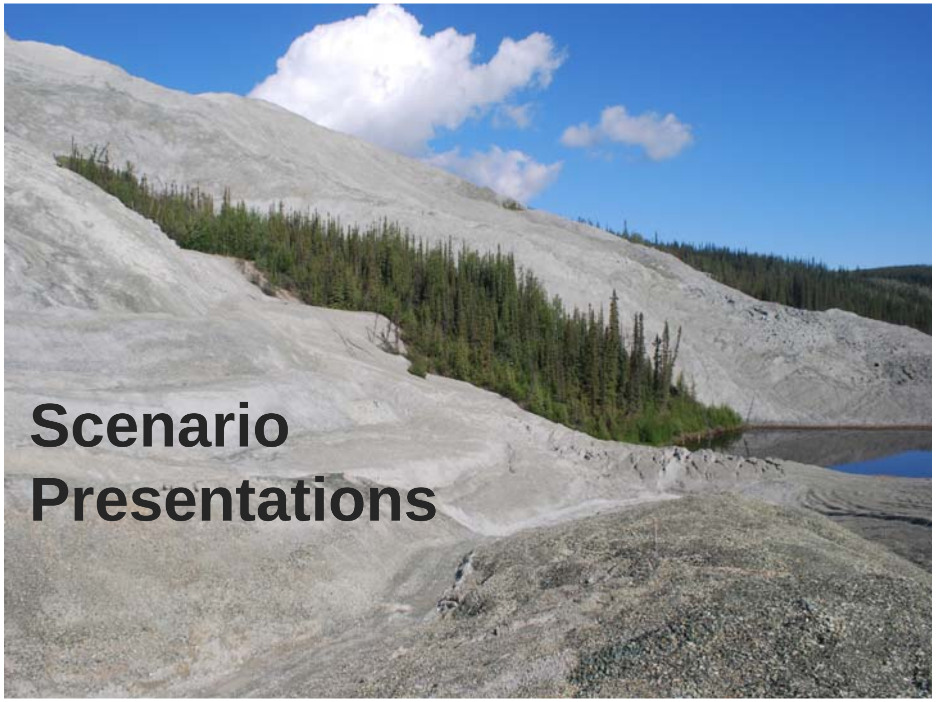
Step 4 – Assess Requirements

- Permitting and compliance requirements
- Schedule and cost estimate

Develop Scenarios

Step 5 – Evaluate your own scenario

- List pro’s and con’s
- List risks and opportunities



Specific Goals

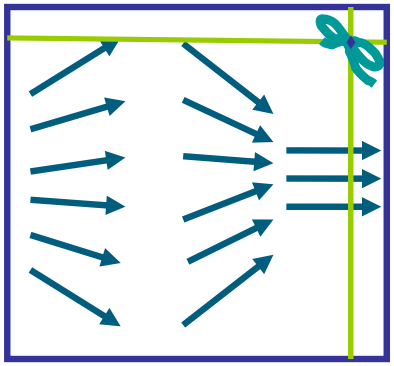
- Review all possible options
- Identify the options most worthy of further consideration
- Prioritize investigations and activities for next few months

Workshop Context

Operations & Regulatory Reviews

Interim Stabilization Actions

Ongoing changes and discussions



Further Studies & Consultation

Final Closure Plan

Final Design & Construction

Agenda Overview

- Tuesday
  – Common understanding
  – Identify possible methods
  – Develop complete scenarios
- Wednesday
  – Review scenarios
  – Identify critical information gaps
  – Define and prioritize steps to resolve them

Present and Assess Scenarios

- Presentations
- Questions (debates)
- Improvements
- Individual assessments

Specific Goals

- Review all possible options
- Identify the options most worthy of further consideration
- Prioritize investigations and activities for next few months

Information needs

- Individual brain-storming
- Round table discussions
  - Further assessments, investigations, studies, research
- Study designs by specialist groups
- Prioritization by multi-disciplinary groups

Study Designs

- Title
- Objective
- Scope of work
- Schedule
- Cost

Title: ***Hijdfh Erhtod Rigkfdd***

Objective:
O8t;oi.kkhvl.kufc.jf.kuf.kuf.lo;oih; oi;ioh; oi. lo8ugfl kulugtflku, uv.glikgu;u.

Task	Time	Cost
Sgtliulsulu luslug;u g;og; a 'oiiya ' s;ugs ;uhg s;llih	*3 mo.*	*$ 20k*
Ld;audh ;alihl;/asli/. 'dsiih /aslidhd '/lasii d/A /ad 'lihd .	*6 mo.*	*$ 40k*
Ld;audh ;alihl;/asli/. 'dsiih /aslidhd '/lasii d/A /ad 'lihd .	*15 mo.*	*$150k*
Total	*2 yrs.*	*$210k*

Study Priorities

- Multi-disciplinary groups

Specific Goals

- Review all possible options
- Identify the options most worthy of further consideration
- Prioritize investigations and activities for next few months

Workshop Objectives

- Seek input into final closure plan for the Clinton Creek mine
- Develop options that can be taken through more detailed assessments and consultation


Thank You

Appendix C
Scenarios Description

Appendix C

Closure Scenarios

Group 1 – Traditional Use Scenario

Objectives:

1. Enable traditional land use
2. Reduce risk of catastrophic flood event

Waste rock/Clinton Creek

- Relocate top of waste rock onto Porcupine Pit and Hudgeon Lake
- Regrade waste rock pile
- Construct new channel for Clinton Creek
- Provide fish ladders @ drop structures
- Fill-in existing channel

Reasoning: reduce risk of flood due to breach; reduce waste rock movement; create a stable channel for Clinton Creek; restore fish passage into Hudgeon Lake

Tailings/Wolverine Creek

- Leave tailings as is
- Construct settling pond on Wolverine Creek u/s road (dredge as required – annually?)
- Consider promoting revegetation of tailings
- Maintain rip-rap channel

Reasoning: avoid disturbing 'crust' (for public/worker safety); reduce (asbestos and metal) contamination of receiving environments; avoid channel breach

Other: minimal road maintenance; dig ditch on hillside of road; add culverts @ low spots

Reasoning: low maintenance costs and low sedimentation

Post-closure Actions:

- Monitoring (water quality, air quality, slope movement) usage
- Inspect after high flow event and repair as required

Requirements:

- DFO approval, YESSA
- 5 years ~ $30M ++?

Pros:

- Site closure

- Low risk of breach
- Restore fish passage
- Reduce contamination (from Wolverine Creek)
- Stimulate local economy
- Mollify DFO, First Nations and Community

Cons:

- Expensive
- Not fully rehabilitated (tailings, Clinton Creek slope)
- Worker health and safety risks

- -

Group 2: Let's Lower Le Lac Dewatering to Success

Objectives:

1. Retain use of the site by people
2. Ensure site has a level of aquatic productivity equal to or greater than pre-mining levels
3. Risk-based, short and long term, cost effective approach
4. "Societal/Stakeholder" acceptance of scenario

Methods:

A: Waste Rock

- Sequential removal of drop structures, creek to follow existing alignment, reduction of lake level/area and water volume, increase crest width (all within an adaptive management process)
- Sequential removal of drop structures:
    - Step 1: siphon to lower lake
    - Removal structure including pulling back waste rock and widening crest as required
    - Monitor: revegetation, waste rock exposure/performance, water flow and behavior
    - Continue other monitoring and maintain gabions
    - After 4 years, evaluate and use insight to plan next step
    - Ideally, remove one drop structure every 5 years

B: Tailings

- Monitor and develop trigger levels for remedial action, otherwise status quo
- Monitor tailings movement and status of rock-line channel
- Develop trigger levels for remedial action
- Water quality monitoring

C: Other

- Remove ld power lines, adequate signage for safety around pits, access/control plan

- Clinton Creek/Porcupine/wolverine confluence wetlands
- Careful placement of relocated materials (waste rock and tailings) to reduce conflicts/influences
- Clinton Creek power supply lines along creek remove
- Pits
  - Adequate signage
  - Develop and implement access controls

Requirements Permitting:

- Land use
- Water license
- DFO letter of advice or authorization
- Consultation/benefit agree with FN

Schedule and Cost

- 20-25 years
- Estimate ~ 25 million (not DCF)

Pro:

- Meets site access objective
- Ample opportunity to meet aquatic objective
- Progressive reduction of risks of catastrophic releases from Lac La Hudgeon
- Adaptive management allows continual reassessment of risks

Con:

- Uncertainty of outcomes
- Long-term maintenance and monitoring
- May need to adjust tailings strategy in the future

Group 3

Objective:

Eliminate to the extent possible the potential for a catastrophic failure and arrive at a closure plan with manageable risk and minimal maintenance.

Waste Rock Dump:

Least Effort/Cost Option

- Long-term maintenance of Gabion drop structures
- Replace Gabion drop structures when necessary (every 10-15 years)
- Continue maintenance
- Incorporate fish passage with first replacement

- Follow long-term performance monitoring protocol (trigger levels)
- Maintain site access
    - 40 Mile River bridge
    - Public awareness
- Potential quarry for long-term fill source

Cost:

- $13M now or $400K per year

Schedule:

- In place now

Pros:

- Lowest upfront cost
- Local economic benefit

Cons:

- Highest long-term cost
- Does not reduce risk beyond today
- No short-term change in fish passage

Tailings:

Method:

- Rock drains at toe of north and south lobes
- Emergency spillway above drain
- Develop understanding of failure mechanism to design to fill
    - Drilling
    - Instrumentation
    - Monitoring
    - Stability analysis
- Could regrade/cover tailings in conjunction with rock drains
- Maintain existing rock-lined channel
- Channel improvements and culvert replacement at road crossing
- Need to source rock
    - Quarry
    - Porcupine Creek waste rock dump (water quality?)
    - Evaluate channel bed material between rock-lined channel and road – is cover or excavation of tailings necessary?

Monitoring and Maintenance:

- Monitor water levels upstream of tailings and rock drain
- Periodic dredging of debris removal of inlet to rock drain
- Maintain site access
- Monitor and maintain rock-lined channel as required – vegetation
- Surface water quality

Cost:

- Lowest capital cost $6M?
- Care and maintenance $50K per year (includes necessary OHS)

Schedule:

- Year 1 – investigations
    - Stability
    - Rock source
    - Year 1 to 2 – monitor
      DECISION
    - Year 2 – design and permits
    - Year 3 – construction
      TOTAL = 3 YRS FROM TODAY

Permitting:

- Water license
- YESAA

Pros:

- Robust/redundancy in design
- Relatively low cost to significantly decrease risk (assume status quo not acceptable)
- Possibility to add cover and revegetate later
- Local economic stimulus (long-term)

Cons:

- Long-term maintenance requirements

Group 4

Objectives:

1. Protect human health and safety
2. Cost effectiveness

3. Protection of fish habitat (existing or enhanced)
4. Maintain current levels with land use activities

Waste Rock

Methods:

- Stabilize/regrade waste rock
  - Downstream
  - Hudgeon Lake
  - Porcupine Pit
- Maintain existing channel for overflow in flood events
- Design/install longer-flatter channel over waste rock for fish habitat
- Less risk for catastrophic flood
- Maintain current lake level of minimal lowering

Closure Actions:

- Geotechnical investigation to determine sub-surface waste rock stability
- Determine alignment and gradient of channel to determine optimal level of lake; cost effectiveness; waste rock relocation
- Cover open asbestos fibers in snowshoe pit
- Local quarry supply rip-rap for lined channel
- Construction challenges are anticipated if lake level is lowered
- Evaluate benefit of lowering lake level vs. new channel construction
- Regrade of steep sloes
- Revegetate by natural means
- Ditch berm around steep sections of pit
- Control of access (public, local, recreational) during/post construction
- Sediment controls/monitoring

Tailings:

Methods:

- Clean-up of north and south lobes
- Armour north and south lobe channel with large rock (drain)
- Channel over top for over flow
- Cover top end of tailings and revegetate

Closure Actions:

- Design/install access road to tailings lobe
- Geotechnical investigation for regarding lobe areas/rock drain inspection
- Locate quarry – supply rip-rap
- Excavate tailings to place rock drain

- Airborne asbestos abatement plan
- Sediment controls and monitoring
- Cover top end of tailings with local till/revegetate
- Earth berm at top to prevent tailings contact/promote planned run-off

Gaps:

- Do tailings add unacceptable contaminants loading to Clinton Creek habitat?
- Can fish survive the contaminant load?
- Is current airborne asbestos from tailings H H risk for site?

Post Closure:

Monitoring:

- Waste rock and tailings movement
- Creek channel profiles
- Regular inspections/remote monitoring
- H_2O quality – productivity + H of invertebrates and fish
    - New channel and downstream

Maintenance:

- Channel repairs
- Site access maintenance

Other:

- Signage
- Traffic counts
- Weather stations
- Public access restriction?

Schedule and Costs:

- 2010 ($1-2M)
    - Geotechnical investigations
    - Source rock supply
    - Stability modeling
    - Hudgeon Lake (confirm ability to support fish? Data gaps? Bathymetry?)
    - Baseline biological monitoring in Fortymile R
    - Water and sediment toxicity tests
    - Spatial sediment chemistry assessment
    - Air quality monitoring relative to utilization
- 2011 ($1M)
    - Detailed design
    - Permitting/approvals

  - Public consultation
  - Start tendering?
- 2012 ($20-30M)
  - Tender and start construction
  - 3 year window

Permitting and Compliance:

- Fisheries Act Authorization
- H_2O License A or B
- YESAA Consultation
- YWC Act – Asbestos Abatement Plan

Pros:

- Reduced risk of catastrophic failure
- Improved fish habitat
  - Reduced contaminant and asbestos loading from waste rock and tailings
  - Fish access to Hudgeon Lake
- Reduced human health risk
  - Asbestos fibers covered in Snowshoe Pit
  - Partial cover of tailings (top of tailings piles and cover of impacted areas of Wolverine Creek as result of road building activities)
  - Reduced potential of asbestos dust from downgradient sedimentation
- Economic driver – employment
- Cost – not most expensive option?

Cons:

- Cost
- Continued limited habitat in Hudgeon Lake (low O_2 level)
- Partially exposed tailings remain
- No improvements to habitat in Wolverine Creek