

APPENDIX 1 ALTERNATIVE OPTIONS

The remediation option alternatives discussed in this appendix were refined from the following primary remediation options summarized in Table 1.

Table 1 Primary Remediation Options with Alternatives

Primary Option	Components	Alternatives
Clinton Creek		
B	CC-2 / WR-3 / HL-1	B2: Replace eight proposed gabion drop structures with riprap channel
C	CC-4 / WR-1 / HL-1	C2: Replace eight proposed gabion drop structures with riprap channel C3: Replace eight proposed and four existing gabion drop structures with riprap channel
D	CC-4 / WR-3 / HL-1	D2: Replace eight proposed gabion drop structures with riprap channel D3: Replace eight proposed and four existing gabion drop structures with riprap channel
E	CC-G / WR-3 / HL-3	E2: Shift alignment away from north valley wall to mitigate slope stability concerns E3: Shift alignment away from north valley wall and armour channel
I	CC-2 / WR-3 / HL-1	I2: Replace eight proposed gabion drop structures with riprap channel
Wolverine Creek		
D	WC-3 and WC-7 / T-5	D2: Lower waste rock cover of tailings pile base to 415 m, backfill Wolverine Creek upstream of tailings to 412 m, and eliminate rock drain
E	WC-3 and WC-7 / T-2 and T-3	E2: Backfill Wolverine Creek upstream of tailings to 419 m, and eliminate rock drain

The remediation option alternative designs are shown on drawings in Appendix 2 and described in the following sections.



1. CLINTON CREEK REMEDIATION OPTION ALTERNATIVES

1.1 Option B2 - CC-2 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option B2 is the same as for Option B except that the eight gabion drop structures would be replaced with a 300-m long riprap channel. The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 8% and would be armoured with heavy rock riprap with a median diameter of 800 mm. Figure 1 shows a typical channel section.

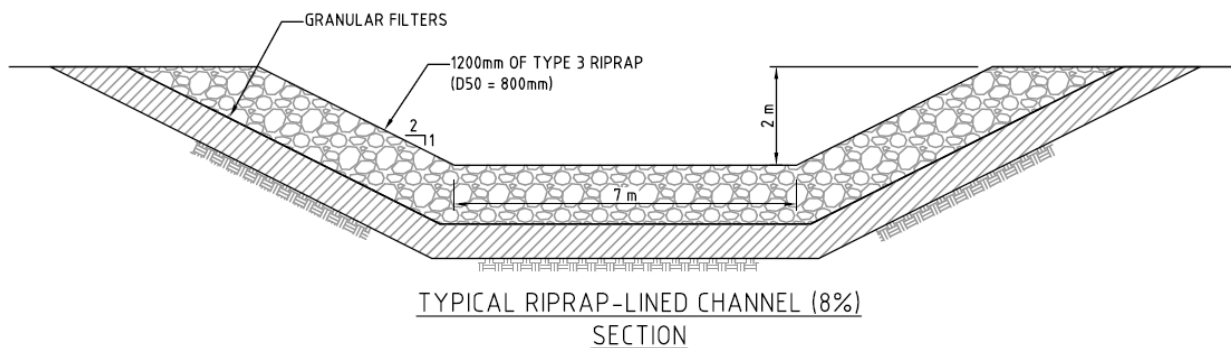


Figure 1 Clinton Creek Option B2 - Typical 8% Grade Riprap-Lined Channel

The construction schedule of the riprap-lined channel is expected to be similar to that provided for the gabion drop structures from Option B.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.

1.2 Option C2 - CC-4 / WR-1 / HL-1

The scope of work for Clinton Creek Remediation Option is the same as for Option C except that the eight proposed gabion drop structures (i.e., downstream of Drop Structure No. 4) would be replaced with a 550 m-long riprap channel. The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 4.5% and would be armoured with heavy rock riprap with a median diameter of 500 mm. Figure 2 shows a typical channel section.

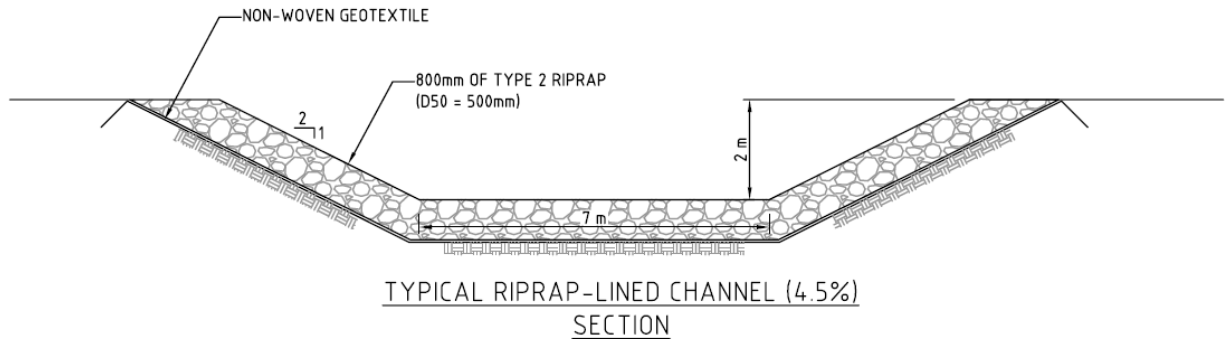


Figure 2 Clinton Creek Option C2 - Typical 4.5% Grade Riprap-Lined Channel

The construction schedule of the riprap-lined channel is expected to be similar to that provided for the gabion drop structures from Option C.

Regular visual inspections and surveys of the riprap-lined channel would be required. The ongoing movement of the waste rock dump would deform the channel, necessitating its replacement approximately every 45 years, as discussed in Section 3.3.10 of the report.

1.3 Option C3 - CC-4 / WR-1 / HL-1

The scope of work for Clinton Creek Remediation Option is the same as for Option C except that the eight proposed and four existing gabion drop structures would be replaced with a 750 m long riprap channel. The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 4.5% and would be armoured with heavy rock riprap with a median diameter of 500 mm. Figure 3 shows a typical channel section.

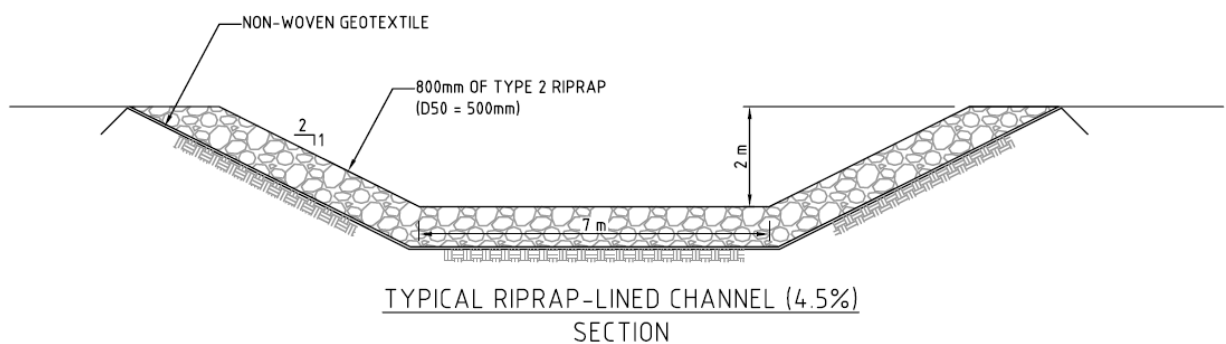


Figure 3 Clinton Creek Option C2 - Typical 4.5% Grade Riprap-Lined Channel



The construction schedule of the riprap-lined channel is expected to be similar to that provided for the gabion drop structures from Option C.

Regular visual inspections and surveys of the riprap-lined channel would be required. The ongoing movement of the waste rock dump would deform the channel, necessitating its replacement approximately every 45 years, as discussed in Section 3.3.10 of the report.

1.4 Option D2 - CC-4 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option D2 is the same as for Option D except that the eight proposed gabion drop structures (i.e., downstream of Drop Structure No. 4) would be replaced with a 550 m-long riprap channel. The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 4.5% and would be armoured with heavy rock riprap with a median diameter of 500 mm. Figure 4 shows a typical channel section.

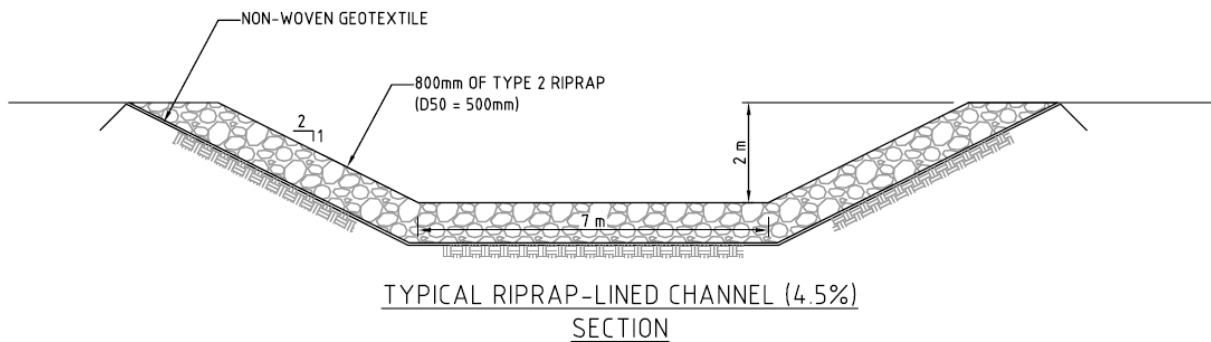


Figure 4 Clinton Creek Option D2 - Typical 4.5% Grade Riprap-Lined Channel

The construction schedule of the riprap-lined channel is expected to be similar to that provided for the gabion drop structures from Option D.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.

1.5 Option D3 - CC-4 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option D3 is the same as for Option D except that the eight proposed and four existing gabion drop structures would be replaced with a 750 m-long riprap channel. The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 4.5% and would be armoured with heavy rock riprap with a median diameter of 500 mm. Figure 5 shows a typical channel section.

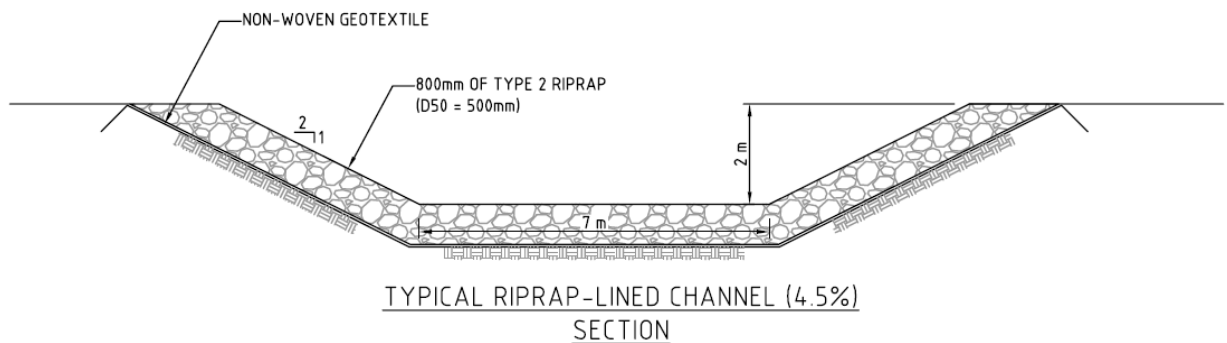


Figure 5 Clinton Creek Option D3 - Typical 4.5% Grade Riprap-Lined Channel

The construction schedule of the riprap-lined channel is expected to be similar to that provided for the gabion drop structures from for Option D.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.

1.6 Option E2 - CC-4 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option E2 is the same as for Option E except that the upstream portion of the channel alignment is shifted further to the south, away from the north valley wall. The channel was shifted horizontally approximately 2.5 m for each 1 m that the channel is lowered. The intent of this change is to mitigate potential slope stability concerns of Option E, and thereby reduce the contingency allowance from 50% to 25%. Figure 6 shows the revised alignment of the lowered section of channel.

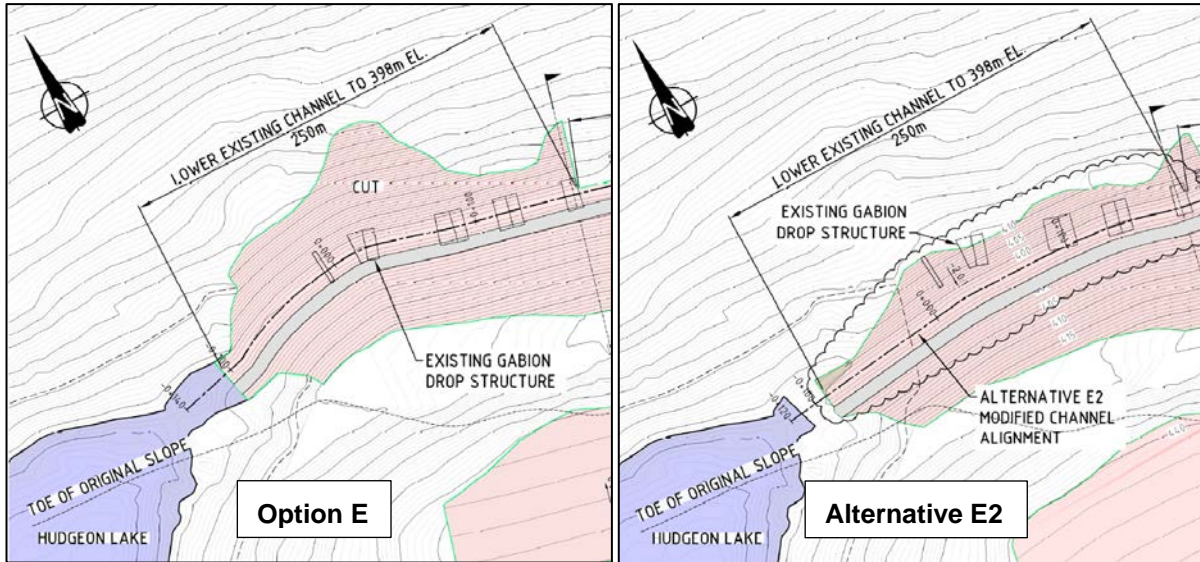


Figure 6 Clinton Creek Option E2 - Modified Channel Alignment

It should be noted that, while a significant portion of the lowered channel is expected to be in bedrock for Option E, almost none of the lowered channel is expected to be in bedrock for Option E2; however, this is not considered to be an issue as channel erosion in the lowered section should be negligible due to the very mild longitudinal slope.

The construction schedule and maintenance requirements will be similar to those provided for Option E.

1.7 Option E3 - CC-4 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option E3 is the same as for Option E2 except that the 550 m of channel downstream of the lowered channel (i.e. the existing Drop Structure No. 4 location) would be armoured with riprap. The intent of this alternative is to mitigate long-term channel erosion that could destabilize the adjacent waste rock dump.

The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 4.5% and would be armoured with heavy rock riprap with a median diameter of 500 mm. Figure 7 shows a typical channel section.

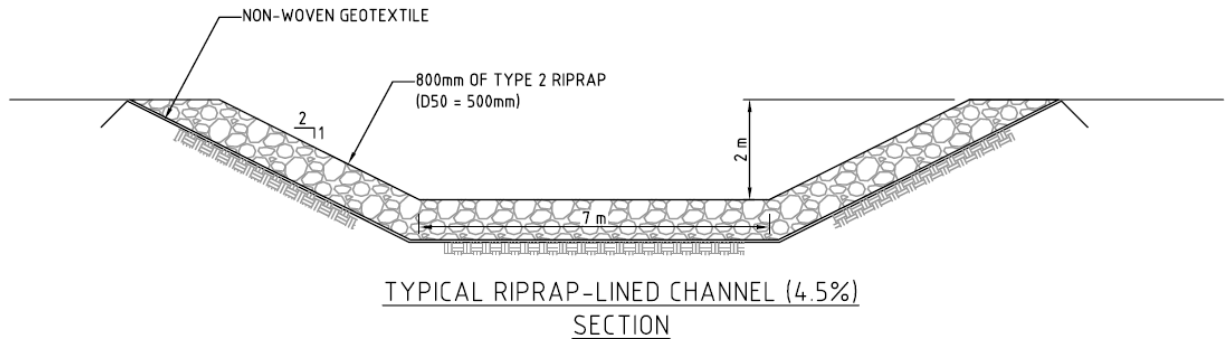


Figure 7 Clinton Creek Option E3 - Typical 4.5% Grade Riprap-Lined Channel

The construction schedule of the riprap-lined channel is expected to be similar to that provided for the channel excavated to bedrock from Option E.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.

1.8 Option I - CC-2 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option I is the same as for Option B except that the new channel alignment would be shifted further north to reduce waste rock excavation volumes. The revised alignment is approximately 50 m south of the existing Clinton Creek channel alignment. The total estimated waste rock excavation volume for Option I is between that for Option D (maintain existing channel alignment) and Option B.

The earthworks component of the construction schedule is considerably shorter than that provided for Option B due to the elimination of approximately 1,300,000 m³ of waste rock excavation. Construction of the riprap channel and gabion drop structures in Option I would be essentially the same as in Option B.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.



1.9 Option I2 - CC-2 / WR-3 / HL-1

The scope of work for Clinton Creek Remediation Option I2 is the same as for Option I except that the eight gabion drop structures would be replaced with a 300 m-long riprap channel. The channel would be 7 m wide, 2 m deep, and be able to convey an estimated 200-year peak discharge of 44.5 m³/s. The channel would have a grade of approximately 8% and would be armoured with heavy rock riprap with a median diameter of 800 mm. Figure 8 shows a typical channel section.

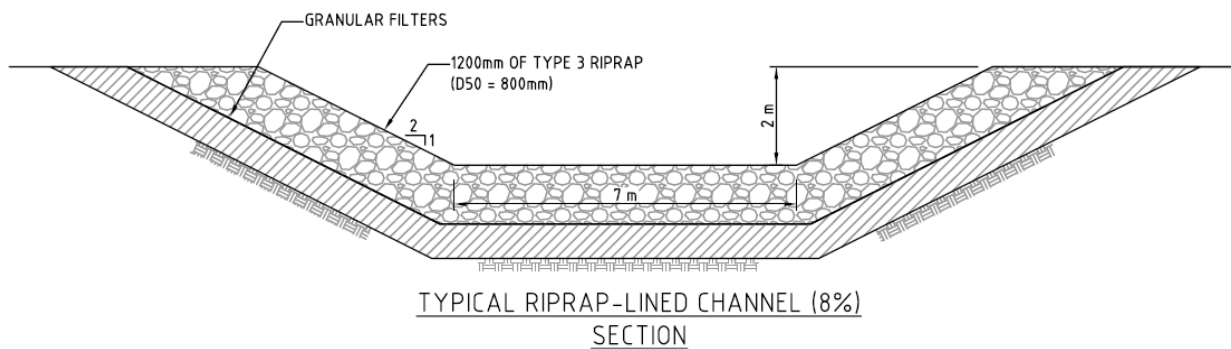


Figure 8 Clinton Creek Option I2 - Typical 8% Grade Riprap-Lined Channel

The construction schedule of the riprap-lined channel is expected to be similar to that provided for the gabion drop structures from Option I.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.

2. WOLVERINE CREEK REMEDIATION OPTION ALTERNATIVES

2.1 Option D2 - WC-7 / T-5

The scope of work for Wolverine Creek Remediation Option D2 is the same as for Option D except for the following changes:

- The waste rock cover over the tailings pile base would be lowered from a top elevation of 422 m to a top elevation of 415 m;
- Wolverine Creek upstream of the tailings would be backfilled to an elevation of 412 m to reduce the ponded water depth, mitigating the potential for a dam classification under the Canadian Dam Association (CDA); and
- The rock drain would be eliminated.

The intent of Wolverine Creek Option D2 is to estimate impact to the Option D LCC of reducing the elevation of the waste rock cover over the tailings pile base and to backfilling Wolverine Creek instead of constructing a rock drain. The reduced waste rock cover elevation of 415 m was not optimized, since no stability analysis was completed. However, it is the suggested minimum elevation in order to achieve a meaningful reduction in tailings movement.

It should be noted that Wolverine Creek was backfilled to one metre below the invert elevation of the armoured channel through the waste rock cover. This is based on the assumption that some ponding of water upstream is acceptable, as long as a dam classification under the CDA is avoided.

The construction schedule of and operational requirements of Option D2 are similar to those of Option C.

2.2 Option E2 - WC-7 / T-2 & T-3

The scope of work for Wolverine Creek Remediation Option D2 is the same as for Option D except for the following changes:

- Wolverine Creek upstream of the tailings would be backfilled with tailings and capped with waste rock to an elevation of 419 m to reduce the ponded water depth, mitigating the potential for a dam classification under the CDA; and
- The rock drain would be eliminated.

The intent of Wolverine Creek Option E2 is to estimate impact to the Option E LCC of backfilling Wolverine Creek instead of constructing a rock drain. Unlike Option D2, the originally proposed tailings pile base elevation of 422 m was maintained to comply with UMA's (2003b) recommendations for tailings stabilization.

It should be noted that Wolverine Creek was backfilled to one metre below the invert elevation of the armoured channel through the waste rock cover. This is based on the assumption that some ponding of water upstream is acceptable, as long as a dam classification under the CDA is avoided.

The construction schedule of Option E2 is shorter than that of Option E due to elimination of the rock drain.

Regular visual inspections and surveys of the riprap-lined channel would be required; however, no regular maintenance or replacement of the channel is expected, assuming that the waste rock is adequately stabilized and the channel is properly constructed using high quality, durable riprap.



3. REMEDIATION OPTION ALTERNATIVES - ESTIMATED LIFE CYCLE COSTS

The life cycle cost estimates, including estimated capital costs (CAPEX); operational costs (OPEX), and life cycle costs are summarized in Table 2 and Table 3. Operational costs are presented as the equivalent annual cost (EAC) of operation. Life cycle costs are presented as the net present cost (NPC) of construction and operation over 50-year and 100-year durations at the preferred real discount rate of 2.5% per year.

Table 2 Clinton Creek Remediation Option Alternatives - Estimated Life Cycle Costs

Option	Description	CAPEX	OPEX (EAC)	50-year LCC (NPC)	100-year LCC (NPC)
B2	<u>CC-2 / WR-3 / HL-4</u> Same as Option B but replacing the eight proposed gabion drop structures with a riprap channel	\$39M	\$0.04M	\$40M	\$41M
C2 ¹	<u>CC-4 / WR-1 / HL-1</u> Same as Option C but replacing the eight proposed gabion drop structures with a riprap channel	\$17M	\$0.03M	\$27M	\$29M
C3 ¹	<u>CC-4 / WR-1 / HL-1</u> Same as Option C but replacing the eight proposed and four existing gabion drop structures with a riprap channel	\$18M	\$0.09	\$20M	\$21M
D2 ¹	<u>CC-4 / WR-3 / HL-1</u> Same as Option D but replacing the eight proposed gabion drop structures with a riprap channel	\$21M	\$0.02M	\$28M	\$30M
D3	<u>CC-4 / WR-3 / HL-1</u> Same as Option D but replacing the eight proposed and four existing gabion drop structures with a riprap channel	\$22M	\$0.04M	\$23M	\$23M
E2	<u>CC-5 / WR-3 / HL-3</u> Same as Option E with upstream channel re-alignment	\$25M	\$0.04M	\$26M	\$27M
E3	<u>CC-5 / WR-3 / HL-3</u> Same as Option E2 but constructing a riprap channel downstream of the lowered section	\$27M	\$0.04M	\$28M	\$29M
I ¹	<u>CC-4 / WR-3 / HL-1</u> Same as Option B but shifting the new channel north to reduce excavation	\$27M	\$0.40M	\$39M	\$42M

**ENERGY, MINES AND RESOURCES: ASSESSMENT AND ABANDONED MINES
CLINTON CREEK SITE
LIFECYCLE COST ANALYSIS FOR REMEDIATION OPTIONS**

Option	Description	CAPEX	OPEX (EAC)	50-year LCC (NPC)	100-year LCC (NPC)
I2	<u>CC-4 / WR-3 / HL-1</u> Same as Option I but replacing gabion drop structures with a riprap channel	\$29M	\$0.04M	\$30M	\$31M

¹Note: The long-term operational requirements associated with this option necessitate maintenance of the 15 km site access road between the Fortymile River Bridge and the former Clinton Creek Mine site. These costs are not included in the OPEX and LCC estimates shown. Refer to Section 7.1 of the main report for these additional costs.

Table 3 Wolverine Creek Remediation Option Alternatives - Estimated Life Cycle Costs

Option	Description	CAPEX	OPEX (EAC)	50-year LCC (NPC)	100-year LCC (NPC)
D2 ¹	<u>WC-7 / T-5</u> Providing a cover over the tailings pile base; constructing an armoured channel through the cover	\$17M	\$0.11M	\$20M	\$21M
E2	<u>WC-7 / T-2 & T-3</u> Stabilizing the tailings pile; providing a cover over the tailings pile base; constructing an armoured channel through the cover	\$35M	\$0.05M	\$36M	\$37M

¹Note: The long-term operational requirements associated with this option necessitate maintenance of the 15 km site access road between the Fortymile River Bridge and the former Clinton Creek Mine site. These costs are not included in the OPEX and LCC estimates shown. See section below for the cost of maintaining site access.