

INDIAN AND NORTHERN AFFAIRS CANADA

**ABANDONED CLINTON CREEK ASBESTOS MINE
ENVIRONMENTAL LIABILITY REPORT**

DRAFT
Prepared for:

Indian and Northern Affairs Canada

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UMA Job No. 4440 038 02

May 2002

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June 5, 2002

File: 2520-160-04-02

Indian and Northern Affairs Canada
345 – 300 Main Street
Whitehorse, Yukon
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Attention: Mr. Brett Hartshorne

Reference Abandoned Clinton Creek Asbestos Mine – Environmental Liability

Enclosed are 3 copies of our draft report summarizing the environmental liability associated with the abandoned Clinton Creek Asbestos Mine, Yukon Territory. Since abandonment of the Clinton Creek Asbestos Mine in the Yukon Territory, concerns have been raised with respect to the physical condition of the site, in particular downstream hazards associated with landslide dams created from unstable waste rock and tailings piles. In areas of significant relief such as the mine site location, flooding from failures of channel blockages can be especially dangerous and their occurrence can be unrelated to normal precipitation events that would be expected to produce flooding conditions. Existing and future conditions at the abandoned Clinton Creek Asbestos Mine potentially expose individuals, property and the environment to some degree of risk associated with flooding, downstream sedimentation and transport of asbestos fibres.

For the purposes of this report, environmental liability is considered to be the cost associated with the implementation of remedial measures to mitigate i) the risks associated with a catastrophic breach of the waste rock and tailings piles and ii) the environmental concerns from chronic erosion and redistribution of tailings and waste rock downstream of the mine site. Based on the monitoring completed to date, the preferred remedial option to address the landslide blockage at the Clinton Creek Waste Rock Dump is channel stabilization for which the capital construction costs are estimated to be in the range of \$2,500,000 to \$6,000,000 depending on whether stabilization of the waste rock dump is also required. Given the possibility of conditions worsening at the outlet before long term remedial measures are implemented, the stabilization of the creek channel could be staged to allow the most immediate concern (the condition of the outlet) to be addressed prior to construction of the works for the entire length

of the channel. In this regard, the estimated construction costs to stabilize a 150m long section of the channel immediately downstream of the Hudgeon lake outlet is in the order of \$500,000. Although this would be the desirable level of effort for the short-term repairs, construction of the first two gabion drop structures, as a minimum, would significantly reduce the immediate threat of a breach.

The estimated capital costs to mitigate the concerns associated with the tailings piles range from \$5,500,000 to stabilize the tailings and construct a stabilized creek channel to about \$30,000,000 to remove a sufficient amount of the tailings to restore natural creek drainage. It should be noted that the recommended length of short-term repairs is not absolute. Any work undertaken to stabilize the creek channel immediately downstream of the Hudgeon lake outlet it is considered worthwhile. In this regard, the minimum amount of work could be limited to the first one or two drop structures.

Should you have any questions or require any additional information, please contact Ken Skaftfeld, P.Eng.

Yours truly,

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ABANDONED CLINTON CREEK ASBESTOS MINE
Environmental Liability Report

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1 INTRODUCTION

This report summarizes the results of our assessment of the environmental liability associated with the abandoned Clinton Creek Asbestos Mine, Yukon Territory. Significant environmental and physical hazards associated with continued degradation of the Clinton Creek channel through the waste rock dump and the Wolverine Creek channel through the tailings piles have been identified (UMA 2000). Of particular concern is the chronic redistribution of asbestos laden tailings and waste rock from the mine site into the downstream creek channel and potential risks to human life and property downstream of the waste rock dump associated with a sudden breach of the Hudgeon Lake outlet. In areas with significant relief, such as the Clinton Creek valley, flooding from failures of channel blockages can be especially dangerous and unrelated to precipitation events that would normally be expected to produce flooding conditions.

For the purposes of this report environmental liability is considered to be the cost associated with the implementation of remedial measures to mitigate i) the risks associated with a catastrophic breach of the waste rock and tailings piles and ii) the environmental concerns from chronic erosion and redistribution of tailings and waste rock downstream of the mine site. This report presents the functional design of remedial works to stabilize the Clinton Creek channel and the conceptual design remedial measures to mitigate the hazards associated with the chronic erosion and/or a breach of tailings along Wolverine Creek. The conceptual design of remedial measures to mitigate the hazards associated with a breach of the waste rock dump was presented previously (UMA, 2001).

2 HISTORICAL SUMMARY

The abandoned Clinton Creek Asbestos Mine is located about 100 km northwest of Dawson City in the Yukon Territory, 9 km upstream of the confluence of Clinton Creek and the Forty Mile River. The mine consists of three open pits (Porcupine, Creek and Snowshoe), two waste rock dumps (Porcupine Creek and Clinton Creek) along the south side of Clinton Creek, and a tailings pile on the west side of Wolverine Creek (Drawing 01). From 1968 until depletion of economic reserves in 1978, the Cassiar Mining Corporation extracted approximately 12 million tonnes of serpentine ore from the bedrock.

Over 60 million tonnes of waste rock from the open pits was deposited over the south slope of the Clinton Creek valley at what is referred to as the Clinton Creek waste rock dump. The ore was transported by an aerial tramway to the mill located on a ridge along the west side of Wolverine Creek, a tributary of Clinton 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 (Wolverine Creek tailings piles). Since closure of the asbestos mine, concerns have been raised with respect to the physical condition of the site, in particular downstream hazards associated with channel blockages resulting from landslides of the Clinton Creek waste rock dump and Wolverine Creek tailings piles.

3 CLINTON CREEK WASTE ROCK DUMP

Four remediation alternatives to mitigate the hazards associated with a breach of the waste rock dump were presented in UMA's Conceptual Design Report (UMA, 2001). These alternatives and their estimated construction cost were valley restoration (\$30M), conveying creek flow around the waste rock dump via a tunnel (\$20M), conveying creek flow over the waste rock dump within a stabilized channel along the existing alignment (\$7M) and conveying creek flow via an alternate alignment across the middle of the waste rock dump (\$14M). Valley restoration and tunnelling were not contingent on stabilizing the waste rock pile. Channel stabilization included approximately 600,000 m³ of waste rock excavation to achieve a stable geometry. It was also pointed out however, that if continued monitoring confirmed that movement rates of the waste rock were sufficiently small or if movements had terminated, the need to stabilize the waste rock dump should be re-evaluated.

Subsequent to preparation of the Conceptual Design Report, waste rock movement monitoring and a detailed survey of the Hudgeon Lake outlet were carried out in June 2001. Over the two-year period from July 1999 to June 2001, annual horizontal movements ranging from 1 to 11cm were observed, or an average annual rate of 7cm. Over the same time period, the average rate of vertical settlement appears to be in the order of 7 cm. The movements confirm previous observations that waste rock pile movements are small (in comparison to movements prior to 1986) and are perhaps decreasing with time. The horizontal movements are summarized on Figure 3-1. The movements can either be interpreted as small constant strain rates or strain rates that are decreasing with time, and as such are referred to as creep movements (as compared with the large movements observed prior to 1986). There are no signs to indicate strain rates are increasing, observations that would be expected if large movements of the waste rock were imminent. These creep movements may continue at similar strain rates for many more years, and may be susceptible (in the horizontal direction) to channel incising along the north edge of the waste rock. A location plan of all the monitoring points and the survey benchmarks, and the monitoring results for all the waste rock movement monitors are included in Appendix A.

Given the possibility of conditions worsening at the outlet before long term remedial measures are implemented, the stabilization of the creek channel could be staged to allow the most immediate concern (the condition of the outlet) to be addressed prior to construction of the works for the entire length of the channel. This strategy would allow mitigation of the catastrophic breach potential but not the chronic erosion that would occur downstream of the stabilized section. Ideally, the short term works could be incorporated into the overall channel stabilization measures. Details of the channel stabilization works are summarized in the following sections.

3.1 Condition of Existing Channel

The existing channel through the waste rock dump is approximately 800 m long and up to 18 m below the existing road near the middle of the waste rock dump. Side slopes on the waste rock are generally at or steeper than 1 horizontal to 1 vertical (1H:1V). The channel has cut its way into the argillite bedrock from about 350 m downstream of the outlet to the lower reaches of the channel through the waste rock. Although most of the exposed bedrock within the channel has some degree of weathering, the transition between the heavily weathered bedrock and underlying more intact bedrock can be visually identified. For the purposes of this report, the upper heavily fractured unit is referred to as weathered bedrock and the material below as intact bedrock. The weathered material is sloped at approximately the same inclination of the natural valley slope, or about 1.5H:1V (Figure 3-3). The intact rock is nearly vertical. Although the elevation of the contact between the weathered and intact rock has not been surveyed, it can be estimated from photographs and field notes. An estimated profile of the intact bedrock surface is shown on Drawing 03.

A detailed survey of Hudgeon Lake outlet and the first 150 to 200 m of channel downstream of the outlet was carried out in July 2001 to provide the necessary information for design of stabilization measures for this area of the channel. Features picked up during the survey include general topography, channel cross sections and the location of tension cracks and springs. The results of the survey are superimposed on the aerial photo on Drawing 04.

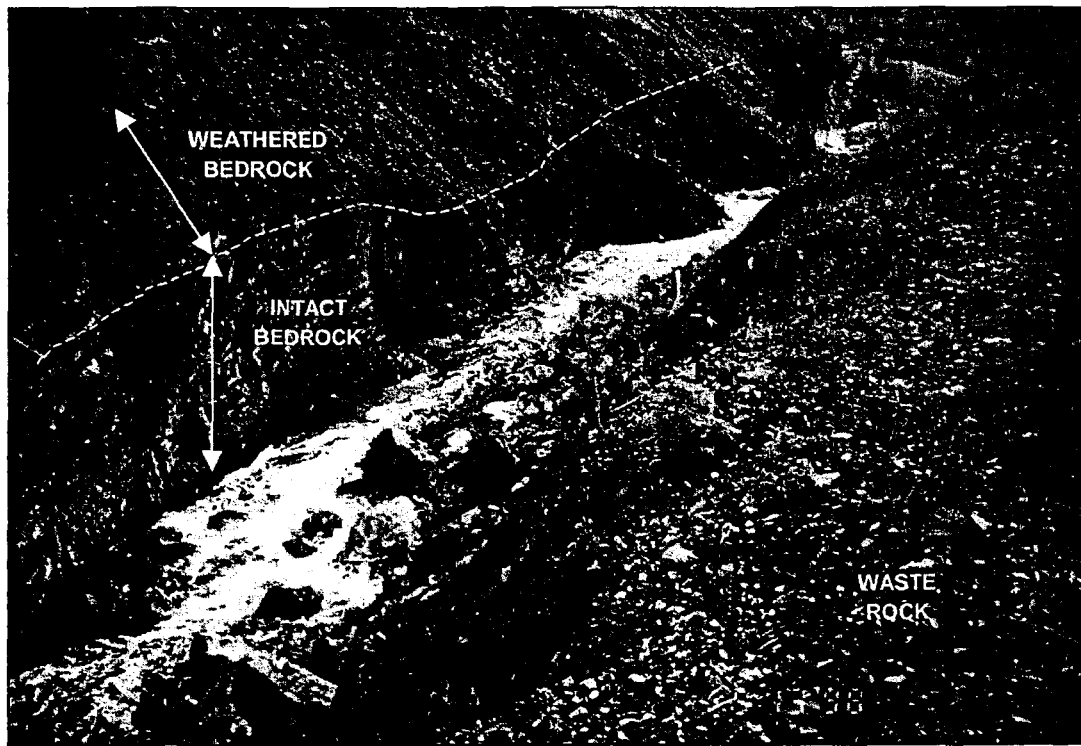


Figure 3-3

Clinton Creek Channel (View Downstream)

3.2 Channel Stabilization

3.2.1 Hydrology

Based on a regional hydrology study (UMA 2000), the 100- and 200-year maximum instantaneous unit discharges can be estimated using Equations 3-1 and 3-2:

Equation 3-1: $q_{100} = 1.4701 \times A^{-0.3117}$

Equation 3-2: $q_{200} = 1.7494 \times A^{-0.3202}$

Where: q_n = instantaneous unit discharge [m^3/s per km^2] for n -year return period and
 A = drainage area [km^2]

4 WOLVERINE CREEK TAILINGS PILE

The environmental and physical hazards associated with continued degradation of the Wolverine Creek channel include the chronic redistribution of asbestos laden tailings and flooding from failures of channel blockages (UMA 2000). A review of the historical information regarding tailings pile movements and the conceptual design of remedial measures to mitigate these hazards are discussed in the following sections.

4.1 Historical Summary

Between 1968 and 1974, tailings were deposited on the upper portion of the west slope of the Wolverine Creek valley (referred to as the south lobe). A failure of the south lobe in 1974 resulted in blockage of natural flow in Wolverine Creek, backing up approximately nine metres of water behind the landslide material (Figure 4-1). In the spring of 1974, a sudden breach of the tailings occurred resulting in a flash flood down Wolverine creek to the confluence with Clinton Creek. The eroded tailings were deposited several metres deep in the creek valley downstream of the tailings. Although the majority of the tailings are believed to have been deposited upstream of the access road, some of the finer material including asbestos fibres entered the Clinton Creek channel where it was deposited possibly as far downstream as the Forty Mile River.

Following failure of the south lobe, a 9 metre deep channel was excavated across the toe of the tailings to facilitate creek flow and a new tailings pile was established north of the failed mass (north lobe). By 1977, the north lobe was showing signs of instability and during the last months of mine operation the tailings were placed in the northwest corner of the north lobe. Partial re-grading of the north and south lobes was undertaken in 1978 and 1979 in an unsuccessful attempt at stabilizing the tailings. In 1978, channel stabilization measures were constructed across the tailings immediately downstream of the south lobe. These measures consisted of a rock-lined channel and a series of rock weirs (Figure 4-2). To date, these measures have performed well although some deterioration was noted during the 2001 site visit.

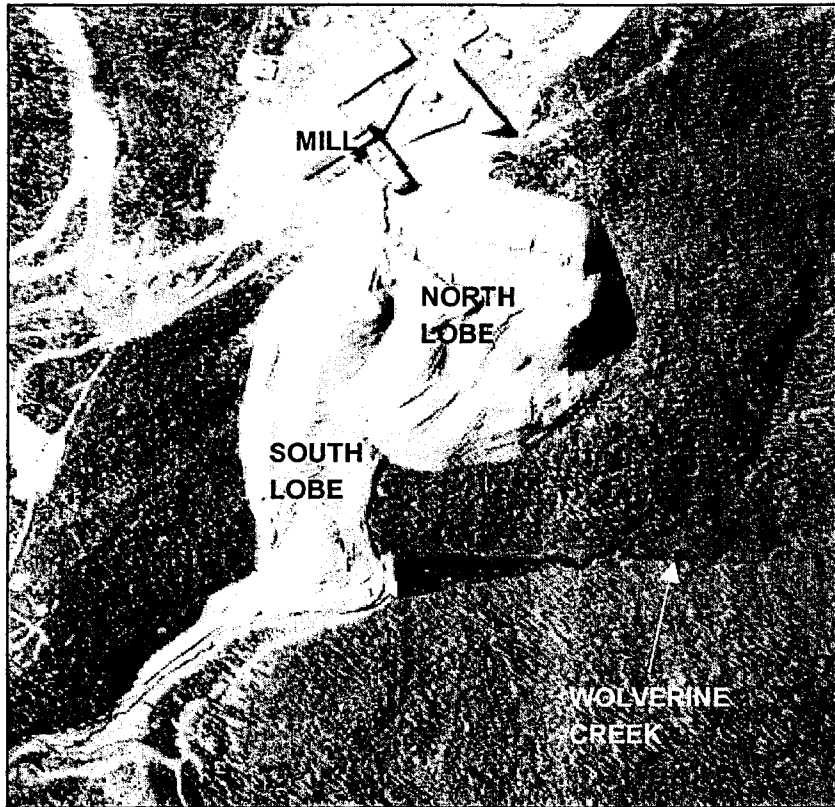


Figure 4-1
Failed South Lobe
(1976)

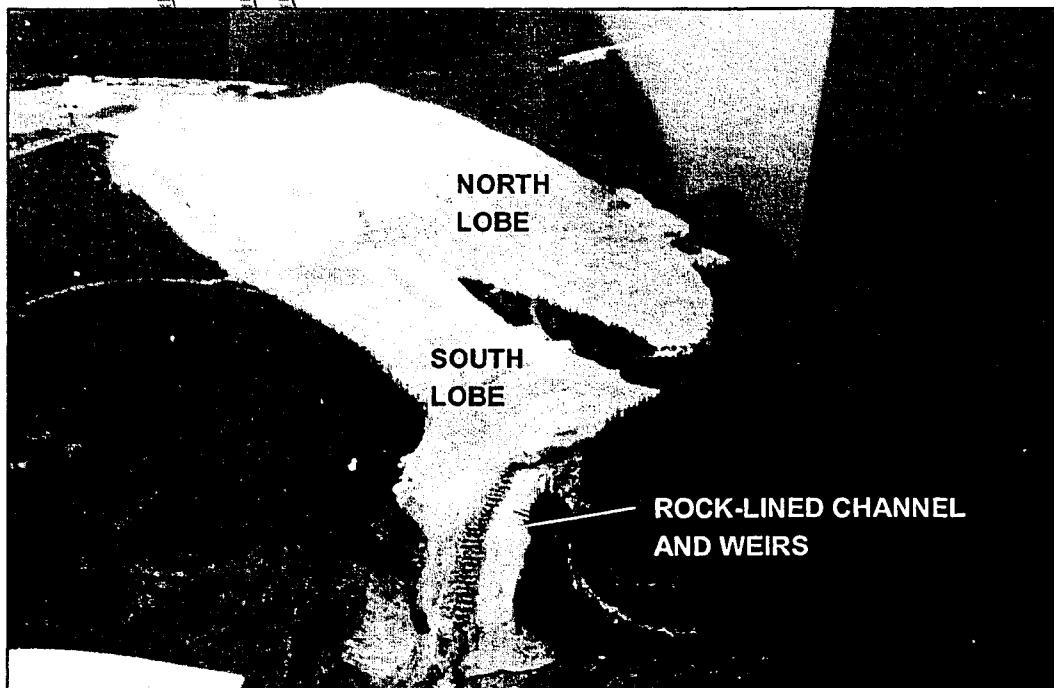


Figure 4-2
Rock-Lined Channel and Weirs

Monitoring carried out from 1976 to 1986 confirmed that displacement rates were much larger for the north lobe as compared to the south lobe due to the toe support provided by the tailings at the bottom of the valley. In general, the displacements varied along the length of the lobes with the largest movements occurring at the toe and small displacements occurring near the top of the slope. The north lobe reached the edge of Wolverine Creek in 1984 and by 1988, had reached the opposite side of the valley and blocked Wolverine Creek, followed by a small breach (Geo-Eng 1988).

4.2 Background Information

A considerable amount of information regarding the tailings pile is contained in reports and drawings filed at INAC's Whitehorse office. Information was extracted related to geotechnical issues, previous remedial strategies and any additional information regarding the nature of the tailings pile instabilities. In chronological order, relevant information from these reports is summarized in the following sections. Anecdotal comments by the writer are provided in Italics.

- In the spring 1974, 9m of water backed up behind and breached the tailings pile blocking Wolverine Creek causing a flash flood down Wolverine Creek to the mouth of Clinton Creek. The author implied that the flash flooding event was predicted in previous reports when he stated "The tailings from the mill are not stable and will undoubtedly continue to slump and block the valley." (Bowie, 1974)
- To reduce the potential for another breach of the tailings pile (south lobe) a channel was bulldozed across the toe region of the slide. Water impounded upstream of the tailings was observed to be seeping through the tailings and/or the native foundation soils, and was emerging in the form of springs at a location slightly downstream of the downstream limit of the tailings. The water was clear and did not appear to be carrying suspended solids. Clinton Creek Mines indicated that tailings deposition would be shifted northward away from the area where the failure occurred where the ground is much flatter (approximately 8 degrees) above the 495.3m contour. (*This feature is evident on the airphotos and the slope below this level is about 17 degrees*). (Golder Brawner 1974)

- Routine surveying of monitoring points on the surface of the tailings began in the fall of 1976. Large displacements of the north lobe were measured after 28 days. Much smaller movements were observed in the failed portion of the south lobe. A 2 metre high pile of native material was pushed up in front of the advancing north lobe and is still visible today. Exposed native soil at the base of the pile slope suggested that the failure surface is confined to unfrozen soil near the original ground surface. A recommendation was made to stop placement of tailings on the northeast side of the tailings pile and to continue monitoring the tailings pile monitors.
- A Site Rehabilitation and Abandonment Plan for the Yukon Territory Water Board was prepared in 1977 (Hardy, 1977). The main points for this report were:
 - Both the north and south lobes of the tailings pile show signs of instability. Wolverine Creek shows signs of very active bank erosion and down cutting.
 - Aerial photography indicated that the north lobe is also moving in a downstream direction (towards the south lobe). In turn, additional toe support is provided by the south lobe to the south edge of the north lobe.
 - Surface characteristics of the unstable tailings pile suggest that the failure mode in this area could be the result of failure within the active layer.
 - The report indicates Cassiar Asbestos Corporation was planning to re-contour the tailings pile to reduce the rate of down slope movement. The intention was to unload the top of the pile by moving some of the tailings to the north and re-depositing them on flatter slopes. It is not certain whether this work was carried out or not. *(Re-contouring was completed in 1978 and was not successful at reducing down slope movements over the long term)*

- Trimming about 6 metres of tailings off of the north lobe in the area where greatest movements have been measured.
- Hardy Associates completed a review of the tailings pile behaviour in 1980, after remedial work recommended by Golder was completed. Report highlights are summarized as follows:
 - The overall dump configuration apparently produces an arching effect and allows some degree of independent behaviour of the south and north lobes.
 - Horizontal movement rates indicated a favourable effect of the re-contouring works (*completed in 1978*) but the entire tailings pile was still unstable. (*The reduced horizontal movement rates only lasted for about 1 year and then increased*).
 - Seasonal changes of thermal and groundwater conditions appear to be the main factors causing the seasonal variation (*in horizontal movement rates*).
 - More detailed information on slide geometry, subgrade, groundwater and thermal conditions may modify the above conclusions that are based solely on available monitoring data.
- Comments from June 1981 site inspection report (Hardy, 1981)
 - Fresh scarps and cracks in the south lobe indicate continuing and possibly accelerating movements of key components of the south lobe.
 - Numerous wide open cracks and almost vertical relatively high scarps exist throughout the north lobe of the pile. The toe area of the north lobe is bulged and the material apparently overrides the natural ground.
 - Differences in movement rates of the monitoring points indicate that the north lobe is not moving as a single mass but that individual lobe segments move somewhat independently while interacting and influencing each other. (*This behaviour shows signs of a retrogressive failure*).
 - Visual inspection of the Wolverine Creek spillway system showed that most of the weirs and embankment armouring are performing satisfactorily. However, the outfall immediately downstream of the last weir is unprotected, retrogressive erosion is occurring and the structural integrity of the last three weirs is poor.

Recommendation made to install a rip-rap apron downstream of the last weir and to rehabilitate any damaged weirs.

- Comments from Review of Rehabilitation Measures Report (Hardy, 1984)
 - Monitoring results from the north and south lobes indicate that the horizontal rate of slope movement is about 1.5 to 1.9 times greater in the summer as compared to the winter season.
 - Five alternate reclamation schemes have been considered including:
 - Use of a coarse rock drain to channel water flow through spoil dumps.
 - Conveyance of Wolverine Creek around the tailings via a 1.8 m diameter hydraulic tunnel.
 - Conveyance of Wolverine Creek through the tailings via one or more large corrugated steel pipes until tailings stabilize and then construct a permanent channel over the tailings.
 - Continued monitoring and maintenance program, recommended by Klohn Leonoff (1984) as the most practical approach, would be to continue the monitoring and maintenance that has been ongoing for the past several years.
 - Dam at the toe of the south lobe to stabilize this portion of the tailings and a rock-lined channel over the tailings to control the path of water. It was recommended to construct a spillway and to install one or two corrugated steel pipes extending through the dam to the armoured channel.
- Observations from June 1984 site inspection report (Klohn-Leonoff, 1984)
 - The toe of the south lobe is considerably more cracked and upthrust than in 1983 and the creek channel between the toe of the tailings pile and the east slope of Wolverine Creek valley is being squeezed by the tailings pile movements.
 - The toe of the north lobe has entered the lake in the valley bottom and extends an estimated 6m beyond the 1983 shoreline.
 - The rock-lined channel constructed over the failed mass of the south tailings lobe has continued to perform well. (*Rock-lined channel was constructed in 1978*).

- Measurements taken during the 1984 site visit showed that the rock-lined channel has a minimum bottom width of about 9m and an effective lined depth of about 1.2m. The riprap forming the energy-dissipating weirs and the channel lining appears to have a mean diameter of about 0.9m.
- Comments from the Clinton Creek Mine Review Report on Waste Dump and Tailings Pile Conditions (Hardy, 1985)
 - The south lobe of the tailings pile continues to move downslope. The toe of the south lobe is rising and gradually blocking the creek channel. This could possibly result in forming a new channel (across the temporary blockage) outside of the present rock-lined spillway. The unlined channel could erode easily through the tailings accelerating the instability.
 - The current program of inspection and unspecified maintenance will not resolve existing problems. However, the monitoring data are extremely useful for the evaluation of possible courses of action. They confirm that large downhill displacements are possible under present conditions with a low static factor of safety. *(Monitoring of the tailings pile was discontinued in 1986).*
- Comments from Clinton Creek Asbestos Mine Abandonment Plan (Klohn Leonoff, 1986)
 - The toe of the north lobe reached the valley bottom in 1985 and, as further movement occurs, it will begin to be buttressed against the opposite valley wall. *(Continual erosion of the tailings forming the west bank of the creek has reduced the potential for buttressing).*
 - The channel conveying the stream past the toe of the south lobe has been squeezed against the east valley wall by the advancing tailings pile. Some erosion at the toe was evident in 1985. The stream appears to have the capacity to remove the tailings at a sufficient rate to maintain the channel without major blockage.

4.3 Condition of Existing Channel

A plan view of the existing tailings piles and Wolverine Creek profile are shown on Drawing 09. Representative creek channel cross sections are illustrated on Drawing 10. As a result of the channel blockages, the alignment and elevation of Wolverine Creek is now about 25 metres further to the east and about 13 metres higher than it was naturally. This new alignment has resulted in erosion of the east valley slope and the tailings that form the west bank of the creek (Figure 4-3).

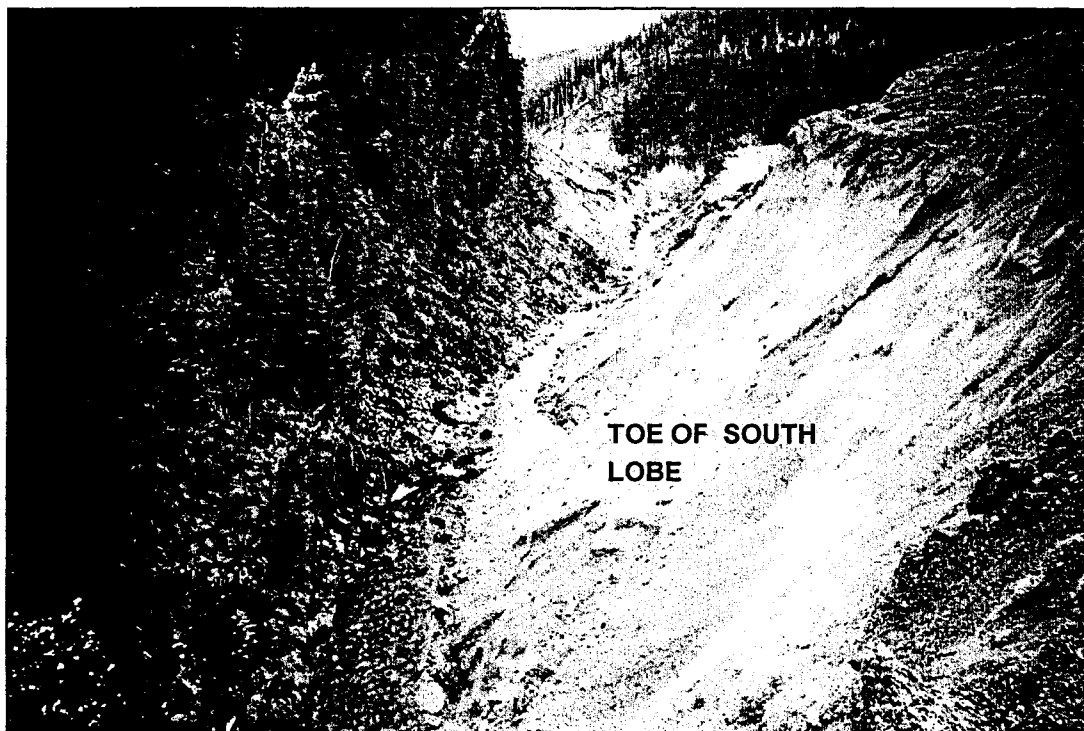


Figure 4-3
Erosion at Toe of South Lobe, View Downstream (1998)

Four beaver dams between the upstream side of the north lobe and the downstream side of the south lobe are believed to have reduced channel velocities and erosion as evidenced by the relatively flat channel gradient through this stretch. Immediately downstream of the last beaver dam however, velocities increase significantly as the channel narrows and the gradient steepens. Between the downstream beaver dam and the rock weirs, the channel has down-cut into the

underlying weathered argillite bedrock resulting in slumping of the valley slope. Downstream of the south lobe, flow appears to be contained within the original modified channel with no significant erosion or down-cutting observed, and the rock lined channel and rock weirs remain largely intact.

4.4 Geotechnical Properties

To facilitate development of a model to assess various remedial options, the geotechnical properties of the tailings and foundation soils, the condition of permafrost and groundwater (piezometric) conditions are required. These geotechnical properties must either be measured or assumed where insufficient information exists. In this regard, several geotechnical properties of the tailings, overburden and weathered bedrock have been previously researched, providing some information with respect to shear strength (friction angle) and unit weight of the material. A drilling program undertaken by Golder Associated in 1978 provided limited information on permafrost although the conditions reported may not be representative of the current thermal regime. There is no information on groundwater (piezometric) levels. The properties of the major stratigraphic units are discussed separately as follows.

4.4.1 Tailings

The tailings are primarily sand and gravel sized serpentine bedrock particles with trace silt and clay sized particles (Golder 1978 and R.M. Hardy 1977). A saturated unit weight of 21.2 kN/m^3 was used in a slope stability analysis conducted by R.M. Hardy (1978). Peak friction angles of 45 degrees for an effective stress range of 0 to 140 kPa and 35 degrees for effective stresses greater than 140 kPa were measured in direct shear testing (Golder, 1978). A peak friction angle of 46 degrees and a residual friction angle of 30 degree were also reported (R.M. Hardy, 1977). These values generally agree with the measured angle of repose of 39 degrees measured at the crest of the tailings pile (Golder Brawner 1974).

4.4.2 Overburden

The overburden soils within the Wolverine Creek valley are reported to be colluvium comprised primarily of sand and silt with trace clay sized particles (Golder 1978). Of five samples tested,

three contained gravel sized particles (12%, 20% and 30% gravel). Moisture contents of samples taken in undisturbed areas (adjacent to the tailings) ranged from 28.2 to 40.6 percent with corresponding saturated unit weights of 17.8 kN/m^3 . Below the tailings pile however, moisture contents ranged from 13.5 to 19.5 percent with saturated unit weights of 21.7 kN/m^3 . These results suggest that consolidation of the active layer and/or thaw-consolidation of the colluvium beneath the tailings pile has taken place. A range of peak shear strengths of 27.5 to 32 degrees and a residual shear strength of 23 degrees were measured in direct shear testing (Golder, 1978 and R.M. Hardy, 1977).

4.4.3 Bedrock

The mine site is located within the unglaciated Yukon-Tanana Upland Region. Bedrock in the area consists of black argillite that was exposed to periglacial weathering and near-surface material is heavily fractured and weathered. It is also possible that thin bedding planes of graphitic material may exist in the bedrock (personal communication, Dr. N. Morgenstern). Results from laboratory testing completed by Golder, 1978 indicate the weathered argillite has a specific gravity of 2.72, unit weights ranging from 22.8 to 24.5 kN/m^3 and moisture contents ranging from 5.2 to 11.4 percent. Direct shear tests were also performed on two samples of weathered argillite comprised of gravel and sand sized particles. The peak friction angles measured were 26 and 27 degrees (Golder, 1978).

4.4.4 Permafrost

The mean annual temperature in the area of the mine is -2.5 degrees C, ranging on average from 15 degrees C in the summer to -32 degrees C during the winter. The area consists of wide spread permafrost distribution up to 60 m thick (Golder, 1978). The thickness of the active layer on the slope (below the tailings pile) is not known with certainty but it is unlikely to exceed about 1 metre (Golder, 1978).

Eight test holes were drilled in May 1978 in and around the tailings pile at the locations shown on Drawing 11. Logs for these test holes are attached in Appendix B. Five test holes were drilled at locations away from the tailings pile to depths of 12 to 18 m. Frozen foundation (colluvium) soils overlying frozen bedrock were encountered in these test holes. Of the three

remaining test holes, two were drilled through the south lobe and one through the north lobe. It does not appear that the tailings were frozen (the test hole logs are not clear in this regard). The foundation soils at the south lobe were unfrozen to a depth of at least 6 m below the tailings (which had been in place for an estimated 4 to 5 years). In contrast, the foundation (colluvium) soils below the north lobe were frozen. These tailings had been in place for an estimated 1 to 2 years at the time of drilling.

Thermistor strings were installed in the three test holes on the tailings (two on the south lobe and one on the north lobe) and one string was installed about 60 m northwest of the tailings pile (Drawing 11). Each thermistor string consisted of 9 thermistors spaced at 1.5 m intervals. For each thermistor string, a temperature profile for the last monitoring date (19-June-1978) is shown in Figures 4-4, 4-5, 4-6 and 4-7. The monitoring results from each installation are summarized as follows:

DRAFT

Thermistor String T6 (adjacent to tailings pile)

Thermistor string T6 is located about 60 m northwest of the tailings pile. The monitoring results indicate that the overburden soils are frozen to depths of at least 12 m. The relatively warm temperatures 5 feet below ground surface indicate that the active layer could extend to 1.5 m in this area although additional monitoring would have been necessary to measure the active layer thickness. In general, the ground temperatures decrease rapidly with depth to about -1.6 degrees C at 3 m below ground surface and then increase slightly to about -1.3 degrees C below the 3 m depth. This data supports the observation of widespread permafrost.

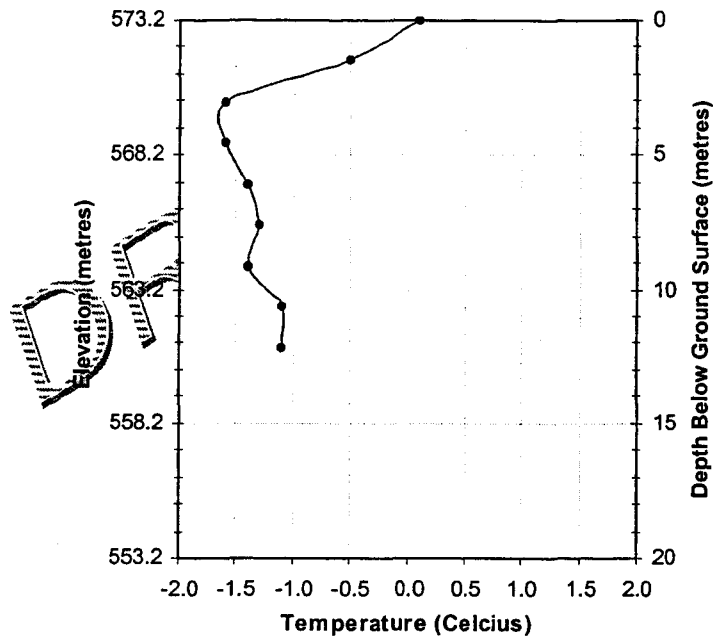


Figure 4-5
Temperature Profile for T6

Thermistor Strings T5 and T8 (South Lobe)

Thermistor strings T5 and T8 are located on the south lobe of the tailings pile at the crest and at mid-slope, respectively. The thermistor strings were vertically positioned across the interface between the tailings and overburden soils. Both the tailings and the overburden were observed to be unfrozen. In thermistor T5, the uppermost point was about 0.5 degrees C cooler than the

three points just below, possibly indicating a cool or frost front is advancing from ground surface. The points in the overburden were typically between 0.2 and 0.5 degrees C indicating some degradation of the permafrost had occurred. The temperature profile in T8 decreases gradually from 0.6 to -0.1 degrees C with depth. The temperature of the overburden material appears to be very close to 0 degrees C. The slightly cooler temperatures in the overburden may be due to the thicker depth of tailings at this location (18 m). This is about twice the thickness found at thermistor string T5.

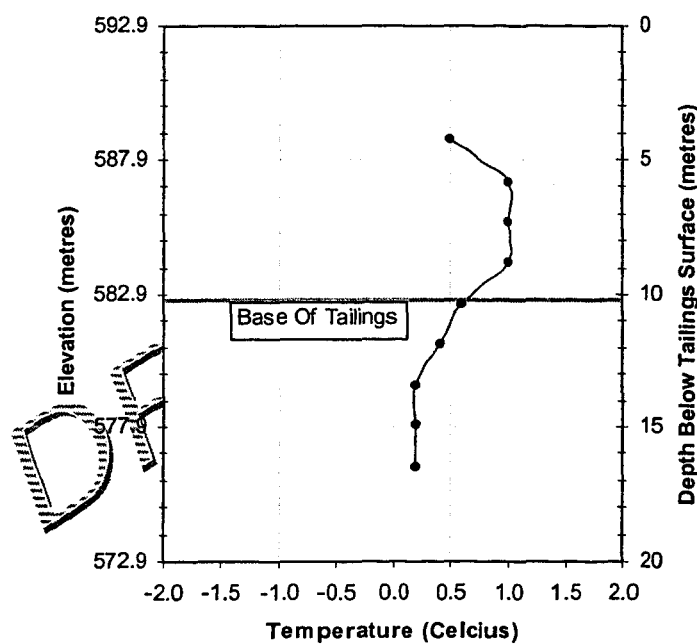


Figure 4-6
Temperature Profile for T5

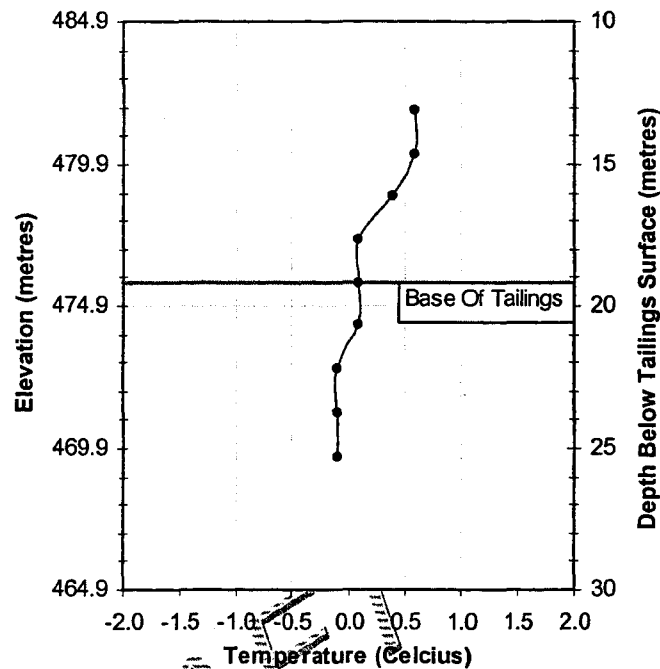


Figure 4-6
Temperature Profile for T8

Thermistor String T7 (north lobe)

Thermistor T7 is located near the northern edge of the tailings pile. The data indicated that the tailings and foundation soils were frozen with the coldest temperatures (-1.6 degrees C) just below the interface of the tailings and foundation soil. The temperatures of the foundation soils appear to gradually increase from -1.5 degrees C at the interface to nearly 0 degrees approximately 6 m below the tailings. It is possible that these tailings were placed during the winter season which would help to insulate the frozen overburden soils. This also might explain the cooler temperatures of the tailings just above the overburden soils.

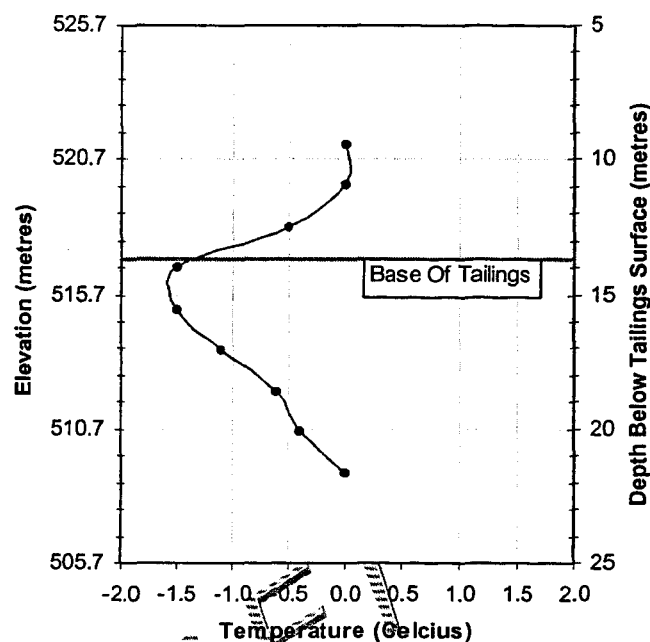


Figure 4-7
Temperature Profile for T7

4.5 Tailings Pile Movements

Historical performance monitoring results have been reviewed to evaluate historical movement trends and failure surface geometries. In 1976, two monitoring points were installed in each lobe of the tailings pile. Approximately nineteen additional monitoring points were added to the upper, lower and mid-slope zones on each lobe between 1977 and 1980. Tailings pile movements were monitored from December 1976 until June 1986 after which no surveys have been undertaken. Information on tailings pile movements, typically summarized as horizontal movement rates between successive monitoring events, has been discussed in a number of reports dating back to 1977. Unfortunately, there is insufficient information to generate plots of cumulative tailings pile movements.

The minimum and maximum movement rates at the upper, lower and mid-slope monitoring zones are shown in Table 4-1. As reported in earlier studies, the movement rates for the south lobe are about one order of magnitude less than those for the north lobe. This can be attributed

to the fact that the south lobe had already failed and reached the bottom of the valley when the monitoring program was initiated (1976). In contrast, the toe of the north lobe had not reached the valley bottom at this point in time. The north lobe did not reach the valley bottom until 1986, at which time deceleration of the tailings was noted (Klohn Leonoff 1987) as toe support was developed. The movement rates in Table 4-1 also indicate that movement rates along the north lobe decrease in the upslope direction, a behaviour indicative of a retrogressive failure pattern. A similar pattern is evident on the south lobe except the lower and mid-slope appear to be moving at nearly the same rate. It is also worth noting that the minimum movement rates for the mid and lower slope of the north lobe and the mid-slope of the south lobe occurred over the first winter season after re-grading work (terracing) was undertaken in these areas during 1978.

Table 4-1
Summary of Horizontal Movement Rates (1978 to 1986)

	Maximum Rate		Minimum Rate	
	Metres/yr	Year Reported	Metres/yr	Year Reported
South Lobe				
Upper slope	0.76	Aug 1981	0	Summer 1980
Mid-slope	6.6	June 1986	1.1	Summer 1978
Lower Slope	4.9	June 1986	0.65	June 1982
North Lobe				
Upper slope	3.6	Sept 1983	0.02	June 1986
Mid-slope	24.2	Sept 1983	3.5	Winter 78/79
Lower Slope	33.5	June 1983	3.5	Winter 78/79

Although there has not been any monitoring of the tailings since 1986, annual inspections and reconnaissance trips confirm that downslope movements of the north and south tailings lobes continue to occur, possibly at rates in the order of 5 m per year. These movements are due, at least in part, to the continued erosion of tailings from the toe of the north and south lobes by

Wolverine Creek. The tailings are eroded and transported downstream by Wolverine Creek almost as quickly as the tailings lobes advance into the valley bottom. Although a comparison of recent and historical aerial photography suggests there is little to no lateral spreading of the tailings within the failed area, it is likely that some mounding of the tailings is occurring (personal communication, M. Stepanek).

4.6 Tailings Pile Stability

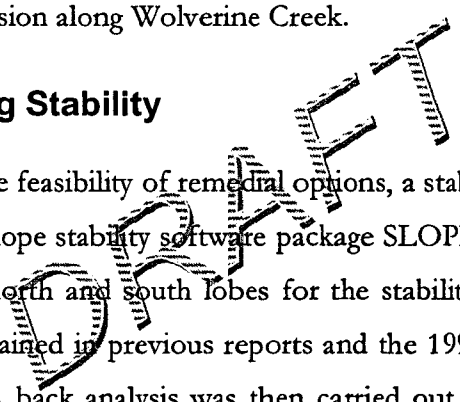
4.6.1 Tailings Pile Failure

The failure mechanism associated with the initial slides may be unique to that event i.e. the mechanism may be different than that associated with the existing movements. The difference could be associated with the thermal regime early in the development of the dump compared with the long-term equilibrium (steady state) condition that may have been eventually reached after termination of mining activities. It is reasonable to assume that the most critical time period would have been the first few years of development when tailings were being actively placed over the valley slope and the initial disturbance to the thermal regime occurred. This is the time period when the rate of thaw might have been the fastest if ice-rich foundation soils were present.

The tailings placed in the south lobe are reported to have been moving downslope soon after placement started (Golder, 1978) and that the failure occurred in a small draw on the valley side slope. This draw is visible in 1951 aerial photography taken prior to mine development (Drawing 12). Based on the results of the geotechnical investigation completed by Golder Associates in 1978, permafrost likely existed in the valley slope prior to placement of the tailings. The failure of both the south and north lobes is likely related to a combination of factors, including a steep foundation (valley) slope and possibly a build-up of pore water pressures within the active layer. When comparing the valley side slopes shown, it is apparent that the upper portion of the valley slope beneath the north lobe is about 13 degrees compared to 18 degrees for the south lobe and lower portions of the north lobe (Drawing 13).

In general terms, the tailings pile failures can be characterized as translational slides showing signs of retrogressive behaviour. The variable movements rates observed along the failure lobes are also indicative of retrogressive failure. With minimal to no toe support at the leading edge of the failure lobes, increased shear stresses within the natural soils due to the weight of the tailings and increased porewater pressures due to thawing permafrost, the shear strength of the underlying soils was exceeded. The position of the failure surface is not precisely known but is likely located within the overburden and/or weathered argillite layer, as evidenced by overburden material pushed up in front of the advancing north and south lobes. It is unlikely that the weak layer exists within the tailings. Slope movements may very well continue until there is sufficient resistance at the toe of the slide, the development of which is impeded by continual toe erosion along Wolverine Creek.

4.6.2 Existing Stability



To investigate the feasibility of remedial options, a stability model was developed for each of the lobes using the slope stability software package SLOPE/w by Geo-Slope. Representative cross-sections of the north and south lobes for the stability models were developed using historical information contained in previous reports and the 1998 aerial photography and digital mapping (Drawing 13). A back analysis was then carried out to determine the operating strengths and piezometric conditions necessary to achieve a factor of safety (FS) equal to unity (FS=1), a value representative of active failures.

The movement trends presented in Table 4-1 for the monitoring points located on the upper slope indicate that relatively little movement of the tailings behind the main head scarps is occurring. Hence, it was assumed that the failure surfaces do not extend any farther back into the tailings than the obvious head scarps that have developed. The existing failure surface was assumed to be approximately parallel with the original ground surface and within a weak layer at a shallow depth in the foundation. A 3 m deep tension crack located at the head scarp was assumed to be filled with water. Residual friction angles of shearing resistance were used for the tailings, overburden and weathered argillite, based on the direct shearing results. The piezometric level within the overburden and weathered argillite bedrock was modeled using the pore water coefficient R_u , which is the ratio of pore water pressure to overburden pressure.

Sensitivity analyses were subsequently carried out to determine the failure surface and the Ru value necessary to provide a factor of safety near 1.0. The resulting failure surface geometry and associated parameters are shown in Figures 4-8 and 4-9.

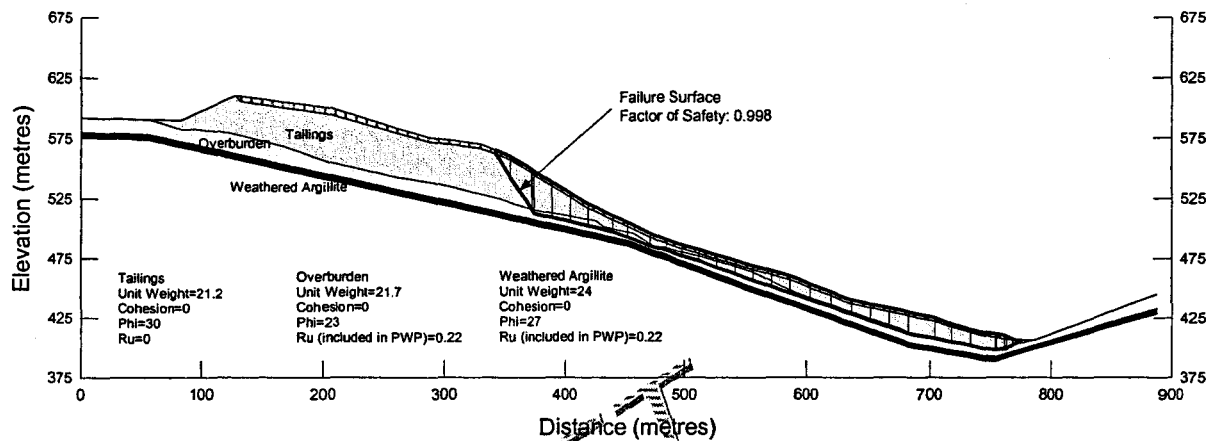


Figure 4-8
North Lobe - Existing Geometry

The analysis indicates that a combination of residual shear strengths and high pore-water pressures in the overburden material are required to achieve a FS of unity. This observation provides further evidence that unique geological conditions, in particular a shallow weak layer within the overburden, the slope of the valley and lack of toe support are responsible for continued movement of the tailings pile. Almost certainly, disturbance of the thermal regime, in particular thawing of the permafrost resulting from the placement of tailings over the valley slope has been a contributing factor. Although detailed knowledge of the changes to the thermal regime that occurred during and following active placement of tailings is not known, it is possible that the thermal regime has still not reached a state of equilibrium.

Given the limited site-specific geological information, there is considerable uncertainty in the absolute values calculated from the back analysis. The model is however, considered sufficient to comment on and assess the relative improvement available through remedial options for the purposes of comparing remediation alternatives (stabilization) and selecting a preferred long term strategy for the same.

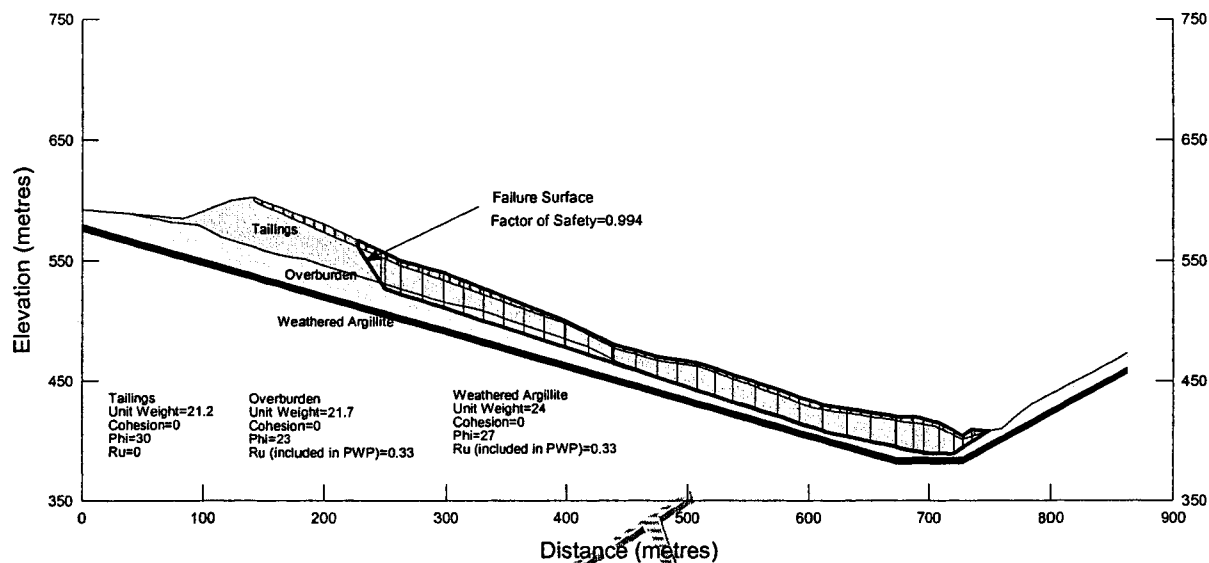


Figure 4-9

South Lobe - Existing Geometry

4.7 Remediation Alternatives

Remediation alternatives must accommodate the on-going movements or include measures to stabilize the tailings. Remedial strategies broadly fall into one of three categories:

- i) Remove a sufficient volume of tailings from the valley and valley side slopes to completely drain the water impounded by the tailings and restore natural creek drainage,
- ii) Continue to convey water over the stabilized tailings or,
- iii) Convey water around the tailings.

Each of these alternatives requires that the tailings be handled with earth moving equipment resulting in air-borne (fugitive) asbestos dust particles. These effects are expected to be confined to the construction period and for a short time after. A protective crust layer has formed over the tailings pile since mine closure that minimizes the potential for wind and run-off erosion of

asbestos particles. It is expected that this crust would redevelop following construction of the remedial measures. Each alternative is discussed in the following sections.

4.7.1 Valley restoration

Of the options considered, removal of the tailings blocking the valley is the only alternative that restores natural creek drainage through the Wolverine Creek valley. Restoring of the valley and the associated natural drainage has the benefit of reducing or eliminating the risk associated with a breach of the tailings by the impounded water and the concern of chronic downstream sedimentation of tailings. Drainage of the impounded water could largely be completed using pumps and/or siphons prior to removing tailings from the valley bottom. Removal of tailings from the side slopes of the valley would have to start at the upper slope and proceed in a downslope direction to prevent the development of slope instabilities. Based on previous monitoring and results from the slope stability analysis, it is anticipated that a portion of the tailings at the top of the valley will not require excavation as they can be stabilized by re-grading.

Based on existing cross sections, approximately 4,000,000 m³ of tailings would have to be excavated to achieve a stable geometry. The excavated material could be disposed of in the open pits on the south side of Clinton creek. An additional 1,000,000 m³ of re-grading would be necessary to achieve stability of the tailings in the upper slope area. The area of excavated tailings and the final geometry of the tailings pile and Wolverine Valley is shown on Drawing 14. The estimated capital costs for valley restoration are summarized in Table 4-2.

Table 4-2
Valley Restoration- Cost Estimate

Description	Unit	Approximate Quantity	Unit Price	Amount
Mobilization & Demobilization	Lump Sum	1	\$500,000	\$500,000
Dewatering	Lump Sum	1	\$250,000	\$250,000
Restore & maintain haul road	Lump Sum	1	\$200,000	\$200,000
Excavate & haul to open pit	Cubic Metre	4,000,000	\$5	\$20,000,000
Re-grading upper slope	Cubic Metre	1,000,000	\$1	\$1,000,000
Upgrade outlet under main road	Lump Sum	1	\$100,000	\$100,000
Subtotal				\$22,050,000
30% Contingency				\$7,350,000
Total Estimated Cost				\$29,400,000

4.7.2 Convey Water Over Tailings Pile

The long term success of conveying water over the tailings in the bottom of Wolverine Creek valley is contingent on stabilizing the tailings piles. Once the tailings have been stabilized, water could be conveyed over the tailings in a channel that has been stabilized to minimize erosion. Conveyance of water through culverts buried in the tailings is not considered practical given the potential settlement and horizontal creep movements of the tailings and the potential for failure and/or blockages of the culvert.

4.7.2.1 Stabilization of Tailings Piles

Design Objective

Stabilization measures are typically designed with an objective to achieve a factor of safety (FS) that reflects the level of confidence in the interpretation of site and geological conditions and the

consequences of continued movement or a slope failure. Although a high degree of uncertainty exists with respect to the site and geological conditions, a minimum factor of safety of 1.25 has been used as the design objective for the conceptual design and cost estimating of remedial measures. The use of this FS for final design is contingent on collecting additional information on soil properties, permafrost and piezometric levels would be obtained through more detailed site investigations. If this additional information is not obtained, a FS of 1.50 should be used for final design of remedial measures. It should be recognized however, that the incremental increase in capital costs associated with higher factors of safety could easily offset the cost of any additional site investigations i.e. construction costs could conceivably double if a FS of 1.50 is required.

Stability Analysis

Slope stability analyses were carried out to determine a revised geometry of the tailings pile that would achieve a minimum overall FS of 1.25. In general, this would be accomplished by re-grading the tailings to off-load material (reduced driving forces) from the upper portion of the slope and adding material at the toe (increased resisting forces). Two options were considered; the first option assumes that the entire tailings pile is unstable and has to be re-graded. The second option assumes that the tailings near the top of the valley (the area upslope of the main head scarps) can be stabilized independent of the areas of the tailings pile that are most actively moving downslope. In both options the creek channel is located across the toe of the tailings. For both options, the slope of the tailings was progressively flattened and the elevation of the tailings at the toe increased until the design objective was met. The necessary elevation of the tailings is 422.0 and 415.0 m for Option A and B respectively, or approximately 12 and 5 m above the existing tailings surface at the toe of the slope. Cross sections through the north and south lobes for each option are shown in plan and section on Drawings 15 (Option A) and 16 (Option B).

For both options, the re-grading plan includes in-filling the ponded areas between the north and south lobes (to the same final elevation as the north and south lobes) and upstream of the north lobe (to approximately the same elevation as the existing water surface). Filling these areas will

reduce the volume of water impounded after re-grading the tailings and decrease the potential for a breach by increasing the length of the channel across the tailings.

Construction Considerations

The cut volume for Option A is approximately 2,700,000m³, of which approximately 2,250,000m³ would be used to re-grade the lower slope of the tailings lobes and fill the existing Wolverine Creek channel. The remainder (450,000 m³) could be placed over the former mill site. The cut volume for Option B is approximately 2,600,000m³, of which approximately 860,000 m³ would be used to re-grade the lower slope of the tailings lobes and fill the existing Wolverine Creek channel. The remainder 1,740,000 m³ could be placed over the former mill site.

Depending on the time of year when construction is undertaken, it may be necessary to control discharge from Wolverine Creek. This could be accomplished by drawing down the impounded water level prior to construction and/or filling in the existing channel through the tailings and allowing water levels to rise upstream of the tailings for the construction period. Draw down of the impounded water between the north and south lobes and upstream of the north lobe may result in some localized instabilities at the toe of the natural valley side slopes. Assuming an average reservoir discharge of about 0.25 m³/sec during the summer, a reservoir volume up to 659,000 m³ and a pumping capacity of 75 m³/min, approximately one week to 10 days would be required to pump the impounded water past the tailings. After pumping at this rate is discontinued, it would take about one month for water levels to recover to the pre-pumping level. Conversely, the impounded water levels could probably be maintained by pumping if the existing channel was filled in with tailings.

4.7.2.2 Stabilization of Channel

The tailings are easily eroded and it will be necessary to stabilize the channel across the toe of the re-graded tailings. Where the channel flows over the north and south lobes, channel stabilization works should be compatible with any movements that may occur following regrading. In this regard, channel stabilization across the north and south lobes can be achieved using a relatively flat grade and lining the channel with a non-woven geotextile covered with

granular material large enough to resist erosion. The proposed channel profile for Option B is shown on Drawing 17. Rigid structures such as concrete linings should be avoided due to the risk of cracking and subsequent failure. A transition between the new channel across the tailings and the existing rock-lined channel will be required to ensure the water stays within the stabilized channel. This transition could be accomplished using cobbles and cobble filled gabion drop structures. Final determination of the drop structure profile between the rock-lined channel and the re-graded tailings would be deferred until detailed design.

Since the existing rock-lined channel and rock weirs downstream of the north lobe have performed reasonably well it is desirable to leave them in place. To reduce the erosion potential of the tailings adjacent to the rock-lined channel it is recommended that this area be graded towards the rock-lined channel and that the small gully along the outer edges of the tailings be filled to blend in with the natural valley slopes. Placement of rocks across the tailings in a 'V' pattern pointing downslope will help direct surface runoff to the rock-lined to channel and minimize the development of erosion channels in the tailings adjacent to the lined channel. The presence of vegetation along the rock lined portion of the channel suggests that it may be possible to establish vegetation in the tailings adjacent to the rock-lined channel if moisture can be preserved to support plant growth (Figure 4-10). Since the establishment of vegetation would help to provide long-term stabilization of the tailings, growth could be encouraged by spreading organic matter such as wood chips, mulch or coniferous trees over the tailings in this area. Rehabilitation of the channel outlet at the confluence with Clinton Creek should also be considered to prevent future overtopping of the road and erosion at the downstream end of the culverts.

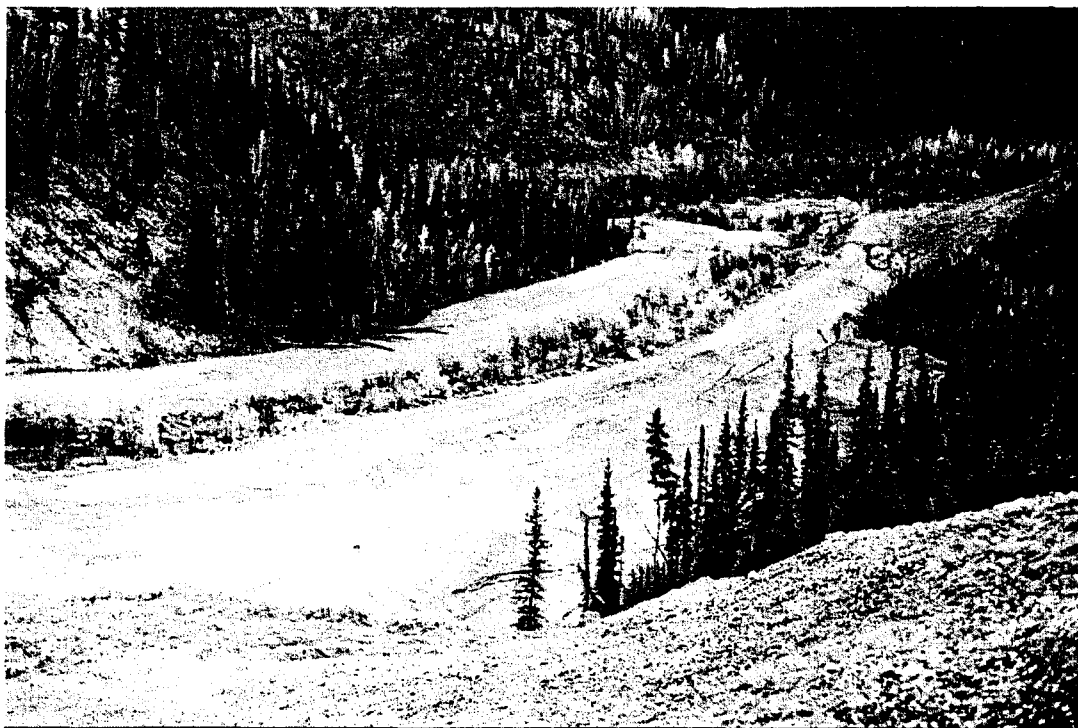


Figure 4-10
Vegetation Along Rock-Lined Channel

The estimated capital costs for stabilization of the tailings piles and channel are summarized in Table 4-3 (Option 1) and 4-4 (Option 2).

Table 4-3
Cost Estimate For Option 1

Description	Unit	Approximate Quantity	Unit Price	Amount
Mobilization & Demobilization	Lump Sum	1	\$500,000	\$500,000
Dewatering	Lump Sum	1	\$250,000	\$250,000
Re-grading	Cubic Metre	2,700,000	\$1	\$2,700,000
Channel Excavation	Cubic Metre	45,000	\$3	\$135,000
Channel Erosion Protection	Lump Sum	1	\$225,000	\$225,000
Drop Structures	Lump Sum	1	\$250,000	\$250,000
Rehabilitate Rock-Lined Channel	Lump Sum	1	\$100,000	\$100,000
Upgrade outfall at main road	Lump Sum	1	\$100,000	\$100,000
Subtotal				\$4,260,000
30% Contingency				\$1,420,000
Total Estimated Cost				\$5,680,000

Table 4-4
Cost Estimate For Option 2

Description	Unit	Approximate Quantity	Unit Price	Amount
Mobilization & Demobilization	Lump Sum	1	\$500,000	\$500,000
Dewatering	Lump Sum	1	\$250,000	\$250,000
Re-grading	Cubic Metre	2,600,000	\$1	\$2,600,000
Channel Excavation	Cubic Metre	45,000	\$3	\$135,000
Channel Erosion	Lump Sum	1	\$225,000	\$225,000

Description	Unit	Approximate Quantity	Unit Price	Amount
Protection				
Drop Structures	Lump Sum	1	\$250,000	\$250,000
Rehabilitate Rock-Lined Channel	Lump Sum	1	\$100,000	\$100,000
Upgrade outfall at main road	Lump Sum	1	\$100,000	\$100,000
Subtotal				\$4,160,000
30% Contingency				\$1,385,000
Total Estimated Cost				\$5,545,000

4.7.3 Convey Water Around Tailings

The conveyance of water through a concrete lined tunnel or directionally drilled, steel or PVC lined tunnel constructed around the unstable tailings was also considered. The inlet structure for the tunnel would likely be located upstream of the north lobe on the east side of the valley. The outlet would be located in the Wolverine creek valley near the down stream limit of the rock-lined channel (Drawing 18). The total distance for this alignment is approximately 700m. It would be necessary to partially infill the valley at the toe of the tailings pile to approximately Elevation 412 m to construct an emergency overflow channel in the event the tunnel entrance is blocked.

A tunnel diameter on the order of 2.0 m would be required to convey the estimated 200-year flood ($17 \text{ m}^3/\text{s}$) (UMA 2000). The full supply level (FSL) would be set around elevation 405m (approximately the current impounded water elevation) and the crown of the tunnel would be placed at the same level. The proposed FSL will provide a live storage of 5 m between the overflow crest at the tunnel inlet and the outflow level of the overflow channel across the tailings to generate sufficient head for the tunnel flow. To allow isolation of the tunnel for inspection and maintenance, a low-head sluice gate would be installed at the inlet. Once

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completed, flow would be diverted into the tunnel. Permanent access to the inlet of the tunnel for future cleaning and maintenance would be difficult due to the steep valley slopes and ice-rich permafrost on the valley slopes.

The estimated costs of tunnelling (based on a conventional concrete lined tunnel) are summarized in Table 4-5.

Table 4-5
Conveyance of Water Around Tailings – Cost Estimate

Description	Unit	Approximate Quantity	Unit Price	Amount
Mobilization & Demobilization	Lump Sum	1	\$500,000	\$500,000
Dewatering	Lump Sum	1	\$250,000	\$250,000
Permanent Access Road to Inlet	Lump Sum	1	\$250,000	\$250,000
Tunneling	Per Metre	700	\$6,000	\$4,200,000
Inlet and Outlet Structures	Lump Sum	1	\$2,000,000	\$2,000,000
Fill In Existing Channel	Cubic Metre	50,000	\$3	\$150,000
Overflow Channel Excavation	Cubic Metre	45,000	\$3	\$135,000
Channel Stabilization	Lump Sum	1	\$225,000	\$225,000
Gabion Drop Structures	Lump Sum	1	\$100,000	\$100,000
Upgrade Outfall at Main Road	Lump Sum	1	\$100,000	\$100,000
Subtotal				\$7,910,000
30% Contingency				\$2,640,000
Total Estimated Cost				\$10,550,000

5 CONCLUSIONS AND RECOMMENDATIONS

Monitoring in June 2001 confirms previous (1999) observations by UMA that the waste rock pile movements are small (approximately 7 cm/year) and likely decreasing with time. To accommodate the observed movements, stabilization of the channel using gabion drop structures to flatten the channel grade is recommended to mitigate the potential of a catastrophic breach of the landslide blockage at the outlet of Hudgeon Lake and the chronic downstream re-distribution of material eroded from the waste rock dump as it advances into the Clinton Creek channel. It is possible that the channel infilling and prevention of further toe erosion will provide sufficient improvement in slope stability to further reduce waste rock dump movements and possibly eliminate the requirement for waste rock regrading. The estimated cost to complete channel stabilization is in the range of \$2,500,000 to \$3,000,000. If waste rock stabilization is required, the estimated capital cost is in the order of \$6,000,000 (including channel stabilization).

Given the possibility of conditions worsening at the outlet before long term remedial measures are implemented, the stabilization of the creek channel could be staged to allow the most immediate concern (the condition of the outlet) to be addressed prior to construction of the works for the entire length of the channel. This strategy would address the most immediate concern regarding the potential of a catastrophic breach of the waste rock plug at the lake outlet. Erosion of the waste rock will continue to occur however, downstream of the stabilized section. Ideally, the short term works could be incorporated into the overall channel stabilization measures. The estimated construction costs to stabilize a 150m long section of the channel immediately downstream of the Hudgeon lake outlet is in the order of \$500,000.

Stability analysis of the tailings pile indicates a shallow weak layer within the overburden and continued toe erosion are responsible for continued movement of the tailings pile. The loss of strength may be related to a number of geological conditions unique to the site including ice content, soil type and the relationship between the rate of thawing and dissipation of excess pore-water pressures. It is likely that disturbance to the thermal regime, including thawing of permafrost beneath the tailings, has resulted from placement of tailings over the valley slope.

Several remediation alternatives were considered to mitigate the existing hazards associated with on-going erosion of the tailings and a breach of the tailings should Wolverine Creek become completely blocked. Remedial strategies broadly fall into one of three categories:

- i) Remove a sufficient volume of tailings from Wolverine Valley to completely drain the impounded water and restore natural creek drainage.
- ii) Convey water over the tailings via a new stabilized channel.
- iii) Convey water around the tailings via a tunnel.

Significant capital costs are associated with these options, ranging from about \$5,500,000 to stabilize the tailings and construct a stabilized creek channel to about \$30,000,000 to remove a sufficient amount of the tailings to restore natural creek drainage. It must be recognized that these options have been evaluated in concept only. Should the implementation of remedial measures be considered, the work completed to date and available information is only considered sufficient to select a preferred alternative. Upon the selection of the remedial repair alternative, a feasibility study including detailed field investigations is recommended to examine the technical feasibility of the preferred option and refine construction cost estimates. The level of detailed field investigations required will depend on the selected alternative.

It is recommended that the waste rock monitoring program established in 1999 be extended to confirm waste rock movements to determine if stabilization of the waste rock dump is necessary. Consideration should also be given to include the monitoring of targets on the tailings piles to establish current movement rates. Should you have any questions or require any additional information, please contact the undersigned.

Respectfully Submitted,
UMA Engineering

Ken Skaftfeld, P.Eng.
Senior Geotechnical Engineer,
Earth and Environmental

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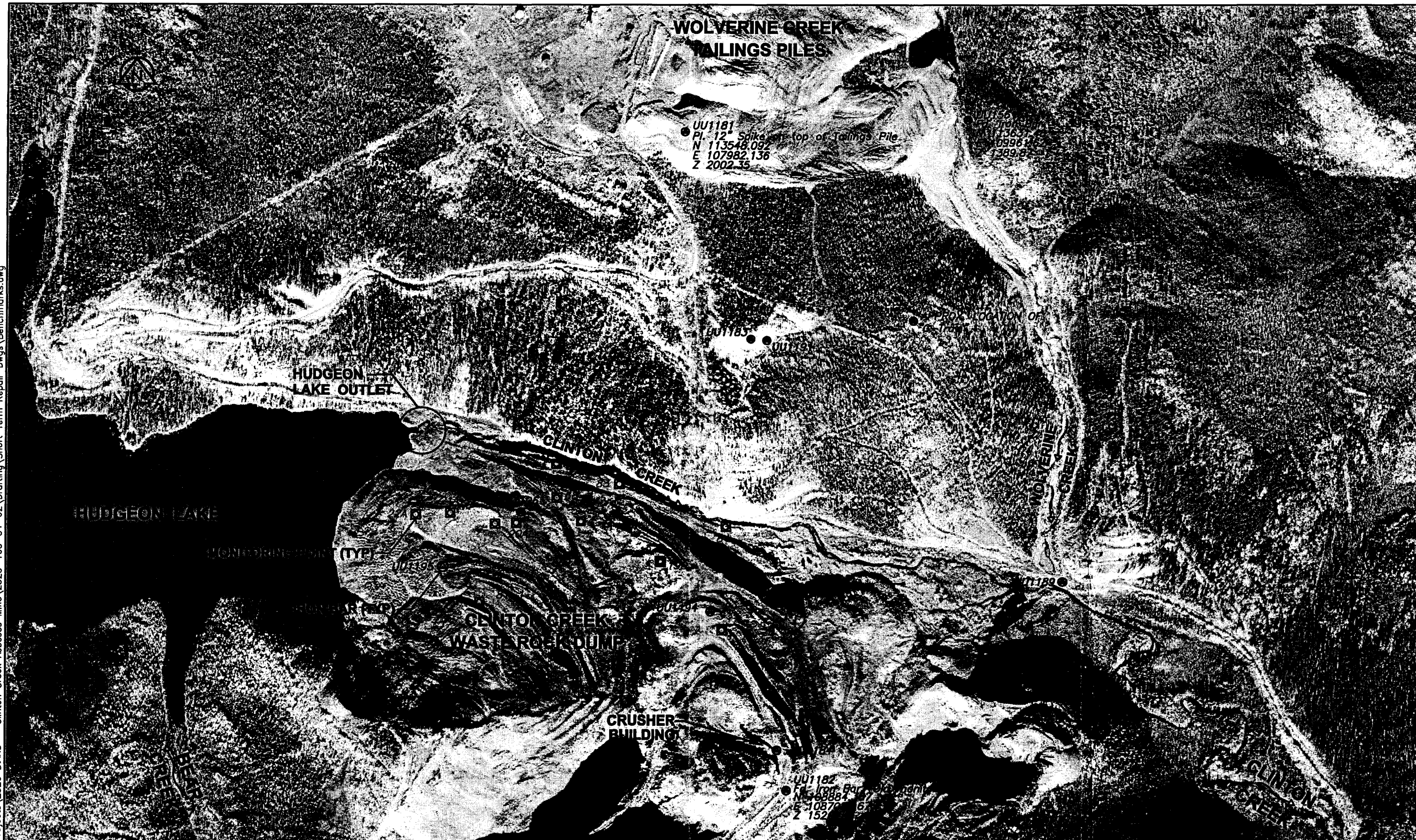
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Appendix A - Waste Rock Monitoring Results

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Plot Scale: 1=1
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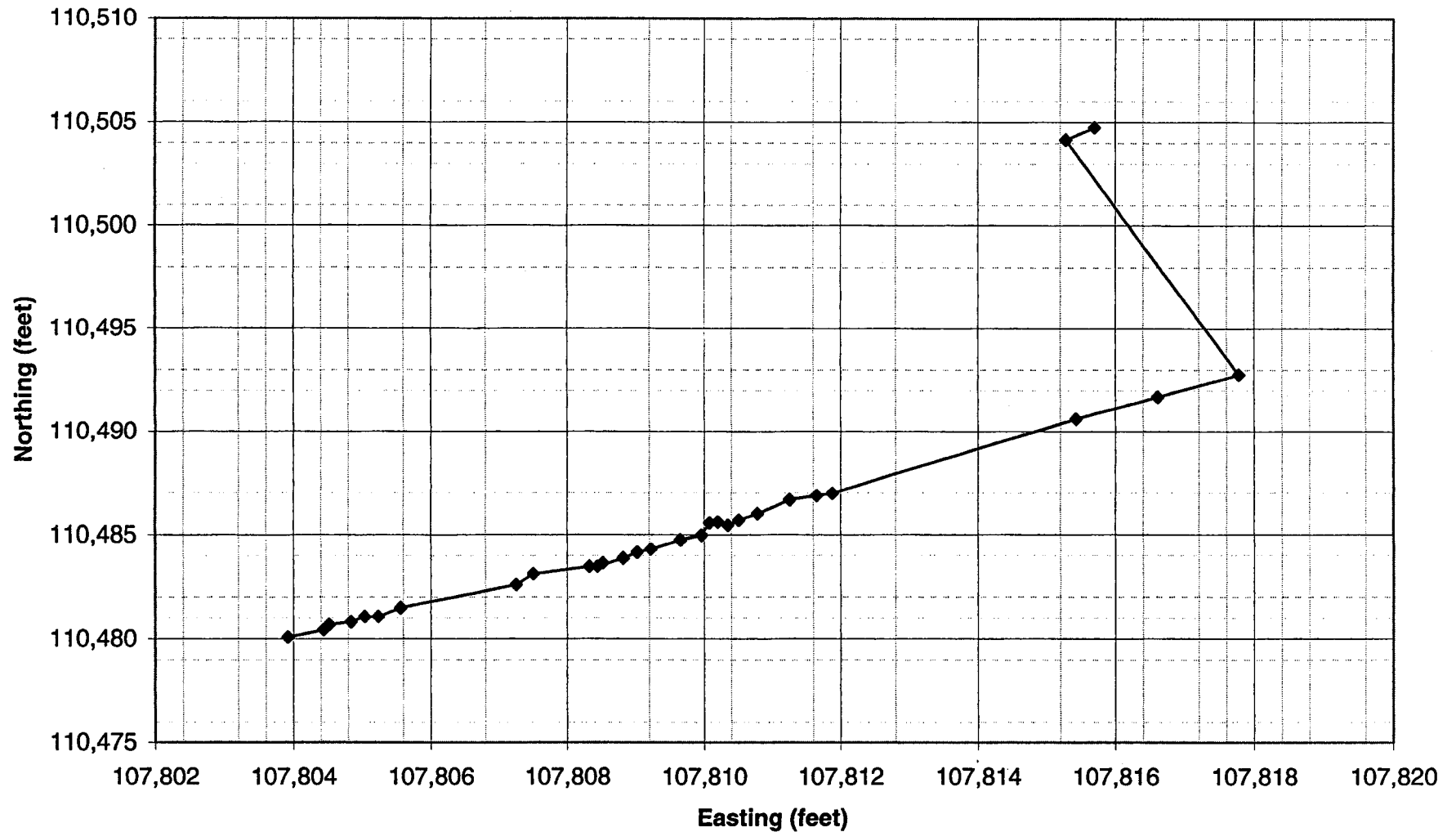
REV.	DESCRIPTION	DRAWN	APP.	DATE

SEAL

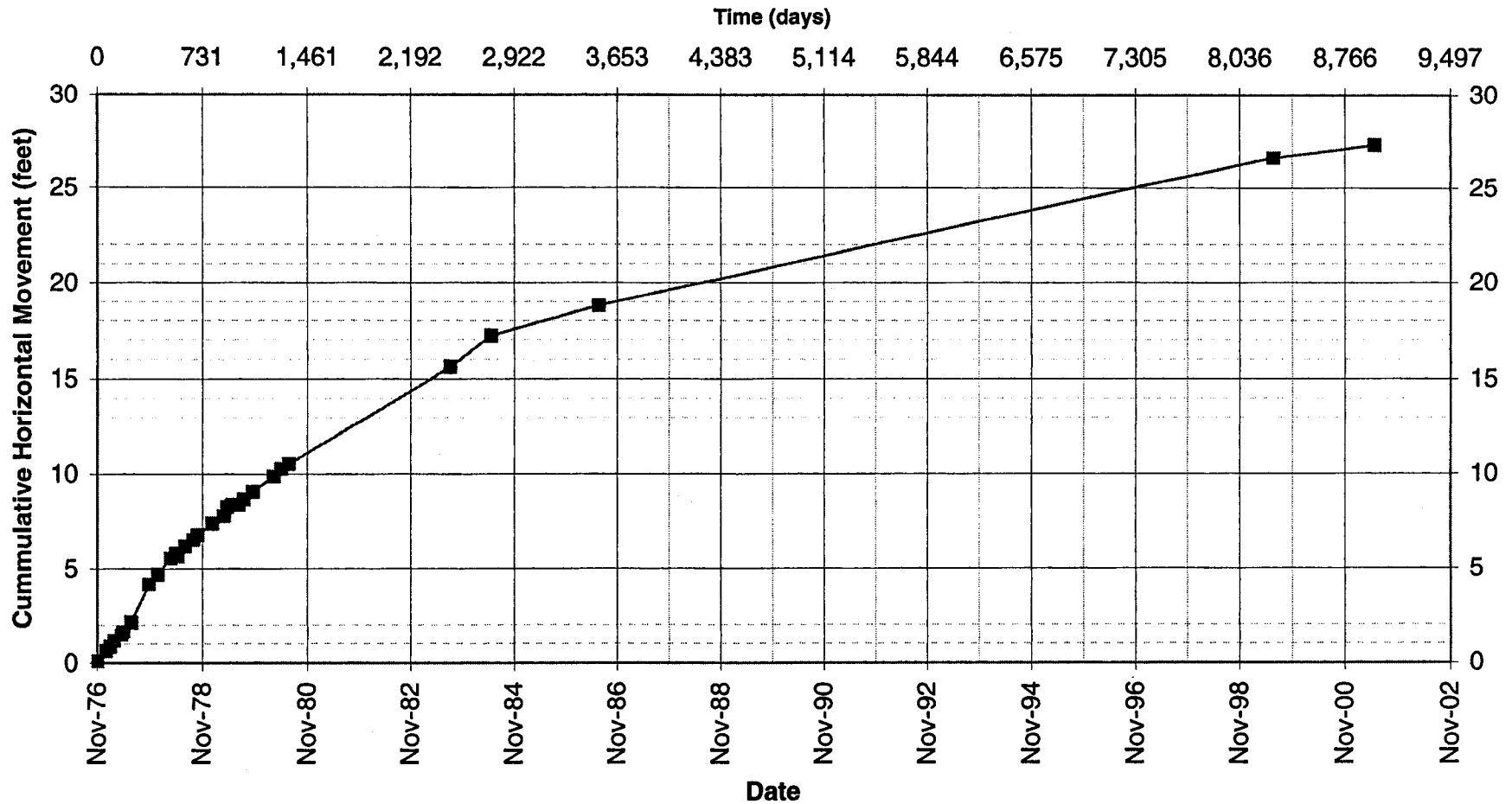
UMA UMA Engineering Ltd.	
• Consulting • Engineering • Construction • Management Services	
APPROVED BY: _____ DATE: MAY, 2002	
DRAWN BY: _____	DESIGNED BY: _____
CHECKED BY: _____	CHECKED BY: GR
SCALE: 1:7,500	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE	
LOCATIONS OF WASTE ROCK MONITORING MONUMENTS AND BENCHMARKS	
DWG. No.	REV.

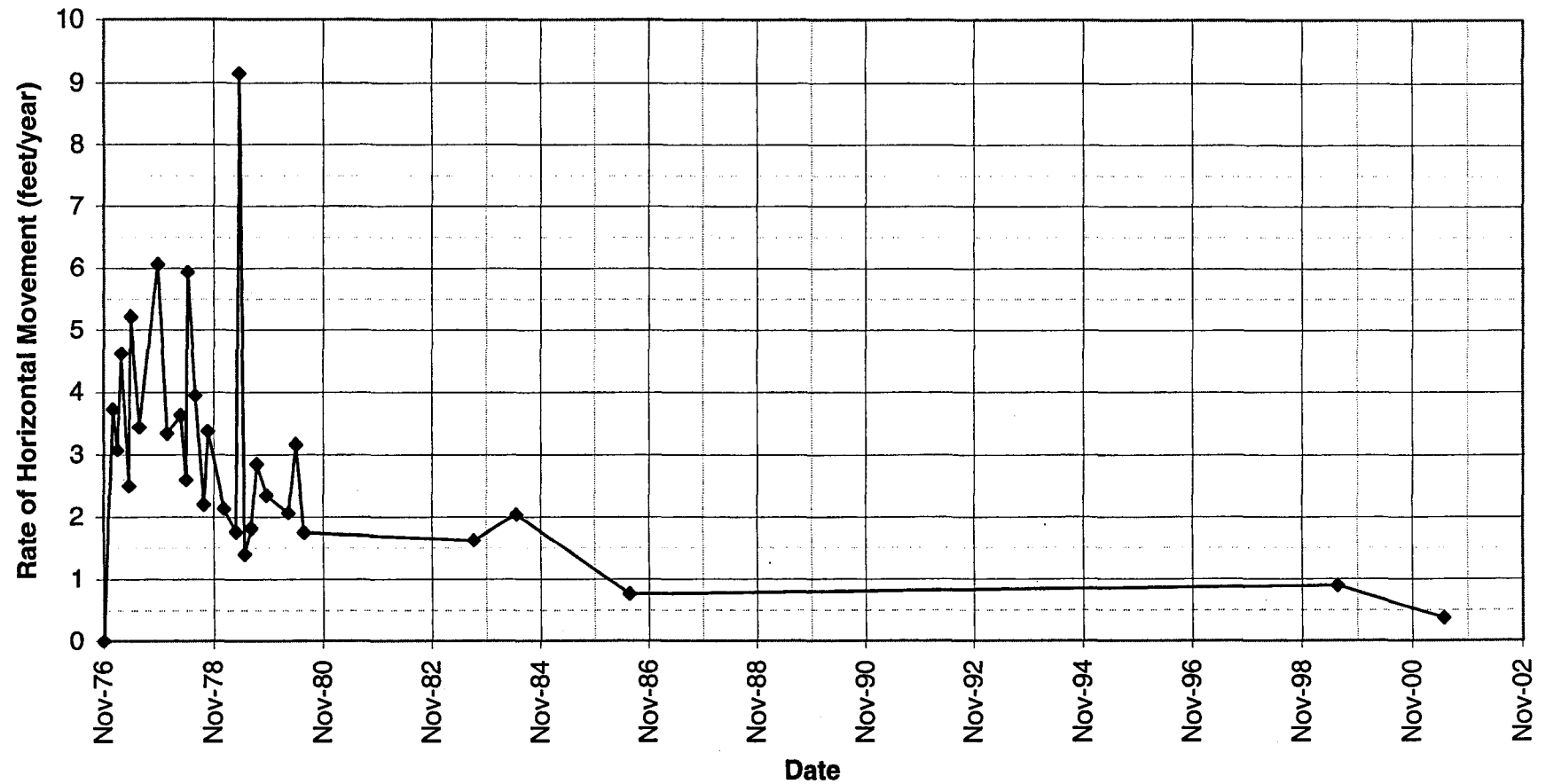
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #19**



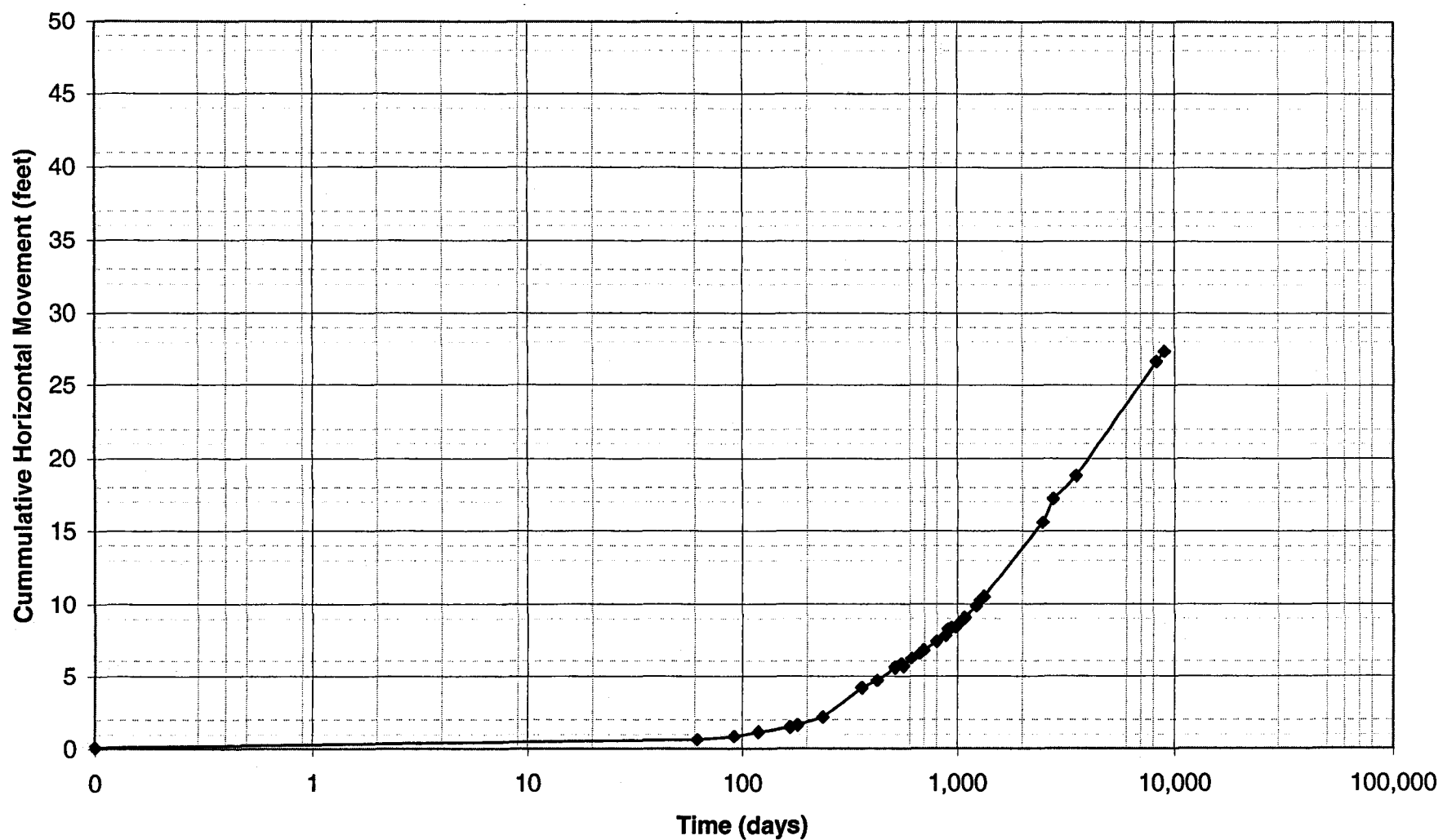
DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monument #19



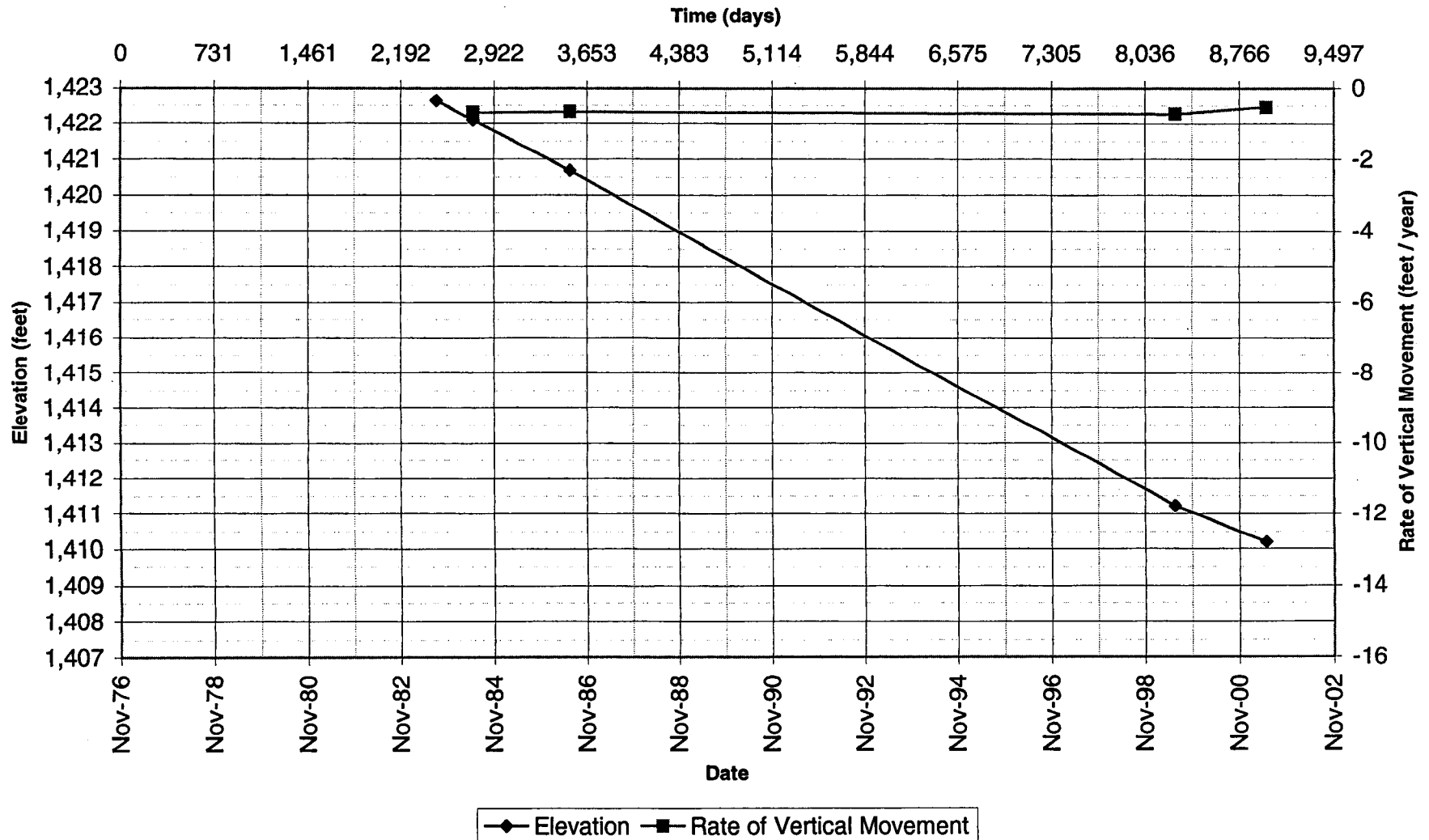
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #19**



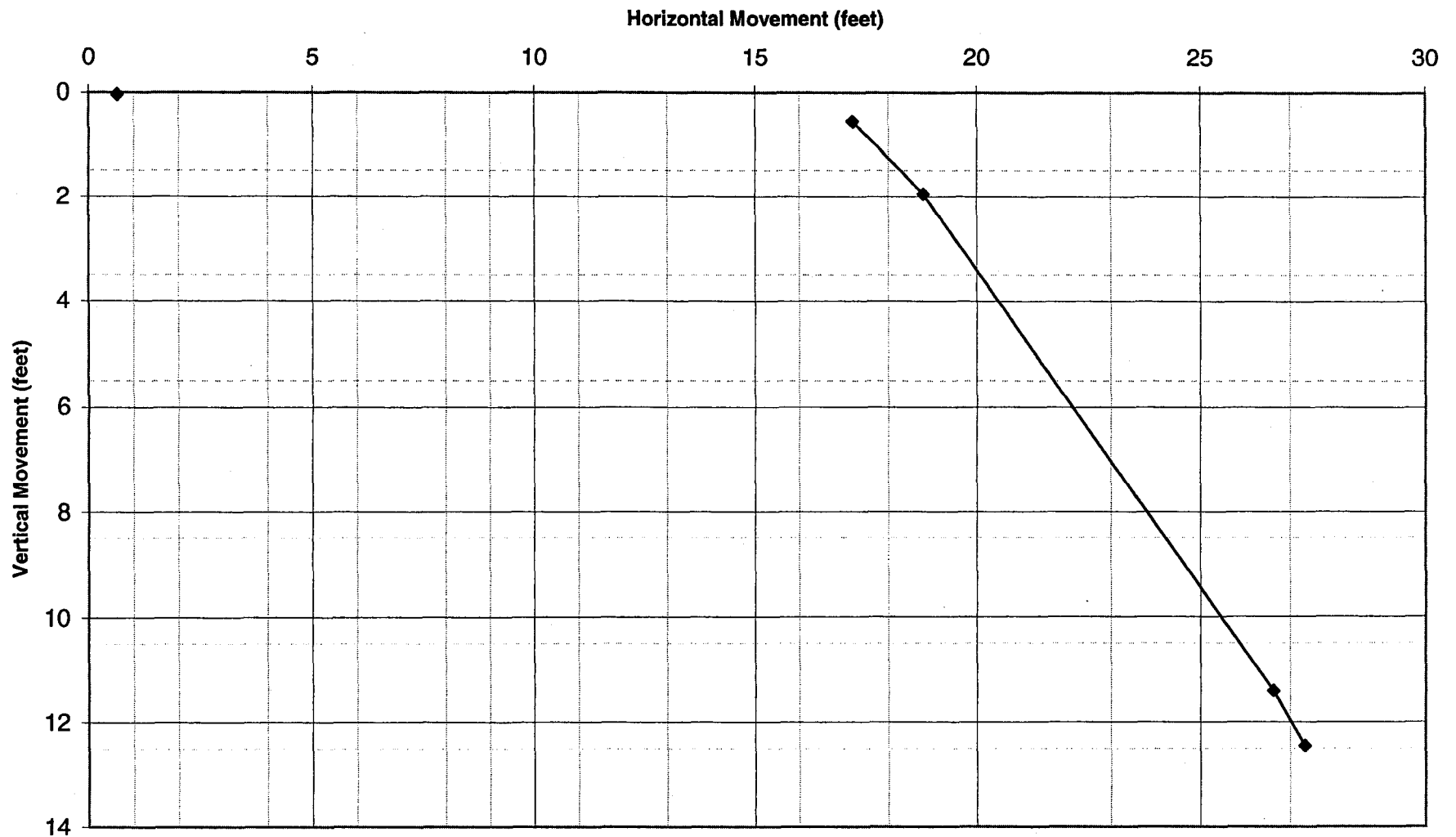
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #19**



DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monument #19



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #19**



Client: DIAND
 Project: Clinton Creek Asbestos Mine
 Job No.: 4440-038-02-02
 Date: 9-Jul-01

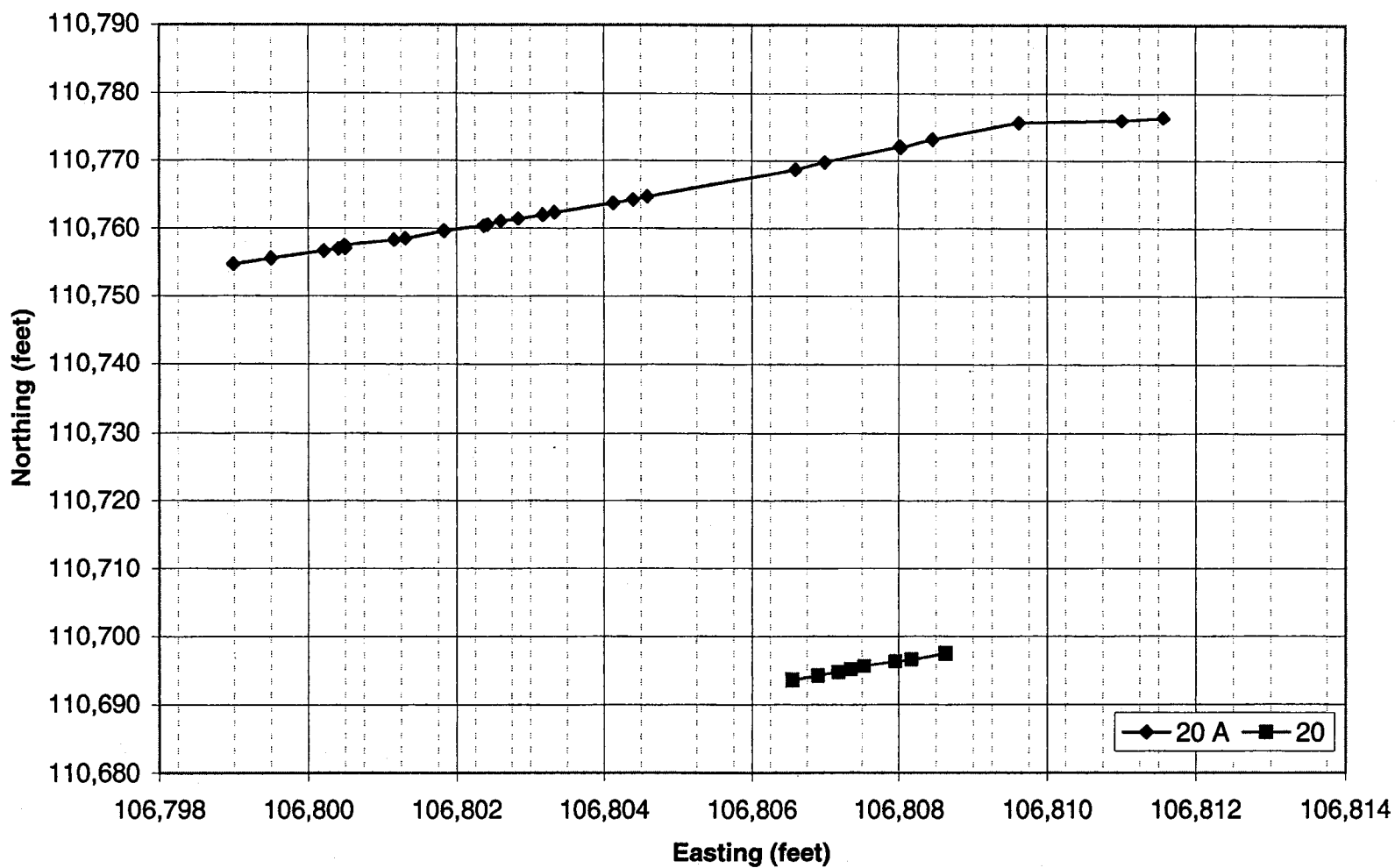
Waste Dump Stability - Monitoring Point #19

Notes: Assume all elevations represent top of monitoring point, not ground surface.
 June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

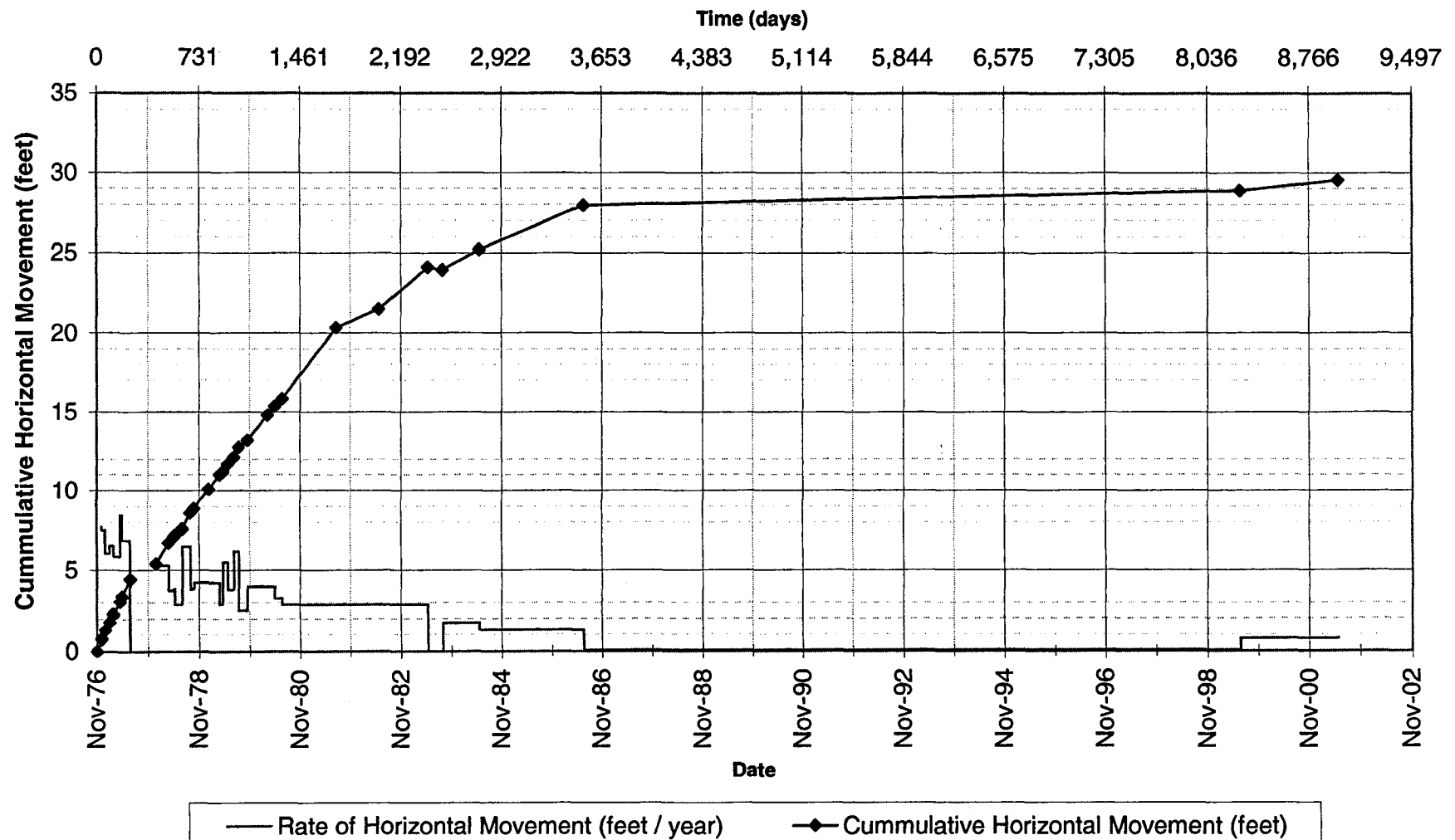
Interpolated values

Monitoring Date	Northing (feet)	Easting (feet)	Elevation (feet)	Time		Horizontal Movement			Vertical Movement		
				Total (days)	Incremental (days)	total (feet)	incremental (feet)	rate (feet/year)	total (feet)	incremental (feet)	rate (feet / year)
24-Nov-76	110,480.08	107,803.92		0	0	0	0	0			
25-Jan-77	110,480.44	107,804.44		62.0	62.0	0.63	0.63	3.723	0.04	0.04	0.24
24-Feb-77	110,480.68	107,804.52		92.0	30.0	0.85	0.25	3.078			
23-Mar-77	110,480.80	107,804.84		119.0	27.0	1.17	0.34	4.620			
10-May-77	110,481.06	107,805.04		167.0	48.0	1.49	0.33	2.494			
24-May-77	110,481.06	107,805.24		181.0	14.0	1.64	0.20	5.214			
19-Jul-77	110,481.48	107,805.56		237.0	56.0	2.16	0.53	3.442			
18-Nov-77	110,482.60	107,807.25		359.0	122.0	4.18	2.03	6.066			
20-Jan-78	110,483.12	107,807.50		422.0	63.0	4.70	0.58	3.343			
20-Apr-78	110,483.48	107,808.32		512.0	90.0	5.56	0.90	3.632			
26-May-78	110,483.64	107,808.52		548.0	36.0	5.82	0.26	2.597			
6-Jun-78	110,483.48	107,808.44		559.0	11.0	5.66	0.18	5.936			
27-Jul-78	110,483.88	107,808.82		610.0	51.0	6.20	0.55	3.949			
22-Sep-78	110,484.16	107,809.02		667.0	57.0	6.53	0.34	2.203			
19-Oct-78	110,484.31	107,809.22		694.0	27.0	6.78	0.25	3.380			
1-Feb-79	110,484.75	107,809.65		799.0	105.0	7.39	0.62	2.139			
22-Apr-79	110,484.98	107,809.96		879.0	80.0	7.78	0.39	1.761			
16-May-79	110,485.57	107,810.08		903.0	24.0	8.25	0.60	9.157			
18-Jun-79	110,485.61	107,810.20		936.0	33.0	8.37	0.13	1.399			
1-Aug-79	110,485.45	107,810.35		980.0	44.0	8.38	0.22	1.819			
7-Sep-79	110,485.69	107,810.51		1017.0	37.0	8.65	0.29	2.845			
10-Nov-79	110,486.00	107,810.78		1081.0	64.0	9.06	0.41	2.345			
4-Apr-80	110,486.67	107,811.26		1227.0	146.0	9.86	0.82	2.060			
24-May-80	110,486.86	107,811.65		1277.0	50.0	10.28	0.43	3.167			
17-Jul-80	110,486.98	107,811.88		1331.0	54.0	10.53	0.26	1.754			
1-Sep-83	110,490.61	107,815.43	1422.64	2472.0	1141.0	15.60	5.08	1.624			
14-Jun-84	110,491.69	107,816.61	1422.09	2759.0	287.0	17.20	1.60	2.034	0.55	-0.55	-0.70
15-Jul-86	110,492.77	107,817.78	1420.69	3520.0	761.0	18.79	1.59	0.764	1.95	-1.40	-0.67
16-Jul-99	110,504.16	107,815.28	1411.23	8269.0	4749.0	26.63	11.66	0.896	11.41	-9.46	-0.73
19-Jun-01	110,504.74	107,815.70	1410.19	8973.0	704.0	27.33	0.72	0.371	12.45	-1.04	-0.54

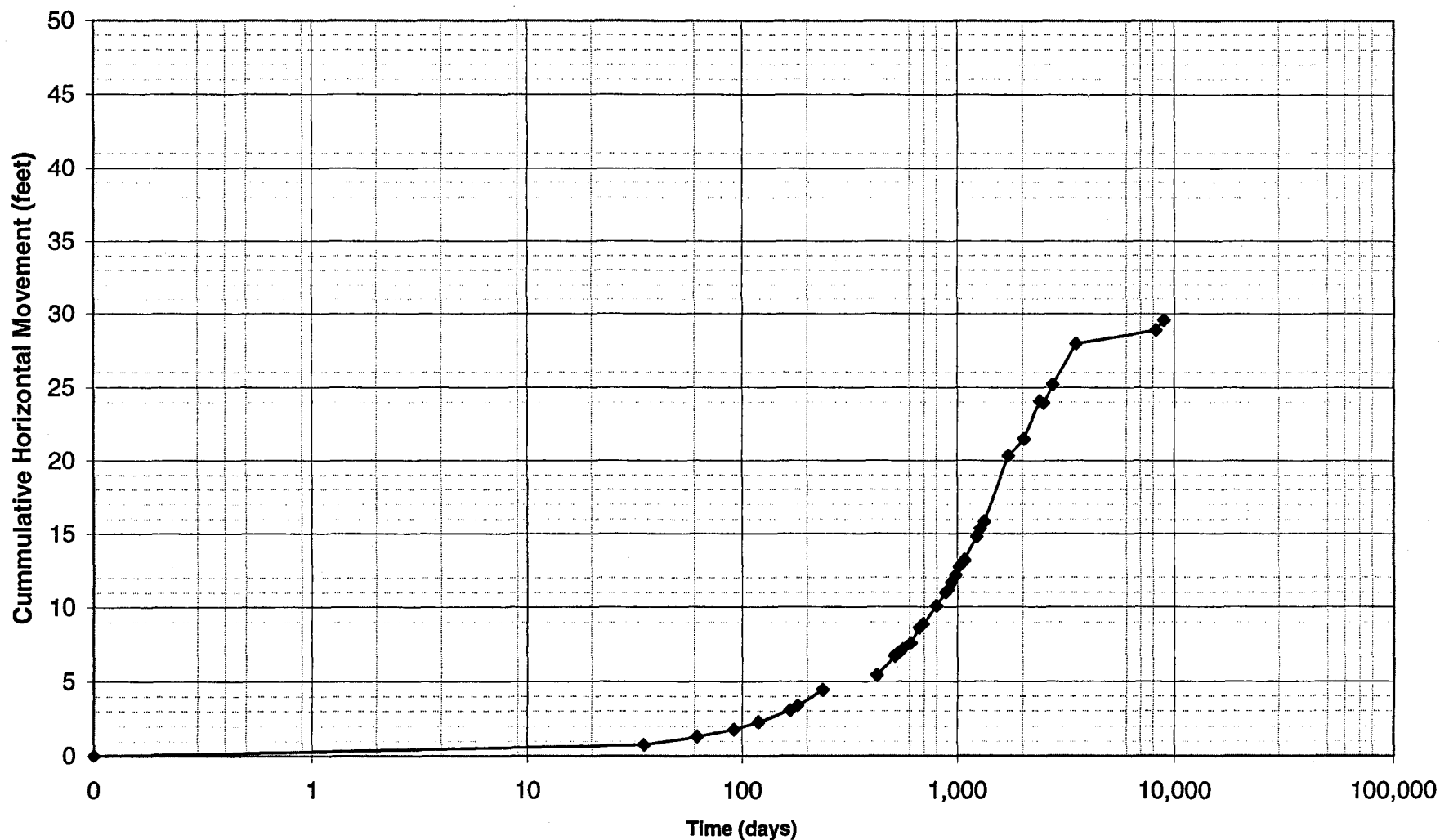
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #20 & 20A**



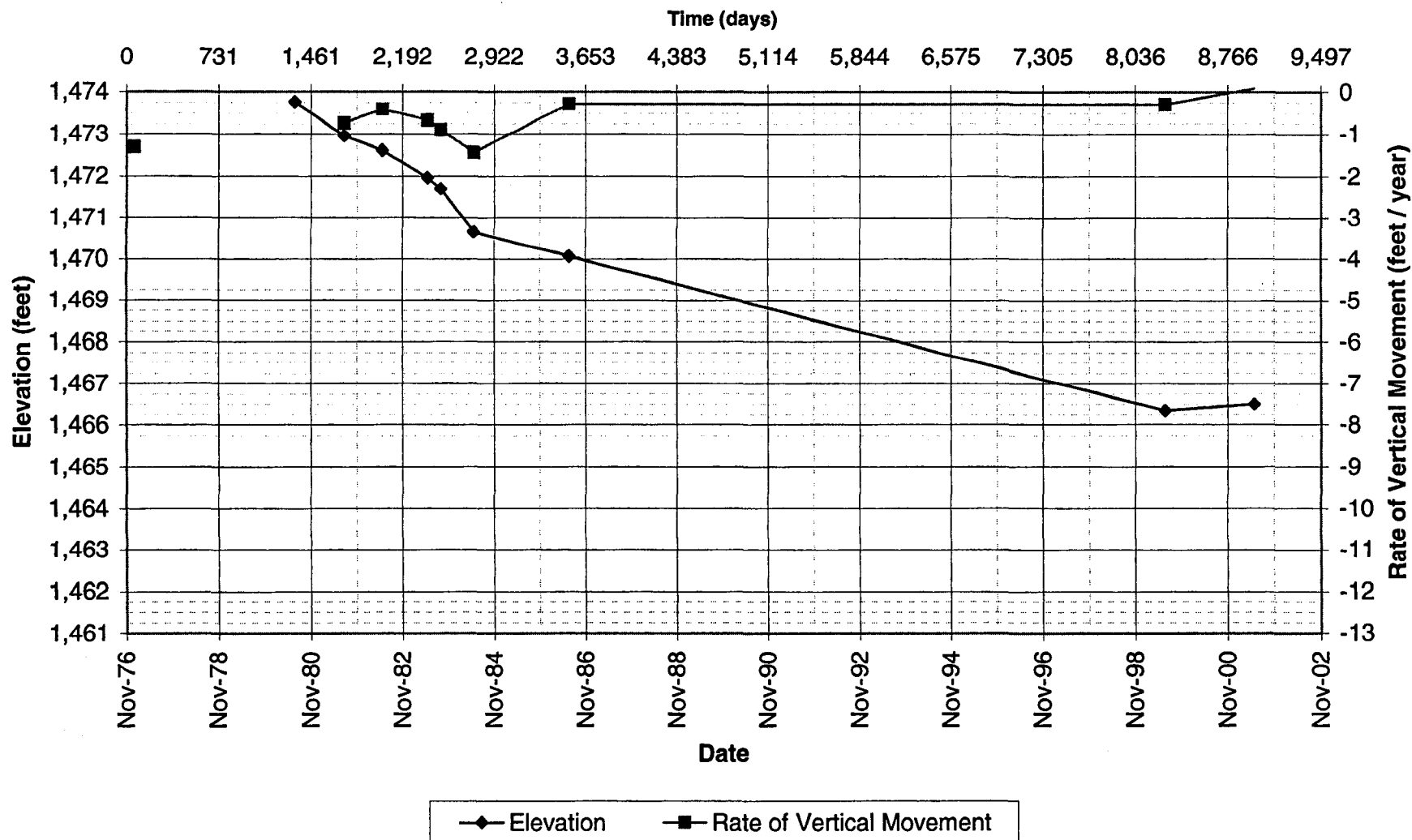
DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monuments #20 & 20A Combined



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #20 & 20A Combined**



DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monument #20 & 20A Combined



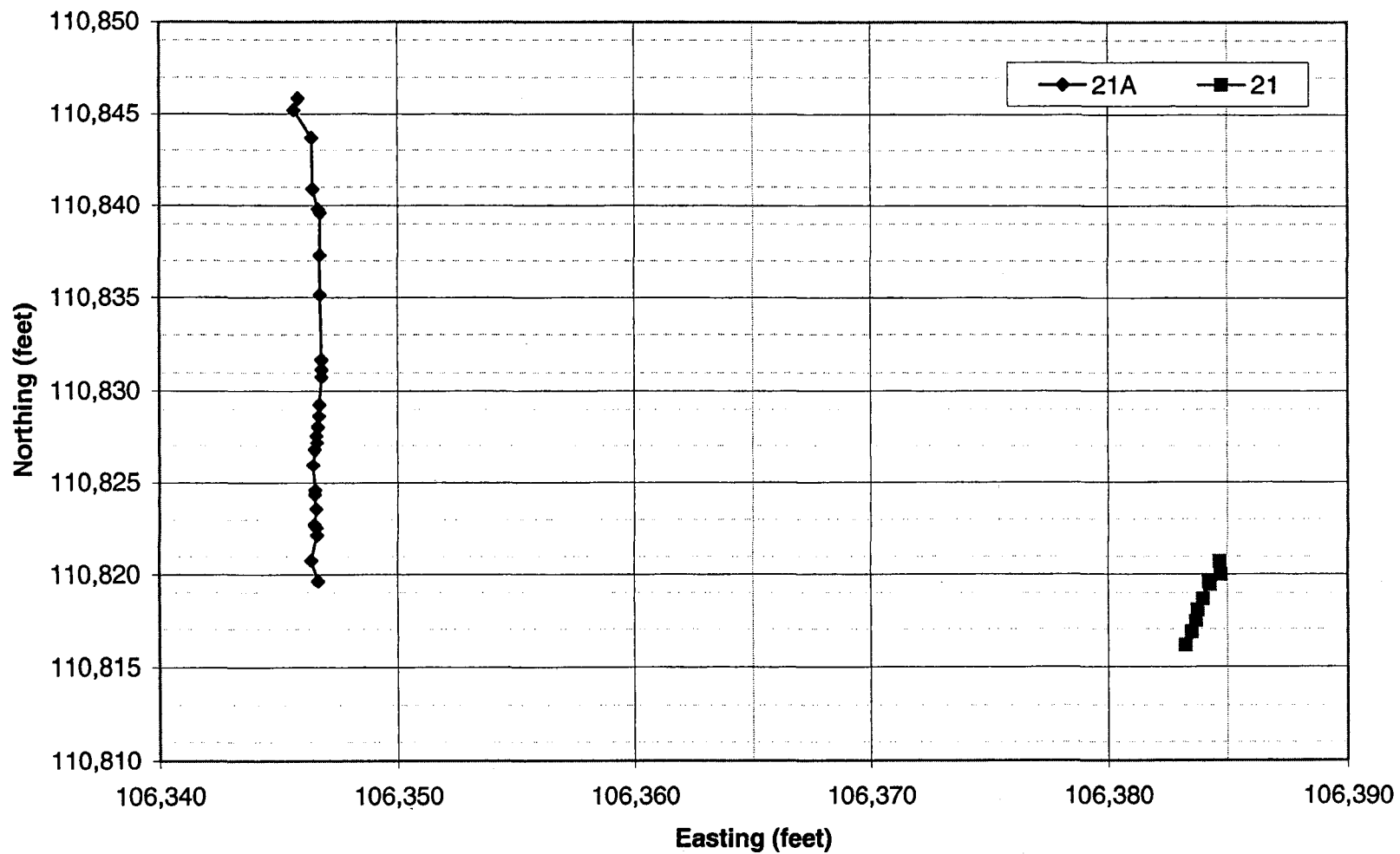
Client: DIAND
 Project: Clinton Creek Asbestos Mine
 Job No.: 4440-038-02-02
 Date: 9-Jul-01

Waste Dump Stability - Monitoring Point #20A

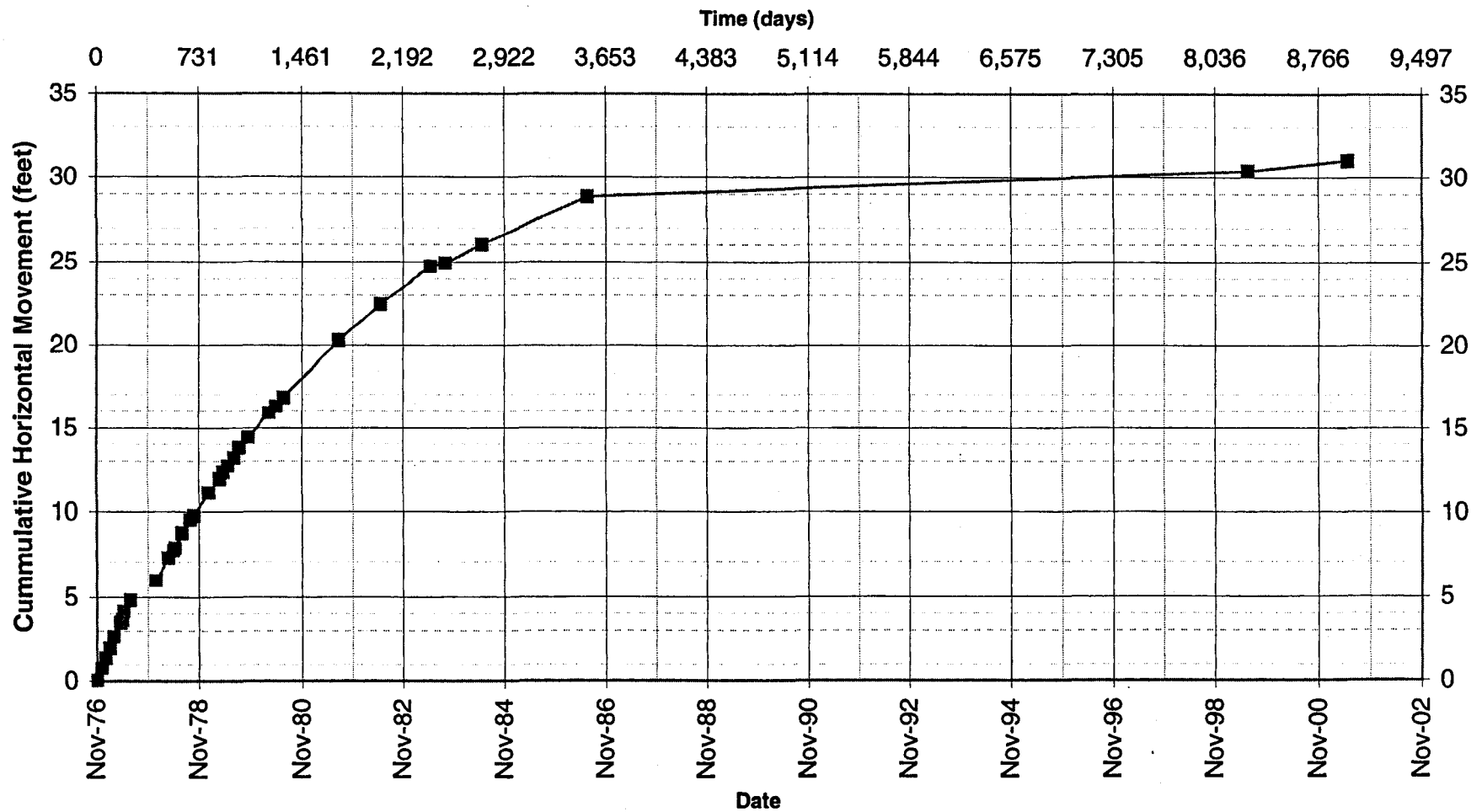
Notes: Assume all elevations represent top of monitoring point, not ground surface.
 June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

Interpolated values											
Monitoring	Northing	Easting	Elevation	Time		Horizontal Movement			Vertical Movement		
Date	(feet)	(feet)	(feet)	Total (days)	Incremental (days)	total (feet)	incremental (feet)	rate (feet/year)	total (feet)	incremental (feet)	rate (feet / year)
#20											
24-Nov-76	110,693.60	106,806.55		0	0	0	0	0			
29-Dec-76	110,694.25	106,806.90		35.0	35.0	0.74	0.74	7.699			
25-Jan-77	110,694.73	106,807.18		62.0	27.0	1.29	0.56	7.512	0.22		
24-Feb-77	110,695.20	106,807.35		92.0	30.0	1.79	0.50	6.081			
23-Mar-77	110,695.65	106,807.53		119.0	27.0	2.27	0.48	6.552			
10-May-77	110,696.30	106,807.95		167.0	48.0	3.04	0.77	5.885			
24-May-77	110,696.55	106,808.17		181.0	14.0	3.37	0.33	6.662			
19-Jul-77	110,697.50	106,808.63		237.0	56.0	4.42	1.06	6.880			
#20A											
18-Nov-77	110,754.71	106,798.99		0	0	0	0	0			
20-Jan-78	110,755.53	106,799.50		63.0	63.0	0.97	0.97	5.595			
20-Apr-78	110,756.63	106,800.21		153.0	90.0	2.27	1.31	5.310			
26-May-78	110,756.94	106,800.41		189.0	36.0	2.64	0.37	3.740			
6-Jun-78	110,757.02	106,800.50		200.0	11.0	2.76	0.12	3.996			
27-Jul-78	110,757.49	106,800.49		251.0	51.0	3.16	0.47	3.364			
22-Sep-78	110,758.27	106,801.16		308.0	57.0	4.17	1.03	6.584			
19-Oct-78	110,758.51	106,801.31		335.0	27.0	4.45	0.28	3.826			
1-Feb-79	110,759.61	106,801.83		440.0	105.0	5.66	1.22	4.230			
22-Apr-79	110,760.36	106,802.37		520.0	80.0	6.58	0.92	4.217			
16-May-79	110,760.55	106,802.42		544.0	24.0	6.77	0.20	2.988			
18-Jun-79	110,761.02	106,802.60		577.0	33.0	7.27	0.50	5.567			
1-Aug-79	110,761.41	106,802.84		621.0	44.0	7.73	0.46	3.799			
7-Sep-79	110,761.94	106,803.17		658.0	37.0	8.35	0.62	6.159			
10-Nov-79	110,762.35	106,803.33		722.0	64.0	8.79	0.44	2.510			
4-Apr-80	110,763.73	106,804.13		868.0	146.0	10.38	1.60	3.988			
24-May-80	110,764.20	106,804.40		918.0	50.0	10.92	0.54	3.957			
17-Jul-80	110,764.65	106,804.59	1473.76	972.0	54.0	11.41	0.49	3.302			
15-Aug-81	110,768.70	106,806.60	1472.96	1366.0	394.0	15.93	4.52	4.189			-0.8
15-Jun-82	110,769.80	106,807.00	1472.62	1670.0	304.0	17.08	1.17	1.405			-0.34
9-Jun-83	110,772.19	106,808.02	1471.96	2029.0	359.0	19.87	2.60	2.642			-0.66
23-Sep-83	110,772.00	106,808.03	1471.7	2135.0	106.0	19.51	0.19	0.655			-0.26
14-Jun-84	110,773.22	106,808.46	1470.66	2400.0	265.0	20.79	1.29	1.782			-1.04
15-Jul-86	110,775.69	106,809.62	1470.07	3161.0	761.0	23.52	2.73	1.309			-0.59
17-Jul-99	110,776.00	106,811.01	1466.34	7911.0	4750.0	24.45	1.42	0.109			-3.73
19-Jun-01	110,776.44	106,811.57	1466.5	8614.0	703.0	25.11	0.71	0.369			0.16
20 & 20A Combined											
24-Nov-76				0.1	0.0	0.00	0.00	0.000			
29-Dec-76				35.0	35.0	0.74	0.74	7.699			
25-Jan-77				62.0	27.0	1.29	0.56	7.510	-0.22		-1.3
24-Feb-77				92.0	30.0	1.79	0.50	6.024			
23-Mar-77				119.0	27.0	2.27	0.48	6.534			
10-May-77				167.0	48.0	3.04	0.77	5.849			
24-May-77				181.0	14.0	3.37	0.32	6.451			
19-Jul-77				237.0	56.0	4.42	1.05	6.873			
18-Nov-77				359.0							
20-Jan-78				422.0	63.0	5.39					
20-Apr-78				512.0	90.0	6.69	1.31	5.309			
26-May-78				548.0	36.0	7.06	0.37	3.740			
6-Jun-78				559.0	11.0	7.18	0.12	3.850			
27-Jul-78				610.0	51.0	7.58	0.40	2.856			
22-Sep-78				667.0	57.0	8.59	1.01	6.470			
19-Oct-78				694.0	27.0	8.87	0.28	3.826			
1-Feb-79				799.0	105.0	10.08	1.21	4.211			
22-Apr-79				879.0	80.0	11.00	0.92	4.199			
16-May-79				903.0	24.0	11.19	0.19	2.873			
18-Jun-79				936.0	33.0	11.69	0.50	5.496			
1-Aug-79				980.0	44.0	12.15	0.46	3.797			
7-Sep-79				1017.0	37.0	12.77	0.62	6.155			
10-Nov-79				1081.0	64.0	13.21	0.44	2.482			
4-Apr-80				1227.0	146.0	14.80	1.60	3.988			
24-May-80				1277.0	50.0	15.34	0.54	3.957			
17-Jul-80			1473.76	1331.0	54.0	15.83	0.49	3.279			
15-Aug-81			1472.96	1725.0	394.0	20.35	4.52	4.184			-0.8
15-Jun-82			1472.62	2029.0	304.0	21.50	1.16	1.391			-0.34
9-Jun-83			1471.96	2388.0	359.0	24.09	2.59	2.634			-0.66
23-Sep-83			1471.7	2494.0	106.0	23.93	-0.16	-0.565			-0.26
14-Jun-84			1470.66	2759.0	265.0	25.21	1.28	1.765			-1.04
15-Jul-86			1470.07	3520.0	761.0	27.94	2.73	1.308			-0.59
17-Jul-99			1466.34	8270.0	4750.0	28.87	0.93	0.071			-3.73
19-Jun-01			1466.5	8973.0	703.0	29.53	0.66	0.342			0.16

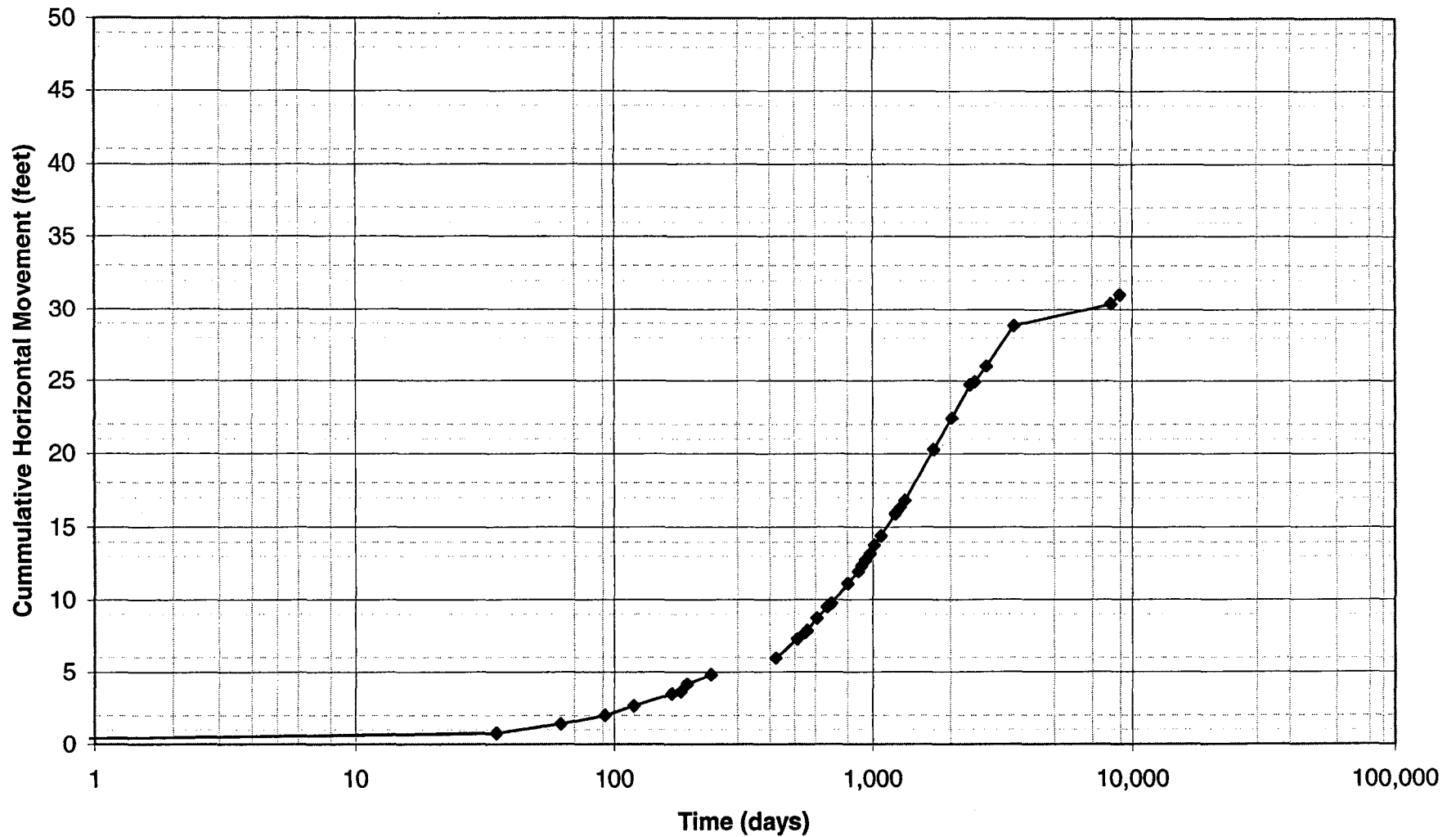
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #21 & 21A**



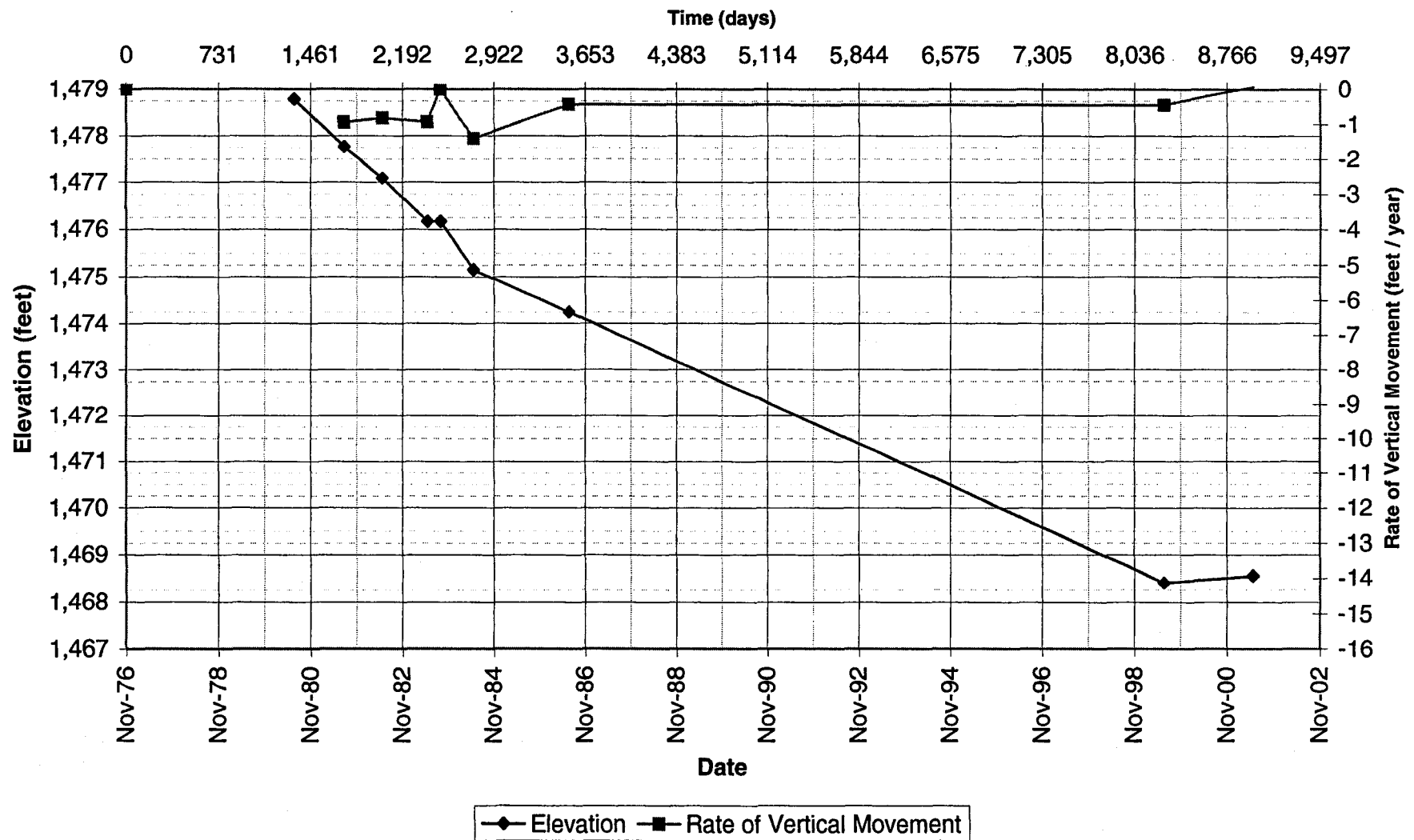
DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monuments #21 & 21A



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #21 & 21A**



DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monuments #21 & 21A Combined



Client: DIAND
 Project: Clinton Creek Asbestos Mine
 Job No.: 4440-038-02-02
 Date: 9-Jul-01

Waste Dump Stability - Monitoring Points #21 & 21A

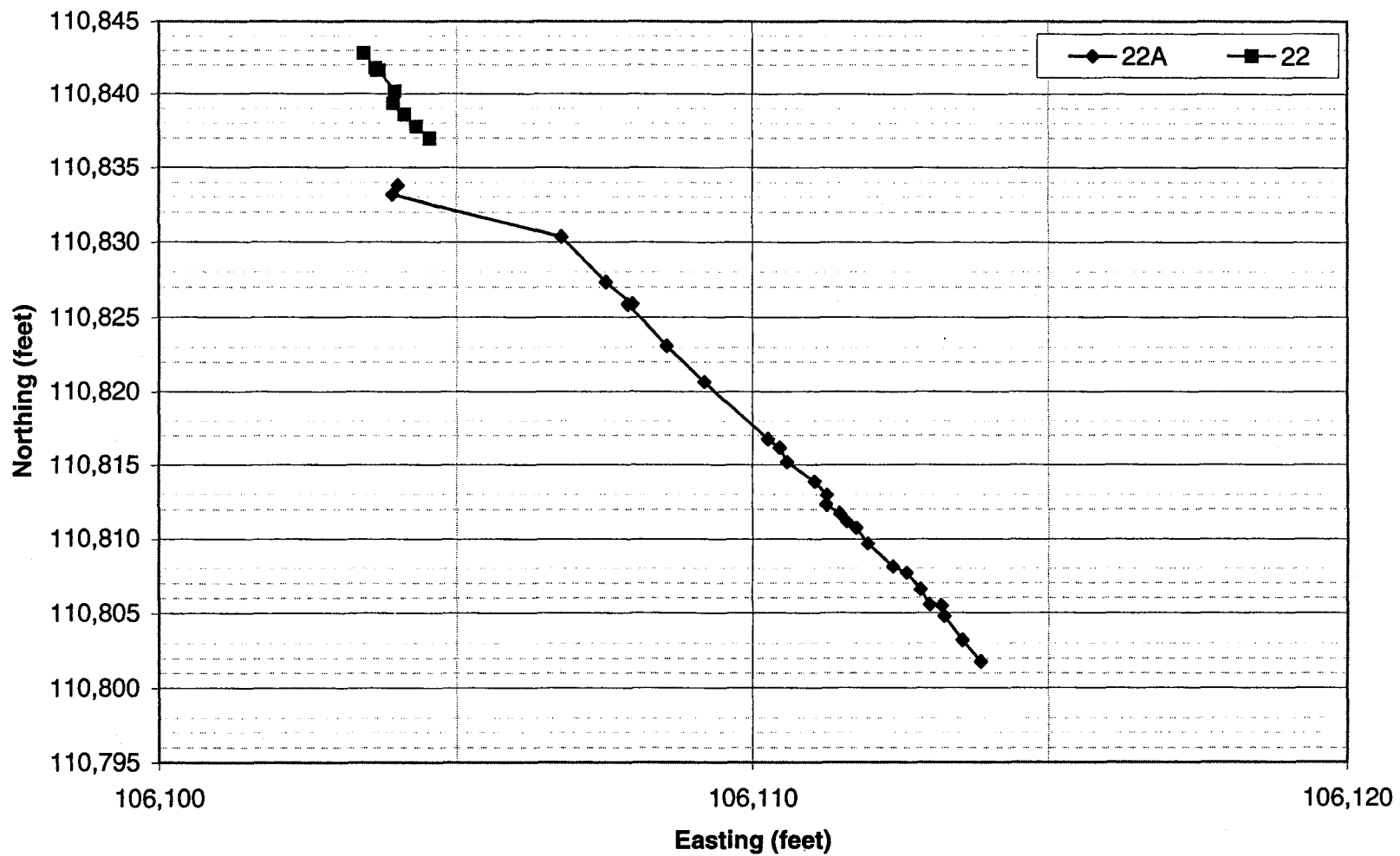
Notes: Assume all elevations represent top of monitoring point, not ground surface.

June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

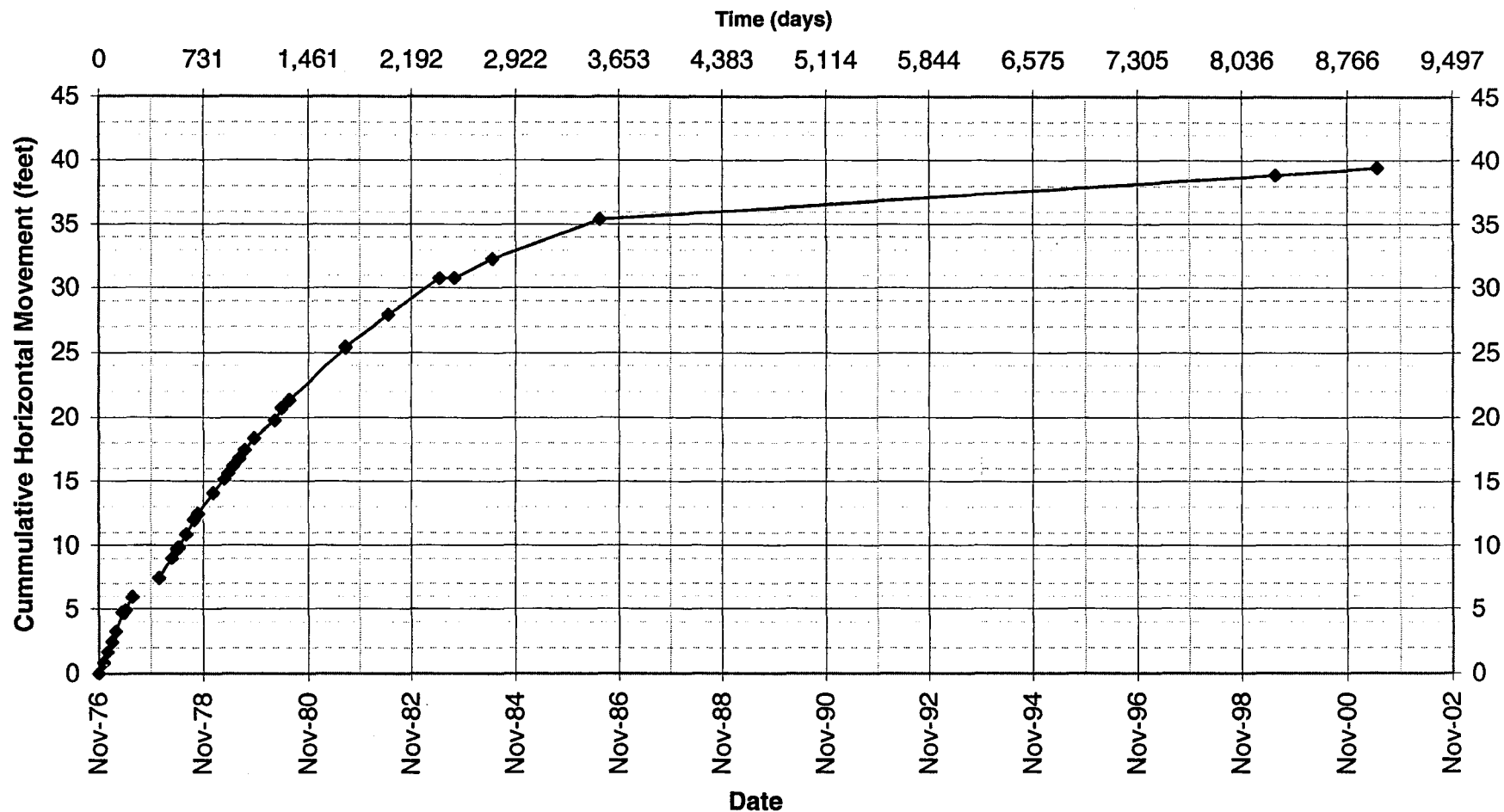
Interpolated using survey and rates of movement

Monitoring	Northing	Easting	Elevation	Time		Horizontal Movement			Vertical Movement		
				Total	Incremental	total	incremental	rate	total	incremental	rate
Date	(feet)	(feet)	(feet)	(days)	(days)	(feet)	(feet)	(feet / year)	(feet)	(feet)	(feet / year)
Monitor Point #20											
24-Nov-76	110,816.15	106,383.25		0	0	0	0	0			
29-Dec-76	110,816.86	106,383.51		35.0	35.0	0.76	0.76	7.885			
25-Jan-77	110,817.46	106,383.68		62.0	27.0	1.38	0.62	8.430	0.45		
24-Feb-77	110,818.06	106,383.76		92.0	30.0	1.98	0.61	7.365			
23-Mar-77	110,818.69	106,383.97		119.0	27.0	2.64	0.66	8.977			
10-May-77	110,819.48	106,384.26		167.0	48.0	3.48	0.84	6.399			
24-May-77	110,819.66	106,384.23		181.0	14.0	3.64	0.16	4.758			
3-Jun-77	110,820.02	106,384.73		191.0	10.0	4.14	0.62	22.488			
19-Jul-77	110,820.73	106,384.68		237.0	46.0	4.80	0.71	5.648			
Monitor Point #20 A											
18-Nov-77	110,819.65	106,346.63		0	0	0	0	0			
20-Jan-78	110,820.78	106,346.36		63.0	63.0	1.16	1.16	6.731			
20-Apr-78	110,822.12	106,346.59		153.0	90.0	2.47	1.36	5.514			
26-May-78	110,822.55	106,346.55		189.0	36.0	2.90	0.43	4.379			
6-Jun-78	110,822.71	106,346.47		200.0	11.0	3.06	0.18	5.936			
27-Jul-78	110,823.57	106,346.55		251.0	51.0	3.92	0.86	6.181			
22-Sep-78	110,824.35	106,346.49		308.0	57.0	4.70	0.78	5.009			
19-Oct-78	110,824.60	106,346.51		335.0	27.0	4.95	0.25	3.390			
1-Feb-79	110,825.95	106,346.43		440.0	105.0	6.30	1.35	4.701			
22-Apr-79	110,826.78	106,346.51		520.0	80.0	7.13	0.83	3.804			
16-May-79	110,827.18	106,346.60		544.0	24.0	7.53	0.41	6.235			
18-Jun-79	110,827.56	106,346.56		577.0	33.0	7.91	0.38	4.226			
1-Aug-79	110,828.04	106,346.63		621.0	44.0	8.39	0.49	4.024			
7-Sep-79	110,828.63	106,346.68		658.0	37.0	8.98	0.59	5.841			
10-Nov-79	110,829.25	106,346.69		722.0	64.0	9.60	0.62	3.536			
4-Apr-80	110,830.75	106,346.79		868.0	146.0	11.10	1.50	3.758			
24-May-80	110,831.15	106,346.79		918.0	50.0	11.50	0.40	2.920			
17-Jul-80	110,831.65	106,346.79	1478.79	972.0	54.0	12.00	0.50	3.380			
15-Aug-81	110,835.13	106,346.73	1477.77	1366.0	394.0	15.48	3.48	3.224	-1.02	-0.94	
15-Jun-82	110,837.30	106,346.71	1477.09	1670.0	304.0	17.65	2.17	2.605	-0.68	-0.82	
9-Jun-83	110,839.58	106,346.72	1,476.17	2029.0	359.0	19.93	2.28	2.318	-0.92	-0.94	
23-Sep-83	110,839.78	106,346.64	1,476.17	2135.0	106.0	20.13	0.22	0.742	0	0.00	
14-Jun-84	110,840.87	106,346.41	1,475.15	2400.0	265.0	21.22	1.11	1.534	-1.02	-1.40	
15-Jul-86	110,843.70	106,346.38	1,474.25	3161.0	761.0	24.05	2.83	1.357	-0.9	-0.43	
16-Jul-99	110,845.21	106,345.62	1,468.40	7910.0	4749.0	25.58	1.69	0.130	-5.85	-0.45	
19-Jun-01	110,845.83	106,345.81	1,468.55	8614.0	704.0	26.19	0.65	0.336	0.15	0.08	
Monitoring Points 21 & 21A combined											
24-Nov-76				0.0	0.0	0.00	0.00	0.00	0	0	0
29-Dec-76				35.0	35.0	0.76	0.76	7.885			
25-Jan-77				62.0	27.0	1.38	0.62	8.417			
24-Feb-77				92.0	30.0	1.98	0.60	7.277			
23-Mar-77				119.0	27.0	2.64	0.66	8.965			
10-May-77				167.0	48.0	3.48	0.84	6.385			
24-May-77				181.0	14.0	3.64	0.16	4.287			
3-Jun-77				191.0	10.0	4.14	0.50	18.217			
19-Jul-77				237.0	46.0	4.80	0.65	5.195			
18-Nov-77				359.0	122.0						
20-Jan-78				422.0	63.0	5.96	1.16	6.731			
20-Apr-78				512.0	90.0	7.27	1.31	5.307			
26-May-78				548.0	36.0	7.70	0.43	4.368			
6-Jun-78				559.0	11.0	7.86	0.16	5.411			
27-Jul-78				610.0	51.0	8.72	0.66	6.131			
22-Sep-78				667.0	57.0	9.50	0.78	5.003			
19-Oct-78				694.0	27.0	9.75	0.25	3.371			
1-Feb-79				799.0	105.0	11.10	1.35	4.699			
22-Apr-79				879.0	80.0	11.93	0.83	3.777			
16-May-79				903.0	24.0	12.33	0.40	6.069			
18-Jun-79				936.0	33.0	12.71	0.38	4.206			
1-Aug-79				980.0	44.0	13.19	0.48	3.979			
7-Sep-79				1017.0	37.0	13.78	0.59	5.822			
10-Nov-79				1081.0	64.0	14.40	0.62	3.536			
4-Apr-80				1227.0	146.0	15.90	1.50	3.752			
24-May-80				1277.0	50.0	16.30	0.40	2.920			
17-Jul-80			1478.79	1331.0	54.0	16.80	0.50	3.379			
15-Aug-81			1477.77	1725.0	394.0	20.28	3.48	3.223	-1.02	-0.94	
15-Jun-82			1477.09	2029.0	304.0	22.45	2.17	2.605	-0.68	-0.82	
9-Jun-83			1,476.17	2388.0	359.0	24.73	2.28	2.318	-0.92	-0.94	
23-Sep-83			1,476.17	2494.0	106.0	24.93	0.20	0.688	0.00	0.00	
14-Jun-84			1,475.15	2759.0	265.0	26.02	1.09	1.503	-1.02	-1.40	
15-Jul-86			1,474.25	3520.0	761.0	28.85	2.83	1.357	-0.90	-0.43	
16-Jul-99			1,468.40	8269.0	4749.0	30.38	1.53	0.117	-5.85	-0.45	
19-Jun-01			1,468.55	8973.0	704.0	30.99	0.61	0.318	0.15	0.08	

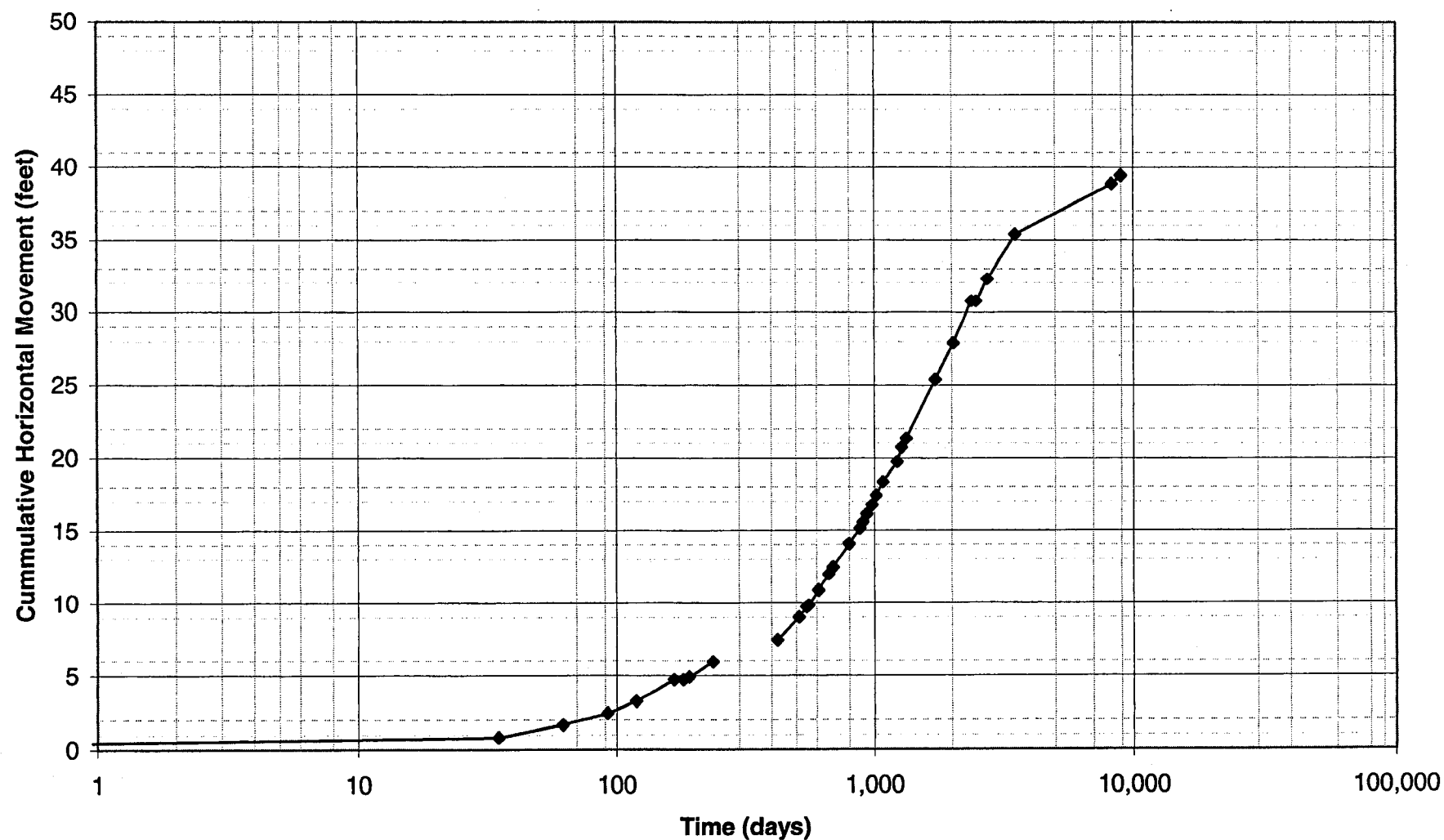
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #22 & 22A**



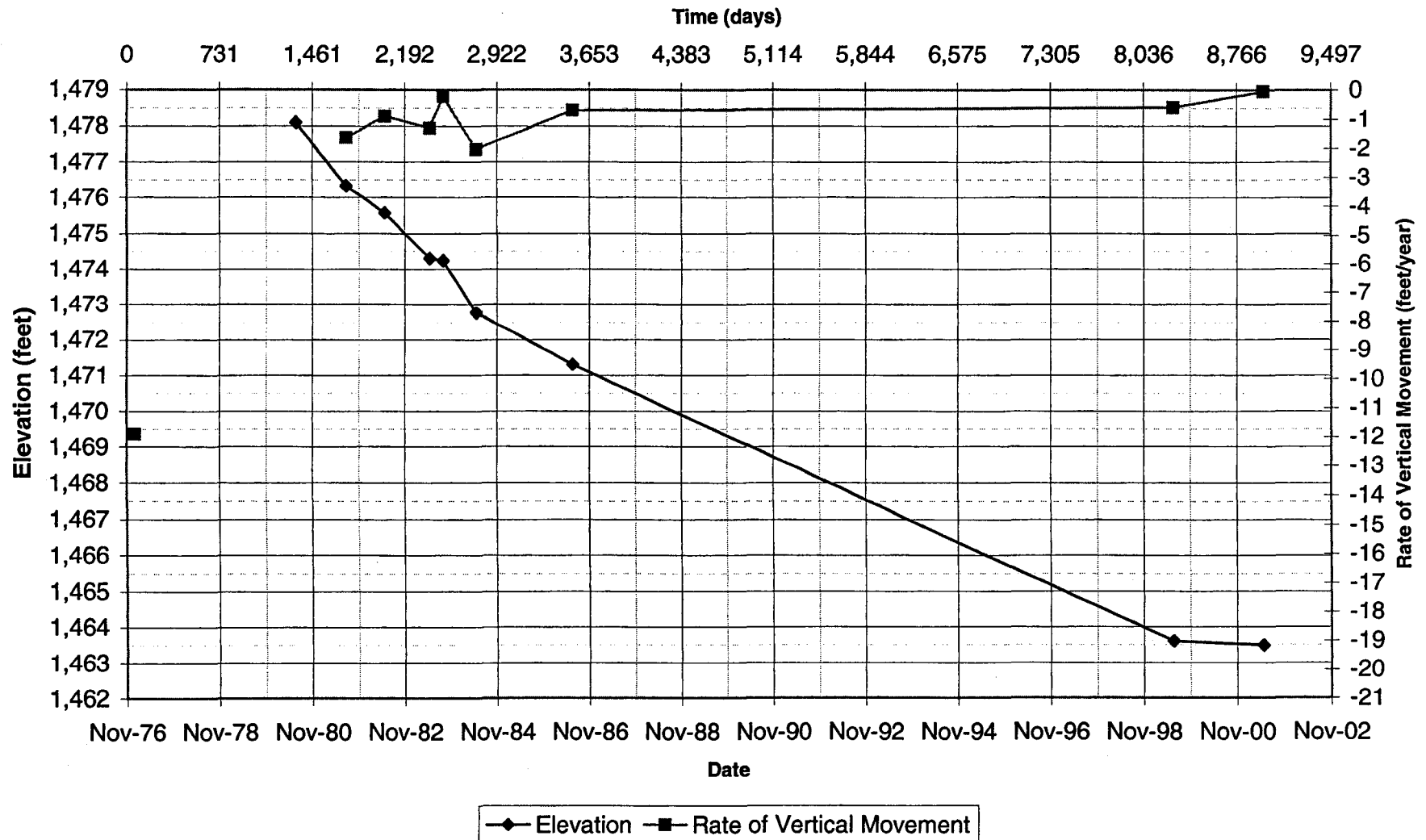
DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monuments #22 & 22A Combined



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #22 & 22A Combined**



DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monuments #22A



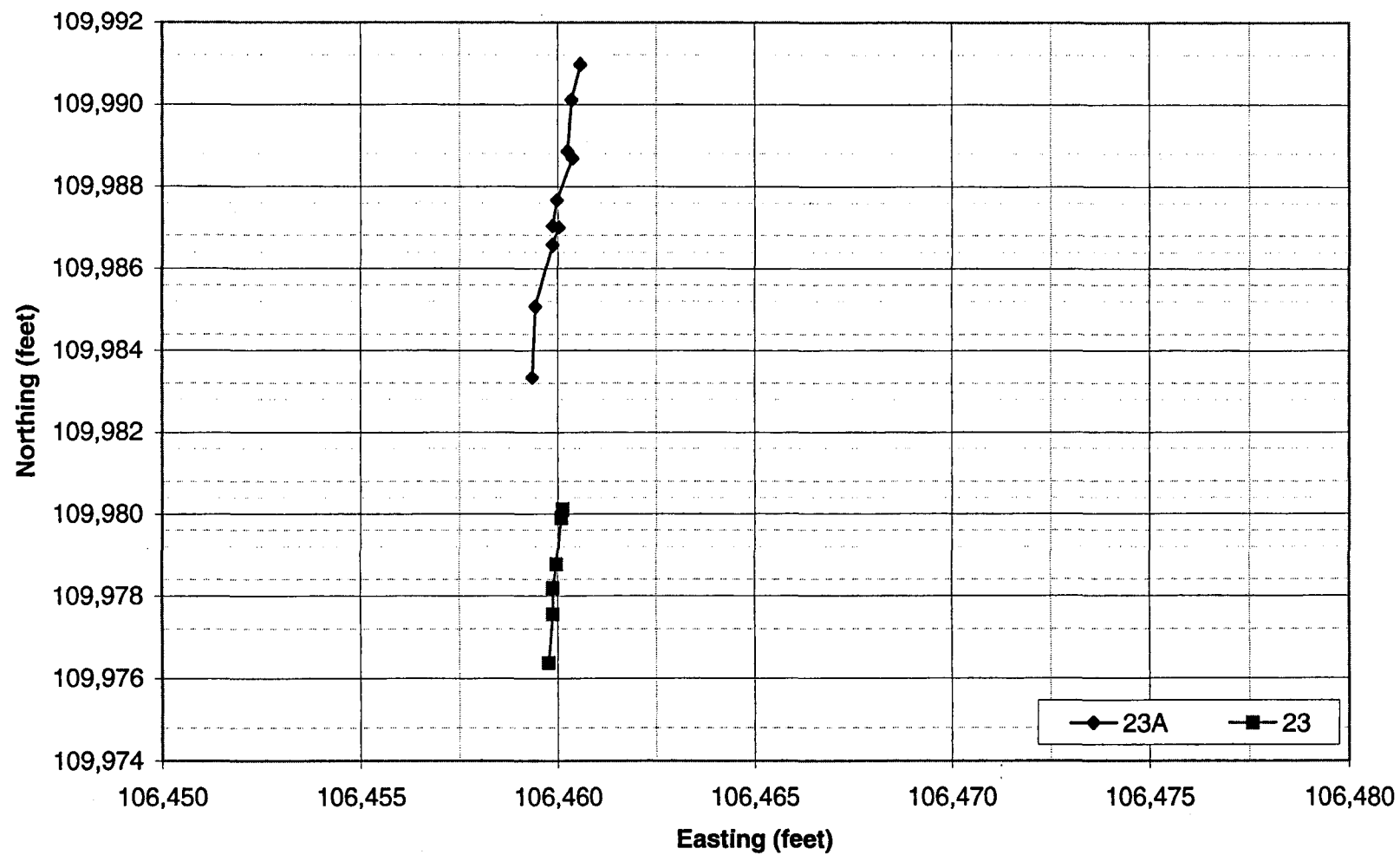
Client: DIAND
 Project: Clinton Creek Asbestos Mine
 Job No.: 4440-038-02-02
 Date: 9-Jul-01

Waste Dump Stability - Monitoring Points #22 & 22A

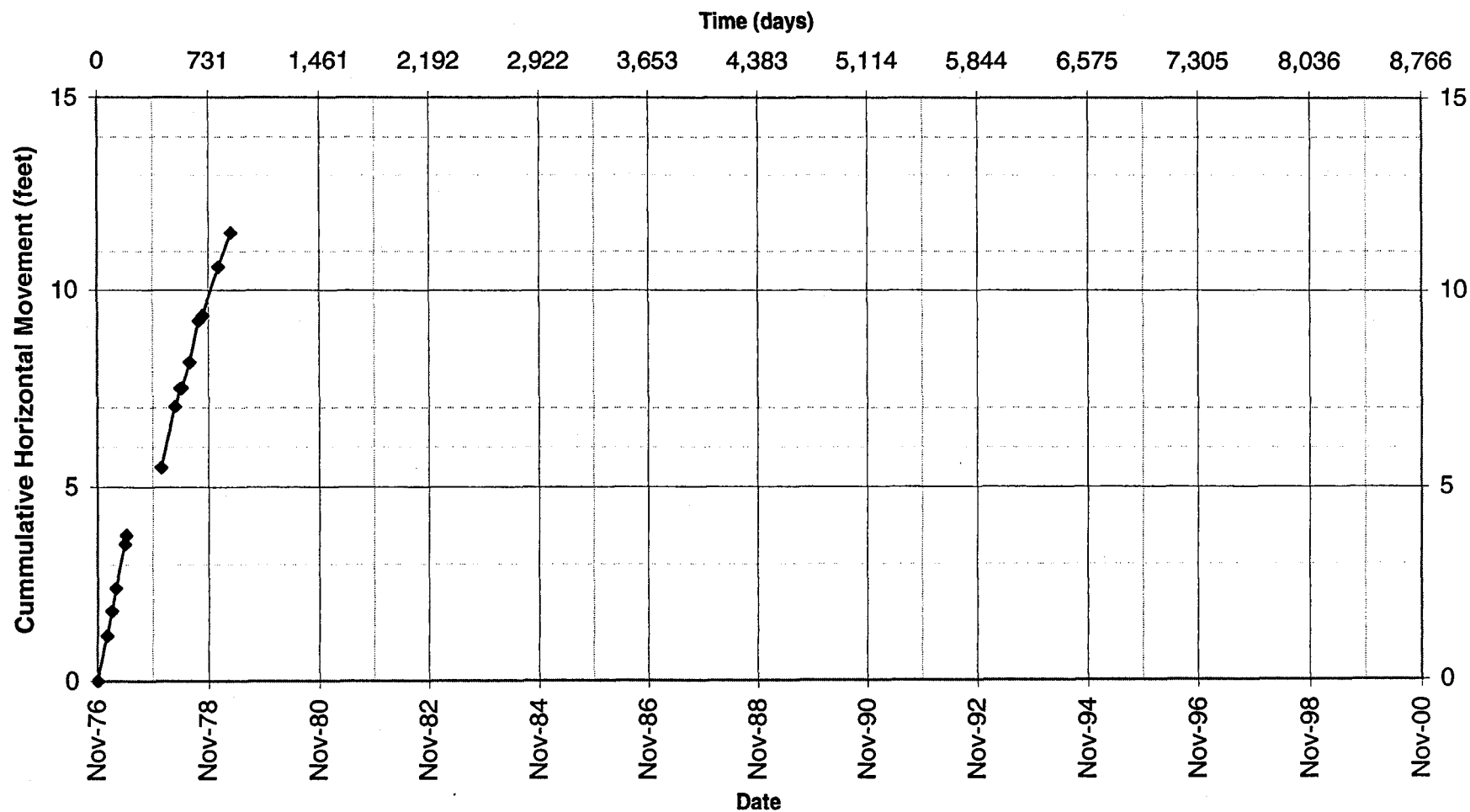
Notes: Assume all elevations represent top of monitoring point, not ground surface.
 June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

Monitoring	Northing	Easting	Elevation	Time		Horizontal Movement			Vertical Movement		
Date	(feet)	(feet)	(feet)	Total (days)	Incremental (days)	total (feet)	incremental (feet)	rate (feet/year)	total (feet)	incremental (feet)	rate (feet / year)
Monitor Point #22											
24-Nov-76	110,836.97	106,104.54		0	0	0	0	0			
29-Dec-76	110,837.76	106,104.32		35.0	35.0	0.82	0.82	8.552			
25-Jan-77	110,838.57	106,104.12		62.0	27.0	1.65	0.83	11.279	-0.88	-0.88	-11.90
24-Feb-77	110,839.33	106,103.93		92.0	30.0	2.44	0.78	9.531			
23-Mar-77	110,840.16	106,103.96		119.0	27.0	3.24	0.83	11.228			
10-May-77	110,841.60	106,103.69		167.0	48.0	4.71	1.47	11.141			
24-May-77	110,841.60	106,103.65		181.0	14.0	4.71	0.04	1.043			
3-Jun-77	110,841.77	106,103.63		191.0	10.0	4.89	0.17	6.248			
19-Jul-77	110,842.80	106,103.43		237.0	46.0	5.93	1.05	8.325			
Monitor Point #22A											
18-Nov-77	110,801.76	106,113.86		0	0	0	0	0			
20-Jan-78	110,803.21	106,113.55		63.0	63.0	1.48	1.48	8.591			
20-Apr-78	110,804.77	106,113.24		153.0	90.0	3.07	1.59	6.450			
26-May-78	110,805.48	106,113.20		189.0	36.0	3.78	0.71	7.210			
6-Jun-78	110,805.56	106,113.00		200.0	11.0	3.90	0.22	7.148			
27-Jul-78	110,806.57	106,112.85		251.0	51.0	4.91	1.02	7.308			
22-Sep-78	110,807.67	106,112.61		308.0	57.0	6.04	1.13	7.210			
19-Oct-78	110,808.10	106,112.38		335.0	27.0	6.51	0.49	6.592			
1-Feb-79	110,809.66	106,111.95		440.0	105.0	8.13	1.62	5.625			
22-Apr-79	110,810.72	106,111.75		520.0	80.0	9.21	1.08	4.922			
16-May-79	110,811.15	106,111.59		544.0	24.0	9.66	0.46	6.978			
18-Jun-79	110,811.70	106,111.48		577.0	33.0	10.22	0.56	6.204			
1-Aug-79	110,812.28	106,111.25		621.0	44.0	10.84	0.62	5.176			
7-Sep-79	110,812.95	106,111.26		658.0	37.0	11.49	0.67	6.610			
10-Nov-79	110,813.85	106,111.05		722.0	64.0	12.41	0.92	5.271			
4-Apr-80	110,815.18	106,110.59		868.0	146.0	13.81	1.41	3.518			
24-May-80	110,816.16	106,110.46		918.0	50.0	14.80	0.99	7.217			
17-Jul-80	110,816.74	106,110.26	1478.09	972.0	54.0	15.41	0.61	4.147			
15-Aug-81	110,820.65	106,109.19	1476.33	1366.0	394.0	19.46	4.05	3.76	-1.76	-1.63	
15-Jun-82	110,823.07	106,108.55	1475.58	1670.0	304.0	21.96	2.50	3.01	-0.75	-0.90	
9-Jun-83	110,825.85	106,107.89	1474.30	2029.0	359.0	24.82	2.86	2.91	-1.28	-1.30	
23-Sep-83	110,825.87	106,107.97	1474.24	2135.0	106.0	24.82	0.08	0.28	-0.06	-0.21	
14-Jun-84	110,827.32	106,107.52	1472.76	2400.0	265.0	26.33	1.52	2.09	-1.48	-2.04	
15-Jul-86	110,830.34	106,106.76	1471.30	3161.0	761.0	29.45	3.11	1.49	-1.46	-0.70	
16-Jul-99	110,833.15	106,103.92	1463.60	7910.0	4749.0	32.93	4.00	0.31	-7.70	-0.59	
19-Jun-01	110,833.78	106,104.01	1463.49	8614.0	704.0	33.50	0.64	0.33	-0.11	-0.06	
Monitor Point 22 & 22A Combined											
24-Nov-76				0.0	0.0	0	0.00	0.00			
29-Dec-76				35.0	35.0	0.82	0.82	8.552			
25-Jan-77				62.0	27.0	1.65	0.83	11.276	-0.88	-0.88	-11.90
24-Feb-77				92.0	30.0	2.44	0.78	9.531			
23-Mar-77				119.0	27.0	3.24	0.80	10.879			
10-May-77				167.0	48.0	4.71	1.47	11.141			
24-May-77				181.0	14.0	4.71	0.01	0.193			
3-Jun-77				191.0	10.0	4.89	0.17	6.232			
19-Jul-77				237.0	46.0	5.93	1.05	8.325			
18-Nov-77				359.0							
20-Jan-78				422.0	63.0	7.42					
20-Apr-78				512.0	90.0	9.01	1.59	6.450			
26-May-78				548.0	36.0	9.71	0.70	7.147			
6-Jun-78				559.0	11.0	9.83	0.12	3.916			
27-Jul-78				610.0	51.0	10.85	1.02	7.291			
22-Sep-78				667.0	57.0	11.98	1.13	7.209			
19-Oct-78				694.0	27.0	12.45	0.47	6.350			
1-Feb-79				799.0	105.0	14.06	1.62	5.622			
22-Apr-79				879.0	80.0	15.14	1.08	4.916			
16-May-79				903.0	24.0	15.60	0.46	6.926			
18-Jun-79				936.0	33.0	16.16	0.56	6.199			
1-Aug-79				980.0	44.0	16.77	0.62	5.126			
7-Sep-79				1017.0	37.0	17.42	0.65	6.404			
10-Nov-79				1081.0	64.0	18.35	0.92	5.271			
4-Apr-80				1227.0	146.0	19.75	1.40	3.501			
24-May-80				1277.0	50.0	20.73	0.98	7.178			
17-Jul-80			1478.09	1331.0	54.0	21.34	0.61	4.127			
15-Aug-81			1476.33	1725.0	394.0	25.39	4.05	3.754	-1.76	-1.63	
15-Jun-82			1475.58	2029.0	304.0	27.90	2.50	3.005	-0.75	-0.90	
9-Jun-83			1474.30	2388.0	359.0	30.75	2.86	2.905	-1.28	-1.30	
23-Sep-83			1474.24	2494.0	106.0	30.75	0.00	0.001	-0.06	-0.21	
14-Jun-84			1472.76	2759.0	265.0	32.27	1.52	2.087	-1.48	-2.04	
15-Jul-86			1471.30	3520.0	761.0	35.38	3.11	1.494	-1.46	-0.70	
16-Jul-99			1463.60	8269.0	4749.0	38.86	3.48	0.267	-7.7	-0.59	
19-Jun-01			1463.49	8973.0	704.0	39.44	0.57	0.298	-0.11	-0.06	

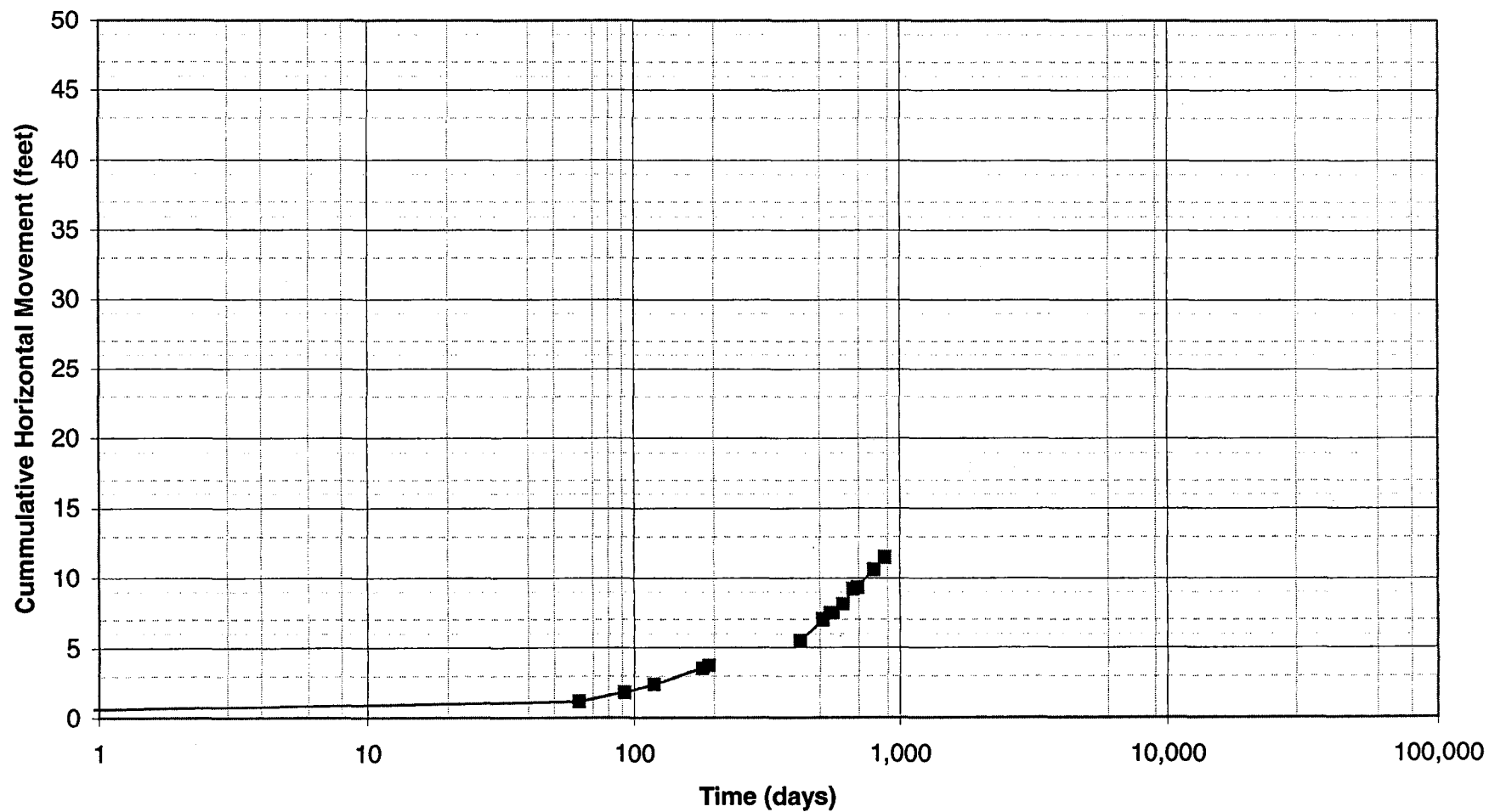
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #23 & 23A**



DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monuments #23 & 23A



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monuments #23 & 23A**

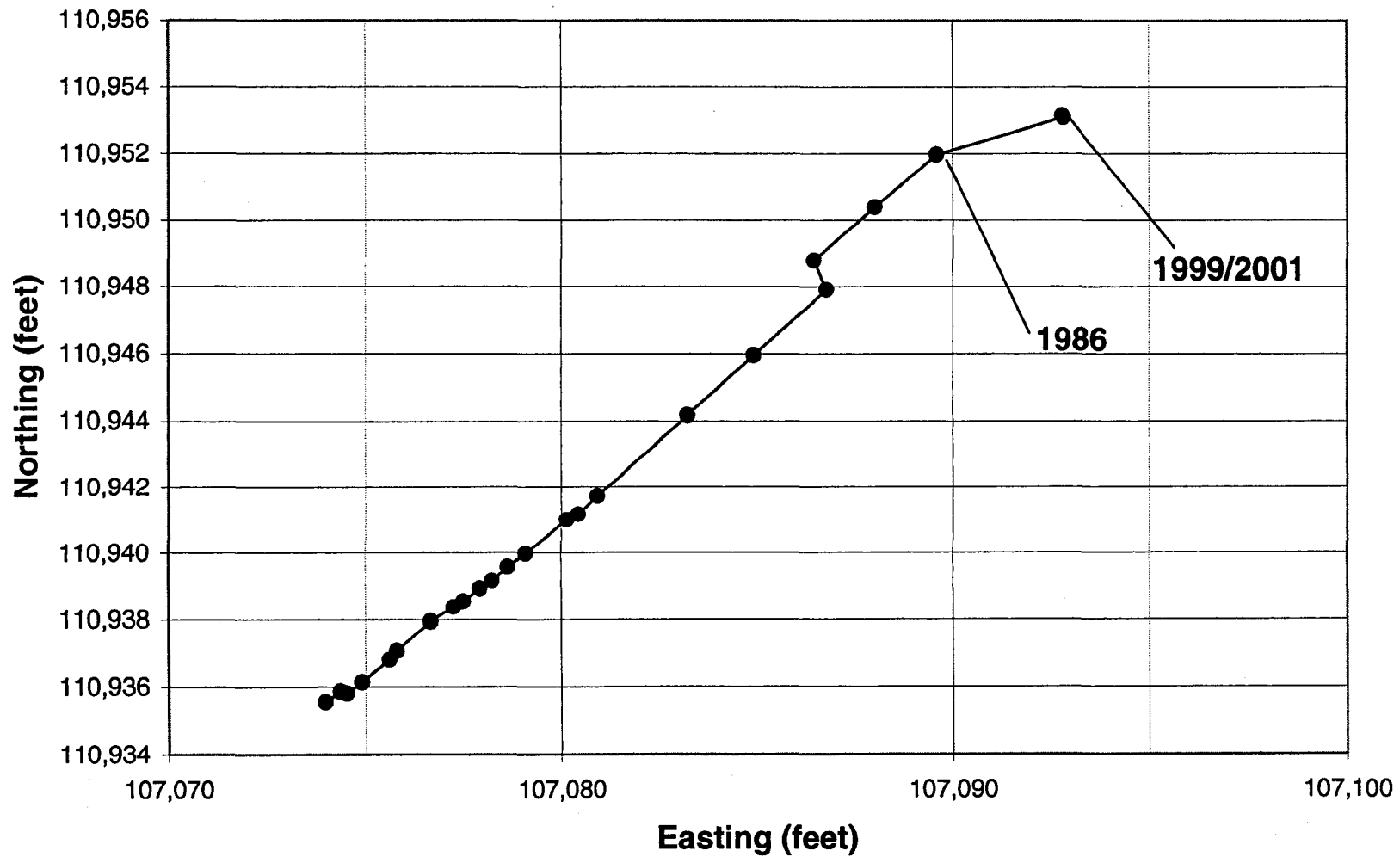


Client: DIAND
 Project: Clinton Creek Asbestos Mine
 Job No.: 4440-038-02-02
 Date: 22-Sep-00

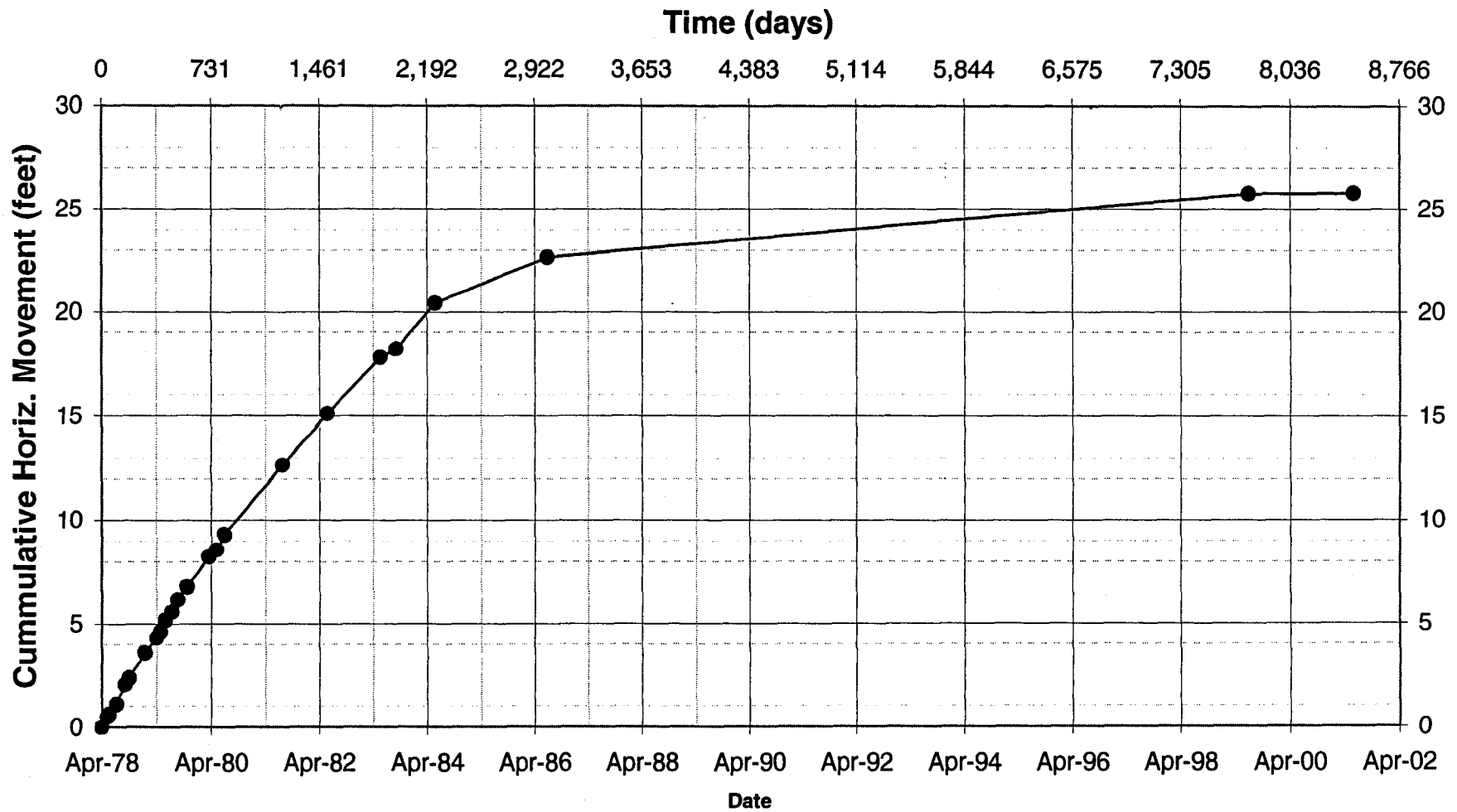
Waste Dump Stability - Monitoring Points #23 & 23A

Monitoring Date	Northing (feet)	Easting (feet)	Elevation (feet)	Time		Horizontal Movement			Vertical Movement		
				Total (days)	Incremental (days)	total (feet)	incremental (feet)	rate (feet/year)	total (feet)	incremental (feet)	rate (feet/year)
Monitor Point #23											
24-Nov-76	109,976.37	106,459.76		0	0	0	0	0			
25-Jan-77	109,977.55	106,459.87		62.0	62.0	1.19	1.19	0.573	0.68		
24-Feb-77	109,978.19	106,459.87		92.0	30.0	1.82	0.64	0.640			
23-Mar-77	109,978.76	106,459.97		119.0	27.0	2.40	0.58	0.643			
24-May-77	109,979.90	106,460.08		181.0	62.0	3.54	1.15	0.554			
3-Jun-77	109,980.11	106,460.12		191.0	10.0	3.76	0.21	0.641			
Monitor Point #23A											
18-Nov-77	109,983.34	106,459.35		0	0	0	0	0			
20-Jan-78	109,985.07	106,459.43		63.0	63.0	1.73	1.73	0.825			
20-Apr-78	109,986.57	106,459.86		153.0	90.0	3.27	1.56	0.520			
26-May-78	109,987.00	106,460.02		189.0	36.0	3.72	0.46	0.382			
06-Jun-78	109,987.04	106,459.86		200.0	11.0	3.73	0.16	0.450			
27-Jul-78	109,987.67	106,459.98		251.0	51.0	4.38	0.64	0.377			
22-Sep-78	109,988.69	106,460.37		308.0	57.0	5.45	1.09	0.575			
19-Oct-78	109,988.85	106,460.25		335.0	27.0	5.58	0.20	0.222			
01-Feb-79	109,990.11	106,460.35		440.0	105.0	6.84	1.26	0.361			
22-Apr-79	109,990.98	106,460.57		520.0	80.0	7.74	0.90	0.337			
Monitor Points 23 & 23A Combined											
24-Nov-76				0.0	0.0	0.00	0.00	0.00			
25-Jan-77				62.0	62.0	1.19	1.19	6.98			
24-Feb-77				92.0	30.0	1.82	0.64	7.76			
23-Mar-77				119.0	27.0	2.40	0.58	7.79			
24-May-77				181.0	62.0	3.54	1.15	6.74			
3-Jun-77				191.0	10.0	3.76	0.21	7.77			
18-Nov-77				359.0	168.0						
20-Jan-78				422.0	63.0	5.49					
20-Apr-78				512.0	90.0	7.03	1.54	6.24			
26-May-78				548.0	36.0	7.48	0.45	4.57			
06-Jun-78				559.0	11.0	7.49	0.01	0.47			
27-Jul-78				610.0	51.0	8.13	0.64	4.58			
22-Sep-78				667.0	57.0	9.20	1.07	6.86			
19-Oct-78				694.0	27.0	9.34	0.14	1.85			
01-Feb-79				799.0	105.0	10.60	1.26	4.38			
22-Apr-79				879.0	80.0	11.49	0.89	4.08			

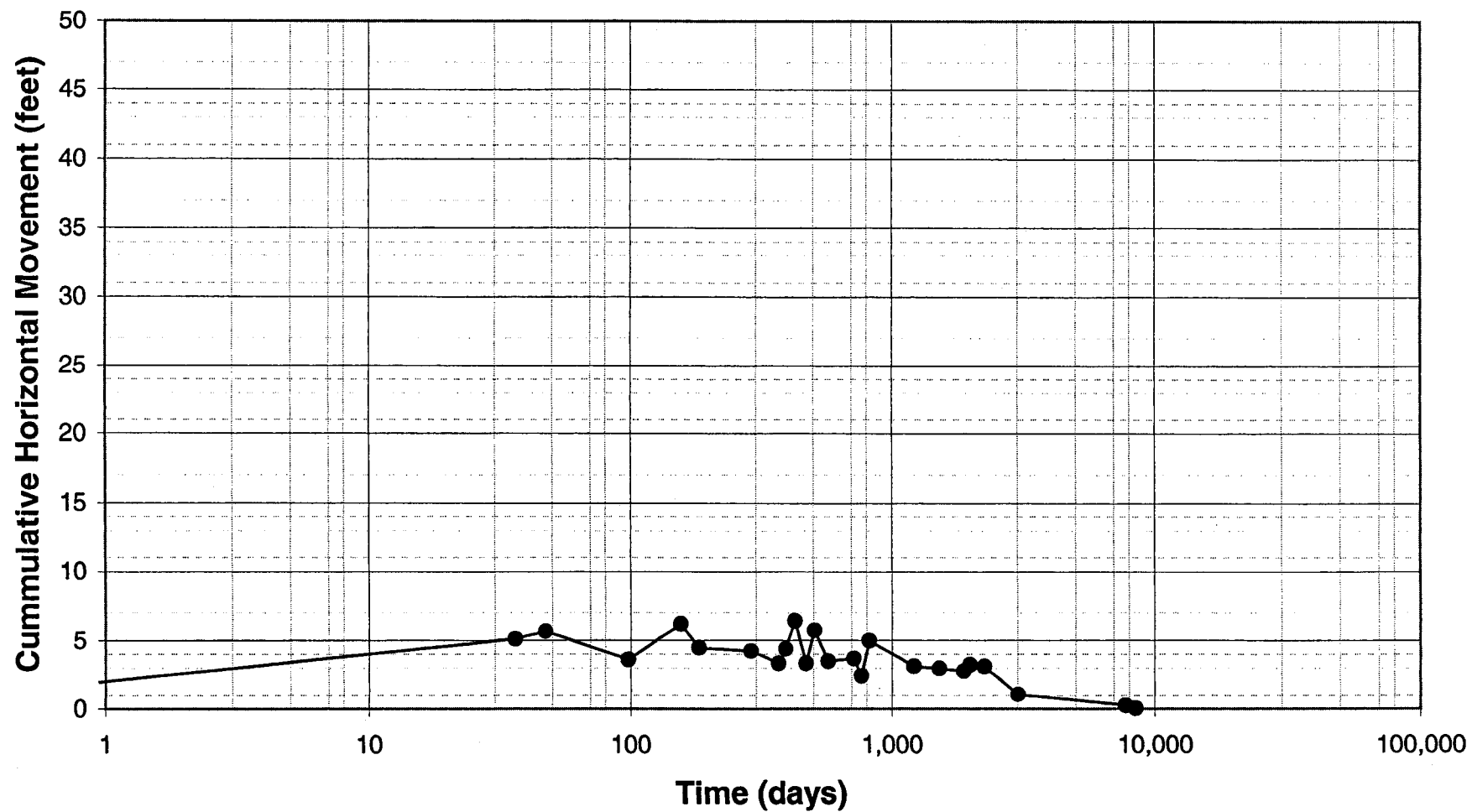
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #68**



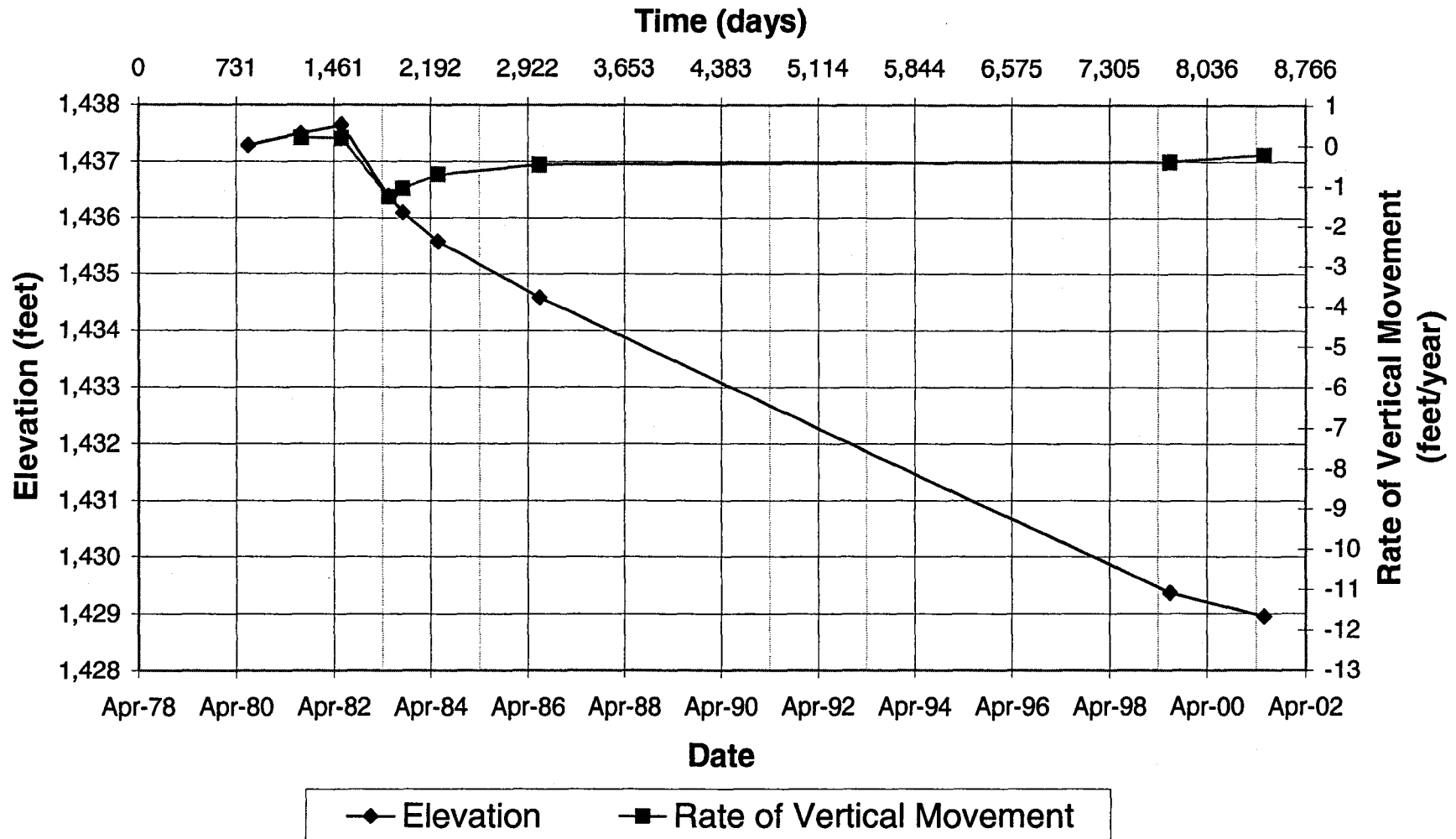
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #68**



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #68**



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #68**



Client: DIAND
 Project: Clinton Creek Asbestos Mine
 Job No.: 4440-038-02-02
 Date: 9-Jul-01

Waste Dump Stability - Monitoring Point #68

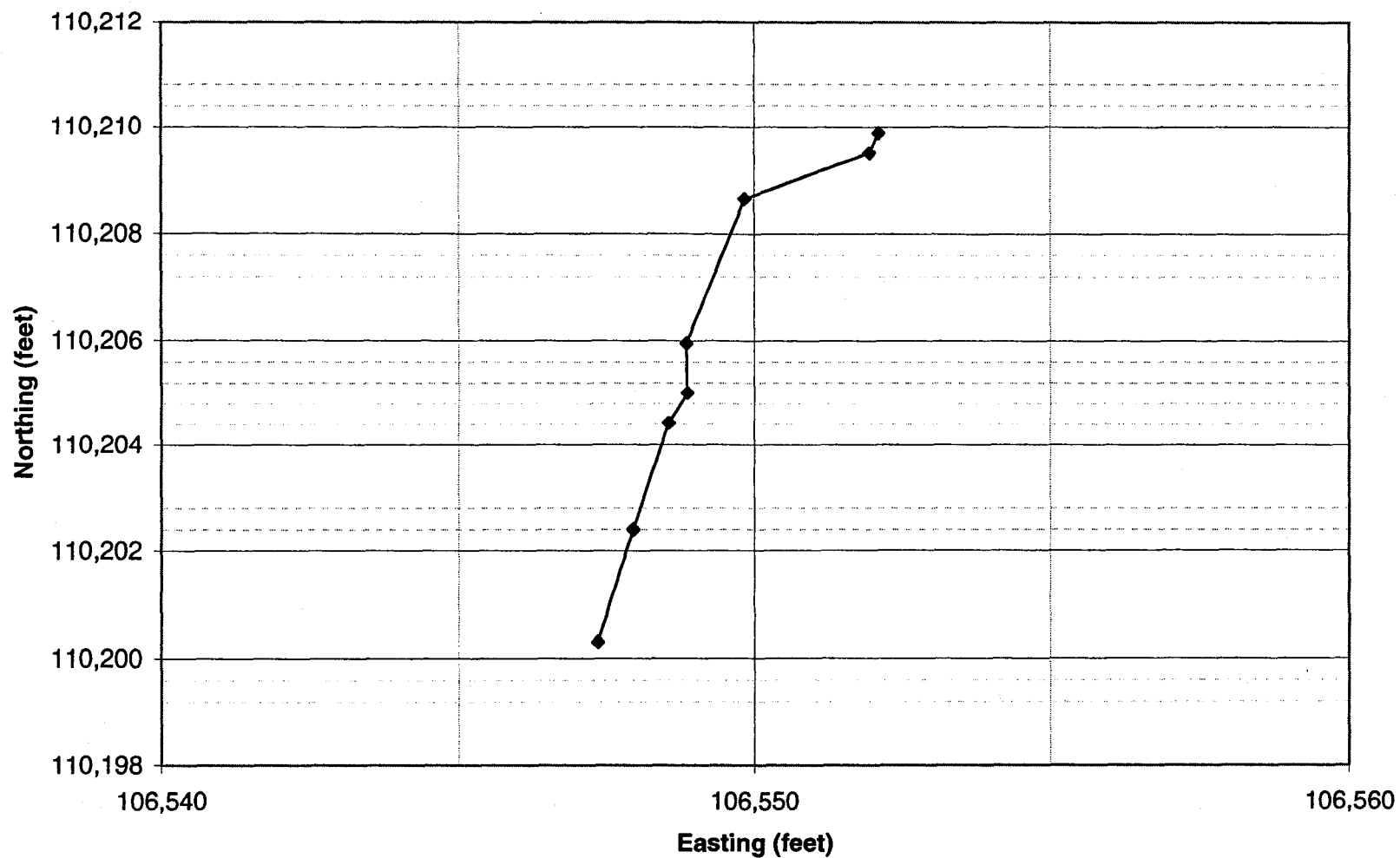
Notes: Assume all elevations represent top of monitoring point, not ground surface.

June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

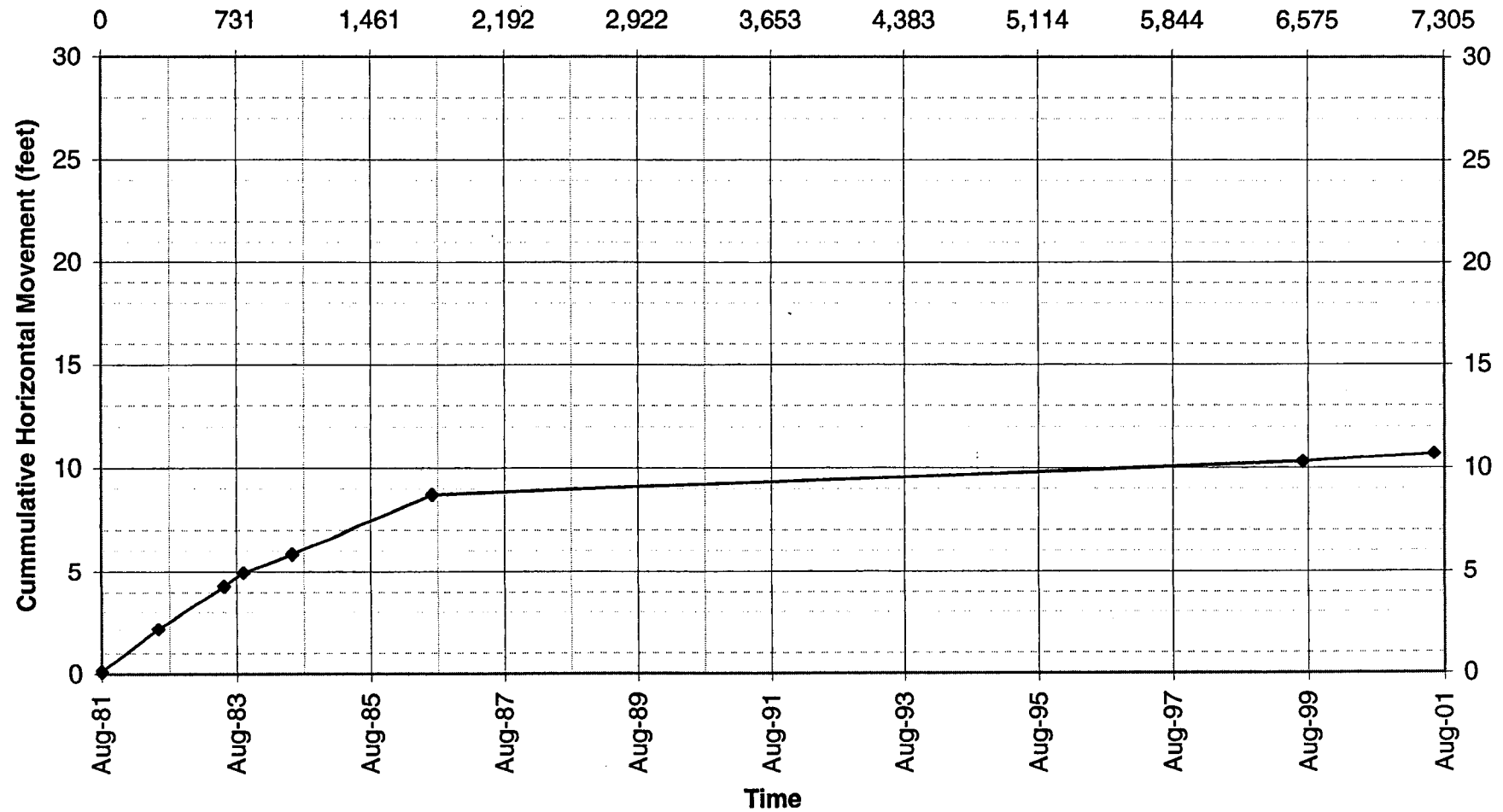
Interpolated Values

Monitoring Date	Northing (feet)	Easting (feet)	Elevation (feet)	Time		Horizontal Movement			Vertical Movement		
				Total (days)	Incremental (days)	total (feet)	incremental (feet)	rate (feet/year)	total (feet)	incremental (feet)	rate (feet/year)
20-Apr-78	110,935.55	107,073.97		0	0	0	0	0			
26-May-78	110,935.87	107,074.36		36.0	36.0	0.50	0.50	5.115			
6-Jun-78	110,935.81	107,074.52		47.0	11.0	0.61	0.17	5.670			
27-Jul-78	110,936.13	107,074.91		98.0	51.0	1.10	0.50	3.610			
22-Sep-78	110,936.80	107,075.61		155.0	57.0	2.06	0.97	6.205			
19-Oct-78	110,937.07	107,075.80		182.0	27.0	2.38	0.33	4.463			
1-Feb-79	110,937.94	107,076.65		287.0	105.0	3.59	1.22	4.228			
22-Apr-79	110,938.37	107,077.24		367.0	80.0	4.32	0.73	3.331			
16-May-79	110,938.53	107,077.48		391.0	24.0	4.60	0.29	4.387			
18-Jun-79	110,938.92	107,077.91		424.0	33.0	5.18	0.58	6.421			
1-Aug-79	110,939.16	107,078.23		468.0	44.0	5.58	0.40	3.318			
7-Sep-79	110,939.58	107,078.63		505.0	37.0	6.16	0.58	5.722			
10-Nov-79	110,939.98	107,079.09		569.0	64.0	6.77	0.61	3.477			
4-Apr-80	110,941.01	107,080.14		715.0	146.0	8.24	1.47	3.677			
24-May-80	110,941.17	107,080.43		765.0	50.0	8.56	0.33	2.418			
17-Jul-80	110,941.72	107,080.92	1437.29	819.0	54.0	9.29	0.74	4.979			
15-Aug-81	110,944.17	107,083.22	1437.50	1213.0	394.0	12.64	3.36	3.113		0.2	0.19
15-Jun-82	110,945.95	107,084.91	1437.65	1517.0	304.0	15.09	2.45	2.947		0.2	0.18
9-Jun-83	110,947.91	107,086.79	1436.40	1876.0	359.0	17.81	2.72	2.761		-1.3	-1.27
23-Sep-83	110,948.78	107,086.46	1436.09	1982.0	106.0	18.19	0.93	3.204		-0.3	-1.07
14-Jun-84	110,950.38	107,088.03	1435.57	2247.0	265.0	20.44	2.24	3.088		-0.5	-0.72
15-Jul-86	110,951.97	107,089.60	1434.58	3008.0	761.0	22.67	2.23	1.072		-1.0	-0.47
17-Jul-99	110,953.09	107,092.83	1429.37	7758.0	4750.0	25.76	3.42	0.263		-5.2	-0.40
19-Jun-01	110,953.15	107,092.80	1428.95	8461.0	703.0	25.77	0.07	0.035		-0.4	-0.22

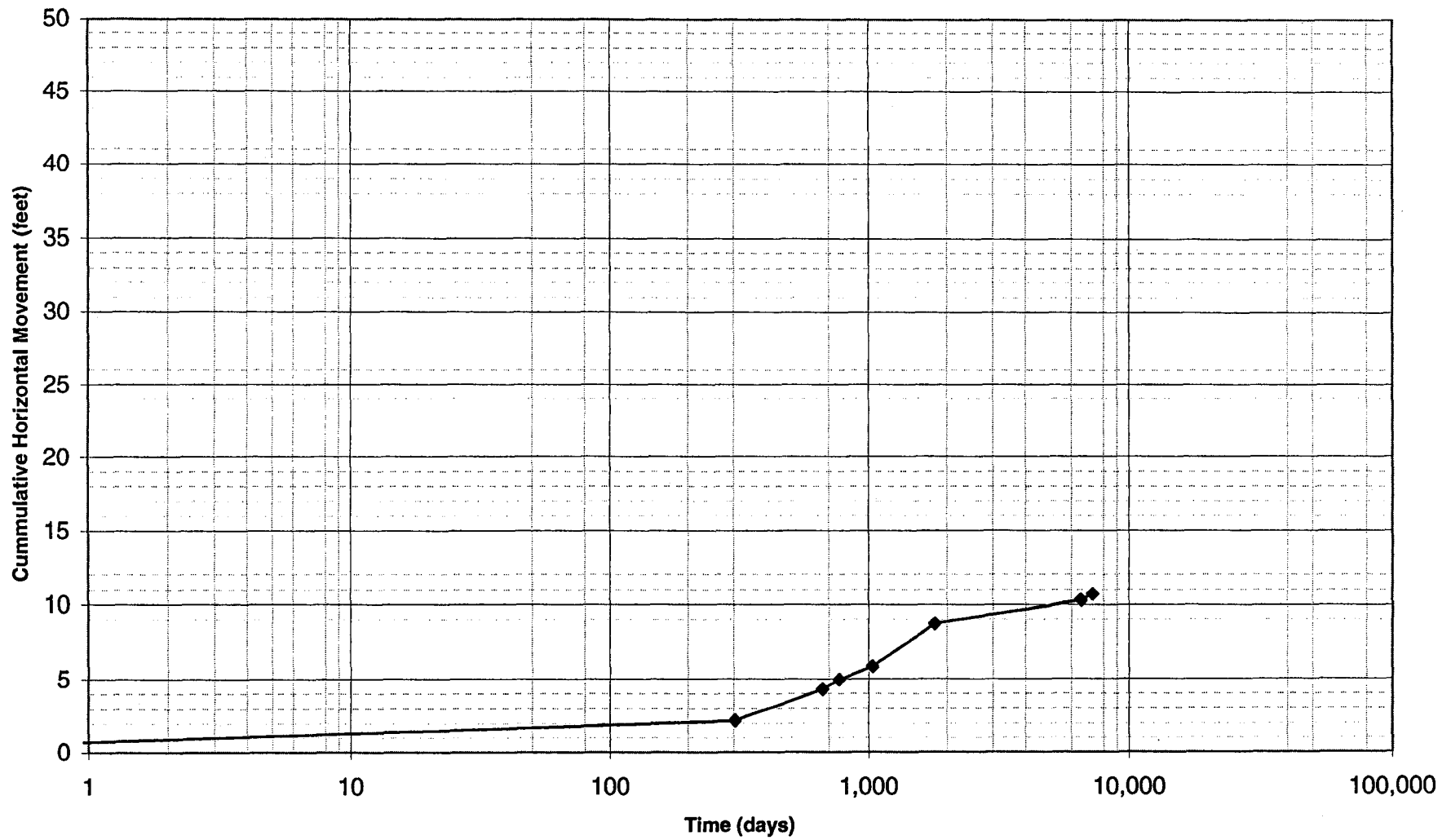
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-1**



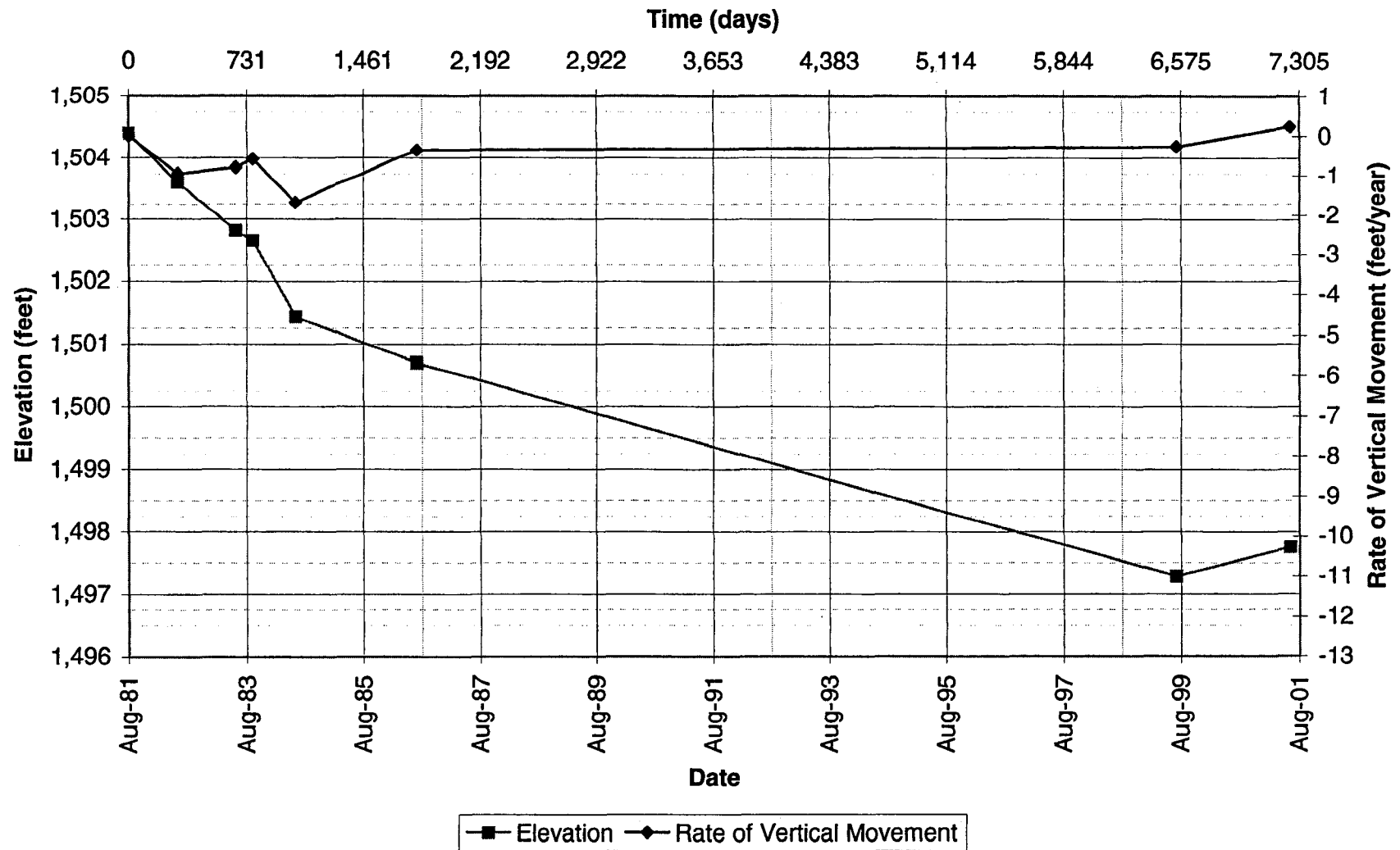
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-1**



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-1**



DIAND: Clinton Creek Asbestos Mine Waste Rock Monitoring Monument #81-1



Client: DIAND
Project: Clinton Creek Asbestos Mine
Job No.: 4440-038-02-02
Date: 9-Jul-01

Waste Dump Stability - Monitoring Point #81-1

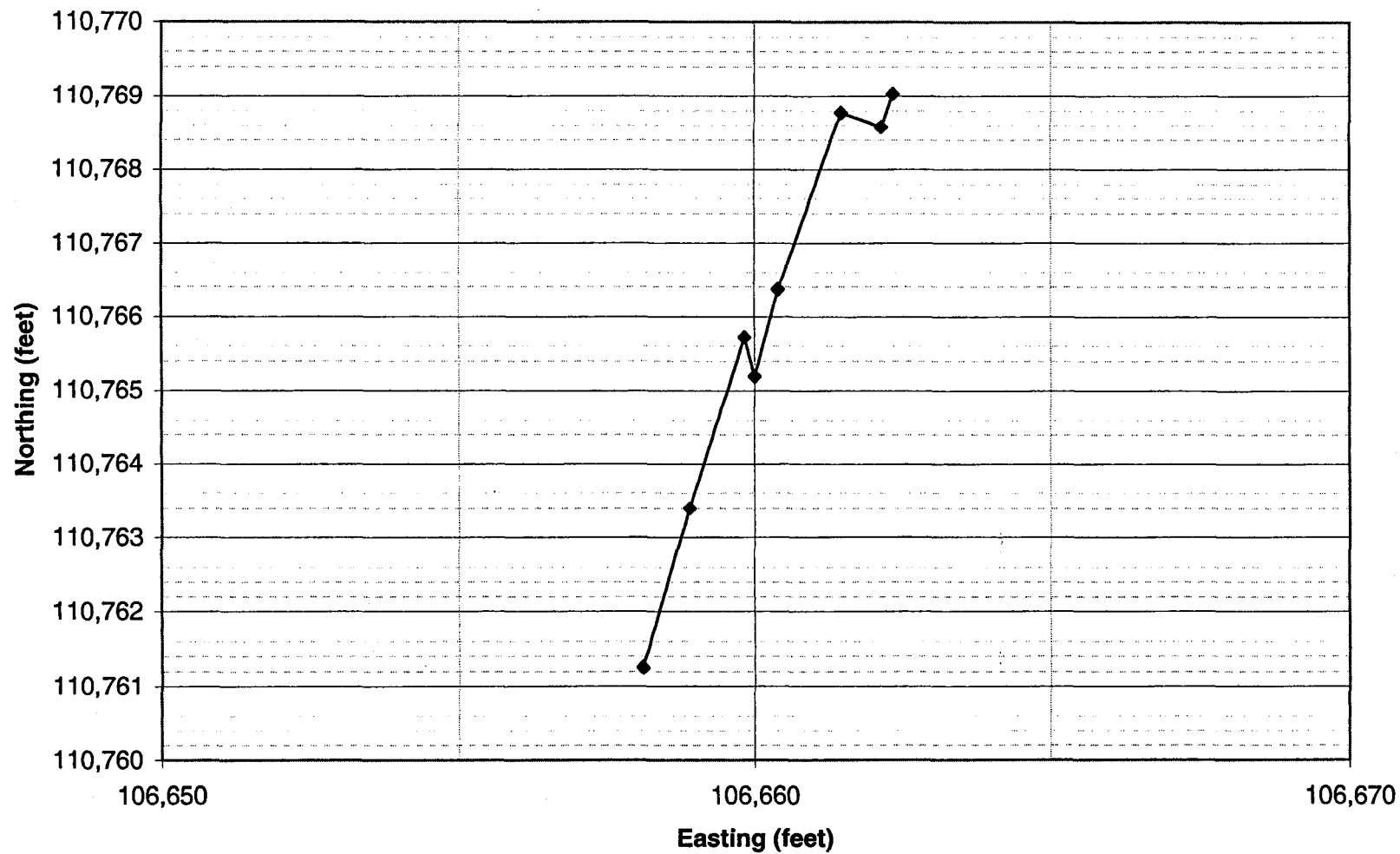
Notes: Assume all elevations represent top of monitoring point, not ground surface.

June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

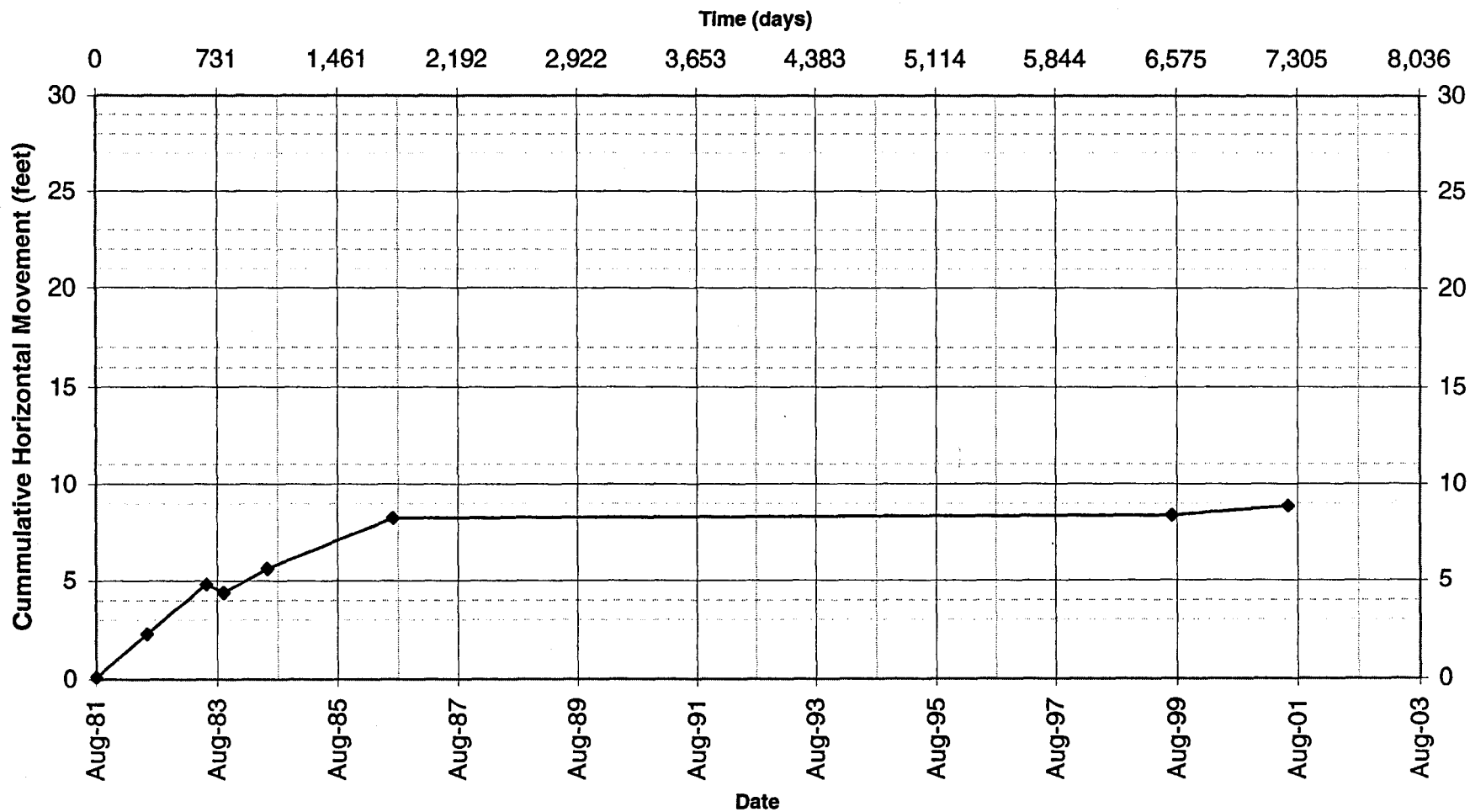
Extrapolated Values Based On Movement rates

Monitoring Date	Northing (feet)	Easting (feet)	Elevation (feet)	Time		Horizontal Movement			Vertical Movement		
				Total (days)	Increment (days)	total (feet)	increment (feet)	rate (feet/year)	total (feet)	incremental (feet)	rate (feet/year)
15-Aug-81	110200.3	106547.35	1504.39	0	0	0	0	0	0	0	0
15-Jun-82	110202.4	106547.95	1503.6	304.0	304.0	2.18	2.18	2.622	-0.79	-0.79	-0.95
9-Jun-83	110,204.42	106,548.55	1502.82	663.0	359.0	4.29	2.11	2.142	-1.57	-0.78	-0.79
23-Sep-83	110,205.01	106,548.86	1502.65	769.0	106.0	4.95	0.67	2.295	-1.74	-0.17	-0.59
14-Jun-84	110,205.95	106,548.85	1501.43	1034.0	265.0	5.85	0.94	1.295	-2.96	-1.22	-1.68
15-Jul-86	110,208.65	106,549.84	1500.7	1795.0	761.0	8.71	2.88	1.379	-3.69	-0.73	-0.35
17-Jul-99	110,209.51	106,551.95	1497.28	6545.0	4750.0	10.29	2.28	0.175	-7.11	-3.42	-0.26
19-Jun-01	110,209.88	106,552.11	1497.75	7248.0	703.0	10.70	0.40	0.209	-6.64	0.47	0.24

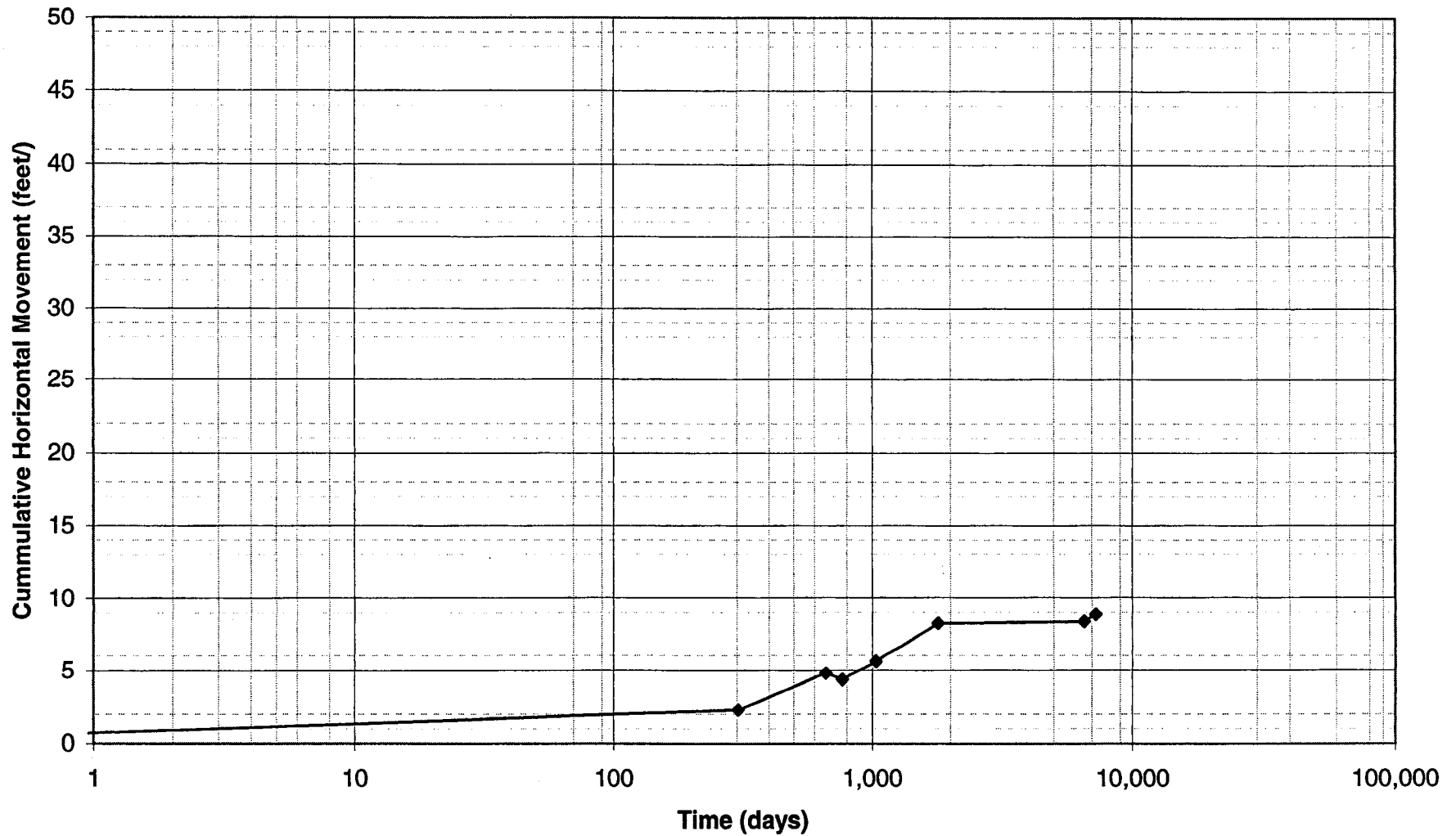
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-2**



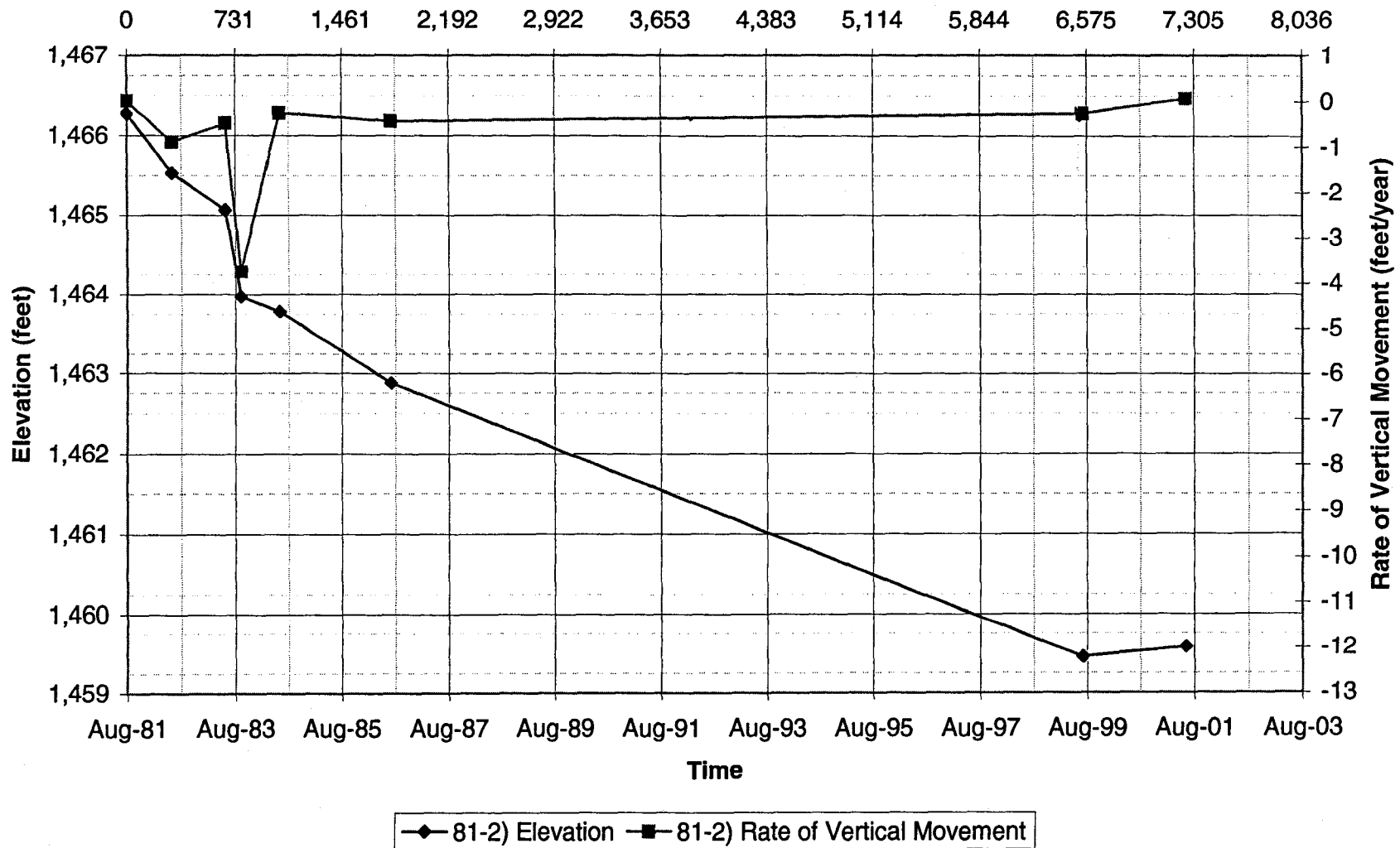
**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-2**



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-2**



**DIAND: Clinton Creek Asbestos Mine
Waste Rock Monitoring Monument #81-2**



Client: DIAND
Project: Clinton Creek Asbestos Mine
Job No.: 4440-038-02-02
Date: 9-Jul-01

Waste Dump Stability - Monitoring Point #81-2

Notes: Assume all elevations represent top of monitoring point, not ground surface.
 June 2001 survey) monitor point elevation = ground elev + monitor rod ht.

Values extrapolated

Monitoring Date	Northing	Easting	Elevation	Time		Horizontal Movement			Vertical Movement		
				Total	Increment	total	increment	rate	total	incremental	rate
	(feet)	(feet)	(feet)	(days)	(days)	(feet)	(feet)	(feet/year)	(feet)	(feet)	(feet/year)
15-Aug-81	110761.25	106658.1	1466.27	0	0	0	0	0	0	0	0
15-Jun-82	110763.4	106658.9	1465.53	304.0	304.0	2.29	2.29	2.754	-0.74	-0.74	-0.89
9-Jun-83	110,765.72	106,659.83	1465.06	663.0	359.0	4.79	2.50	2.541	-1.21	-0.47	-0.48
23-Sep-83	110,765.19	106,660.00	1463.97	769.0	106.0	4.37	0.56	1.917	-2.30	-1.09	-3.75
14-Jun-84	110,766.37	106,660.40	1463.78	1034.0	265.0	5.61	1.25	1.716	-2.49	-0.19	-0.26
15-Jul-86	110,768.77	106,661.46	1462.88	1795.0	761.0	8.24	2.62	1.258	-3.39	-0.9	-0.43
17-Jul-99	110,768.58	106,662.14	1459.45	6545.0	4750.0	8.37	0.71	0.054	-6.82	-3.43	-0.26
19-Jun-01	110,769.03	106,662.33	1459.58	7248.0	703.0	8.86	0.49	0.254	-6.69	0.13	0.07

DRAFT
Appendix B – Test Hole Logs

RECORD OF BOREHOLE 12 (T-5)

LOCATION (See Figure 6)

BORING DATE *May 9, 1978*

BOREHOLE TYPE

BOREHOLE DIAMETER *6 in.*

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

SOIL PROFILE							PIEZOMETER OR STANDPIPE INSTALLATION				
ELEV. DEPTH	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT				ADDITIONAL LAB. TESTING
							W _p	W	W _L		
19452' 0.0'	Surface of Tailing Pile						10	20	30	40	
	Tails										
1911.7'											
33.5'	Compact, light brown, sub-rounded, fine to med. GRAVEL with clay, silt and sand - fluvial lacustrine traces of organics at bottom of tails		1								
			2								
1891.2											
54.0'	End of Hole										
			</								

Thermistor cable installed to 54 ft. (9 units at 5' intervals)

VERTICAL SCALE
1 inch to 20 feet

Golder Associates

DRAWN R.D.
CHECKED EBF

RECORD OF BOREHOLE 13 (T-6)

LOCATION (See Figure 6)

BORING DATE *May 9, 1978*

BOREHOLE TYPE

BOREHOLE DIAMETER *6 in.*

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

Project No. *YJ1216*

SOIL PROFILE		STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT				PIEZOMETER OR STANDPIPE INSTALLATION	ADDITIONAL LAB. TESTING
ELEV.	DEPTH											
<i>1880.6'</i>	<i>0.0'</i>						<i>W_p</i>	<i>W</i>	<i>W_L</i>			
			<i>1</i>				<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>		
			<i>2</i>									
			<i>3</i>									
			<i>4</i>									
<i>1840.6'</i>	<i>40.0'</i>											

Ground Surface in Roadway Cut

Frozen, light brown sub-rounded fine to med. GRAVEL with clay, silt & sand fluvial lacustrines

End of Hole

Thermistor cable instal. to 40 ft. (9 units at 5' interval)

VERTICAL SCALE
1 inch to 20 feet

Golder Associates

DRAWN *R.R.*
CHECKED *EBF*

RECORD OF BOREHOLE 14 (T-7)

LOCATION (See Figure 6)

 BORING DATE *May 10, 1978*

BOREHOLE TYPE

 BOREHOLE DIAMETER *6 in.*

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

Project No. 2-1-10

SOIL PROFILE		STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT				PIEZOMETER OR STANDPIPE INSTALLATION	ADDITIONAL LAB. TESTING
ELEV. DEPTH	DESCRIPTION						W _p	W	W _L			
1741.0 0.0'	<i>Surface of Tailing Pile</i>						15	25	35	45		
	<i>Toils</i>											
1696.0' 45.0'	-Frozen - ice crystals - light brown - sub-rounded - fine to med. GRAVEL with clay, silt & sand. - fluvial - lacustrine		1					0				
			2									
1667.0' 74.0'	<i>End of Hole</i>											

Thermistor cable installed to 74ft. (9 units at 5' intervals)

 VERTICAL SCALE
1 inch to 20 feet

Golder Associates

 DRAWN ER
CHECKED EBE

RECORD OF BOREHOLE 15 (ST-8)

LOCATION (See Figure 6)

BORING DATE *May 11, 1978*

BOREHOLE TYPE

BOREHOLE DIAMETER *6 in.*

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

SOIL PROFILE						PIEZOMETER OR STANDPIPE INSTALLATION	ADDITIONAL LAB. TESTING
ELEV. DEPTH	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	
1607.2'	Ground Surface in Road Cut						
0.0' 1607	-Frozen - light brown - sub rounded - fine to med. GRAVEL with clay silt & sand - fluvial lacustrines		1				
	-Frozen - black - ARGILLITE weathered bedrock		2				
1567.2							
40.0'	End of Hole						

VERTICAL SCALE
1 inch to 20 feet

Golder Associates

DRAWN *R.D.*
CHECKED *EBF*

RECORD OF BOREHOLE 16 (T-8)

LOCATION (See Figure 6)

BORING DATE May 12, 1978

BOREHOLE TYPE

BOREHOLE DIAMETER 6 in.

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

SOIL PROFILE											PIEZOMETER OR STANDPIPE INSTALLATION
ELEV. DEPTH	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT				ADDITIONAL LAB. TESTING
							W _p	W	W _L		
							10	20	30	40	
1623.8 0.0'	Surface of Tailing Pile										
	Tails										
1560.8 63.0'	- light brown - sub-rounded - fine to med. GRAVEL with clay silt & sand. fluvial lacustrine										
1540.8 83.0'	End of Hole										
											Thermistor cable installed to 83.0 ft. (9 units at 5' intervals)

Thermistor
cable installed
to 83.0 ft.
(9 units at
5' intervals)

 VERTICAL SCALE
1 inch to 20 feet

Golder Associates

 DRAWN R.D.
CHECKED EBF

RECORD OF BOREHOLE 17 (D.S.-2)

LOCATION (See Figure 6)

BORING DATE *May 16, 1978*

BOREHOLE TYPE

BOREHOLE DIAMETER *6 in.*

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

SOIL PROFILE							PIEZOMETER OR STANDPIPE INSTALLATION			ADDITIONAL LAB. TESTING	
ELEV. DEPTH	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT W _p W W _L				
0.0'	Frozen dark brown organic silt. sand										
3.0'	Frozen dark brown PEAT										
5.0'	Frozen, light brown,										
7.0'	sub-rounded, fine to med. GRAVEL with clay, silt. & Sand (fluvial lacustrine)										
	ARGILLITE - hard, dry unweathered										
19.0'	SERPENTINE, weathered frozen										
21.0'											
	ARGILLITE BEDROCK soft, weathered, frozen										
46.0'	ARGILLITE BEDROCK unweathered, frozen										
57.0'	End of Hole										

VERTICAL SCALE
1 inch to 20 feet

Golder Associates

DRAWN *R.D.*
CHECKED *E.D.E.*

RECORD OF BOREHOLE 18 (D.S-5)

LOCATION (See Figure 6)

BORING DATE *May 17, 1978*

BOREHOLE TYPE

BOREHOLE DIAMETER *6 in.*

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

Project No. YLZUW

SOIL PROFILE		STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT $\overline{\text{W}_p \quad \text{W} \quad \text{W}_L}$				PIEZOMETER OR STANDPIPE INSTALLATION	ADDITIONAL LAB. TESTING
ELEV. DEPTH	DESCRIPTION											
0.0'	Frozen, dark brown, organic silty. SAND.											
8.0'	Frozen, light brown, sub-rounded, fine to med. GRAVEL with clay, silt & sand (fluvial lacustrine)		1									
19.0'	ARGILLITE frozen, weathered (ice lens approx. 3 in. thick recovered with sample)		2									
32.0'	ARGILLITE - frozen, becoming harder with depth, unweathered		3									
			4									
60.0'	End of Hole											

VERTICAL SCALE
1 inch to 20 feet

Golder Associates

DRAWN R.D.
CHECKED EBF

RECORD OF BOREHOLE 19(D-5-6)

LOCATION (See Figure 6)

BORING DATE May 18, 1978

BOREHOLE TYPE

BOREHOLE DIAMETER 6 in.

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 IN.

DATUM

SOIL PROFILE							PIEZOMETER OR STANDPIPE INSTALLATION			ADDITIONAL LAB. TESTING	
ELEV. DEPTH	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS / FOOT	ELEVATION SCALE	WATER CONTENT PERCENT				
								W _p	W	W _L	
0.0'	Frozen, light brown sub-rounded, fine to medium GRAVEL with clay, silt & sand (alluvial)										
7.0'	Frozen silt with layers of fibrous peat										
17.0'	Frozen, light brown sub-rounded, fine to medium GRAVEL with clay, silt and sand (fluvial lacustrine)	-1-									
20.0'	ARGILLITE Frozen, weathered	-2-									
32.0'	ARGILLITE - frozen becoming harder with depth, unweathered	-3-									
60.0'	End of Hole										

VERTICAL SCALE
1 inch to 20 feet

Golder Associates

DRAWN R.D.
CHECKED EEF

DRAFT
DRAWINGS



UMA UMA Engineering Ltd. **INDIAN AND NORTHERN AFFAIRS CANADA**

ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY

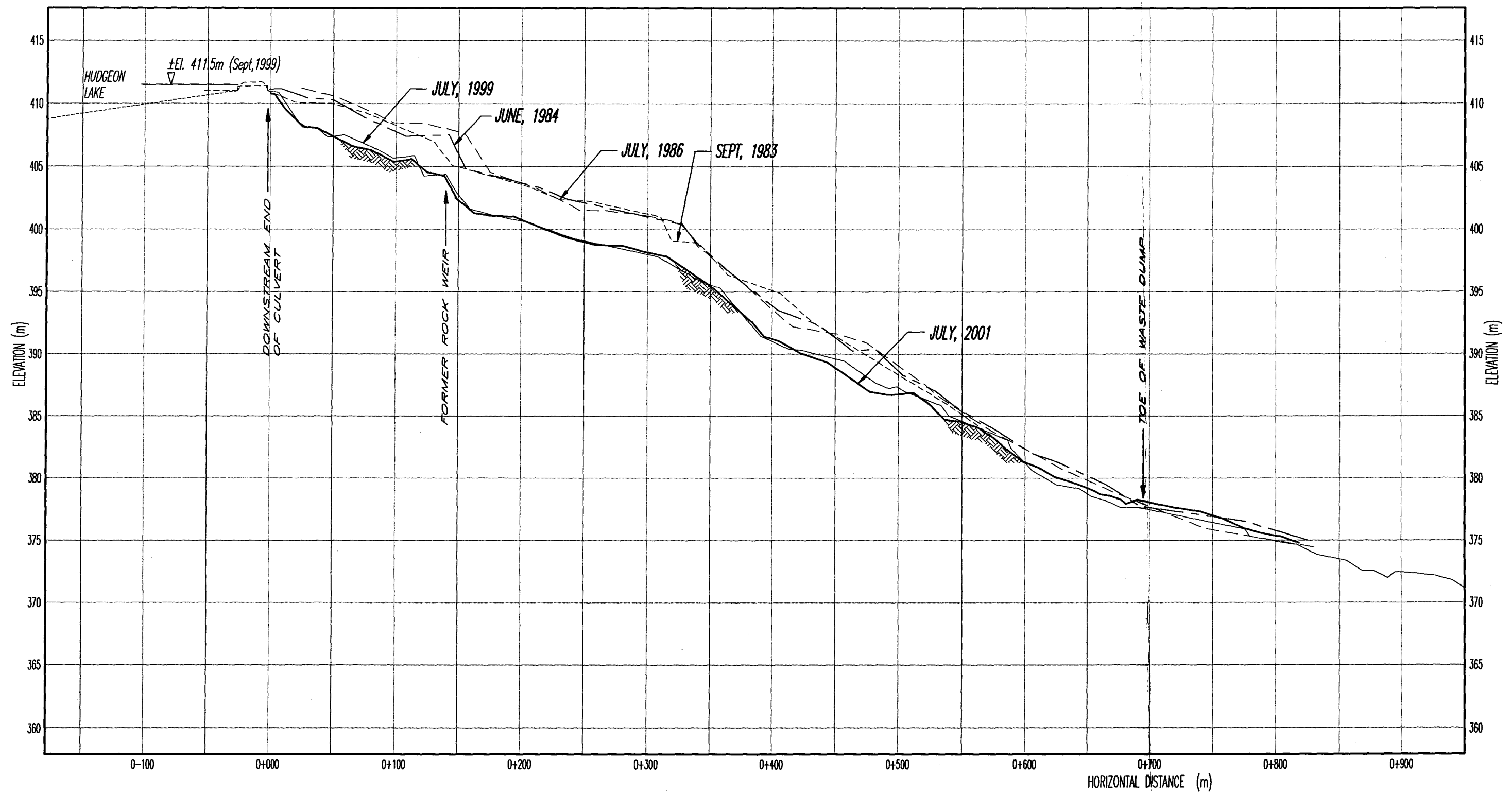
MINE SITE PLAN	01	-
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SCALE: 1:7,500	NO. 4440-038-02

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Plot Scale: 1=1
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CLINTON CREEK CHANNEL PROFILE

VER. SCALE 1:300
 HOR. SCALE 1:3000

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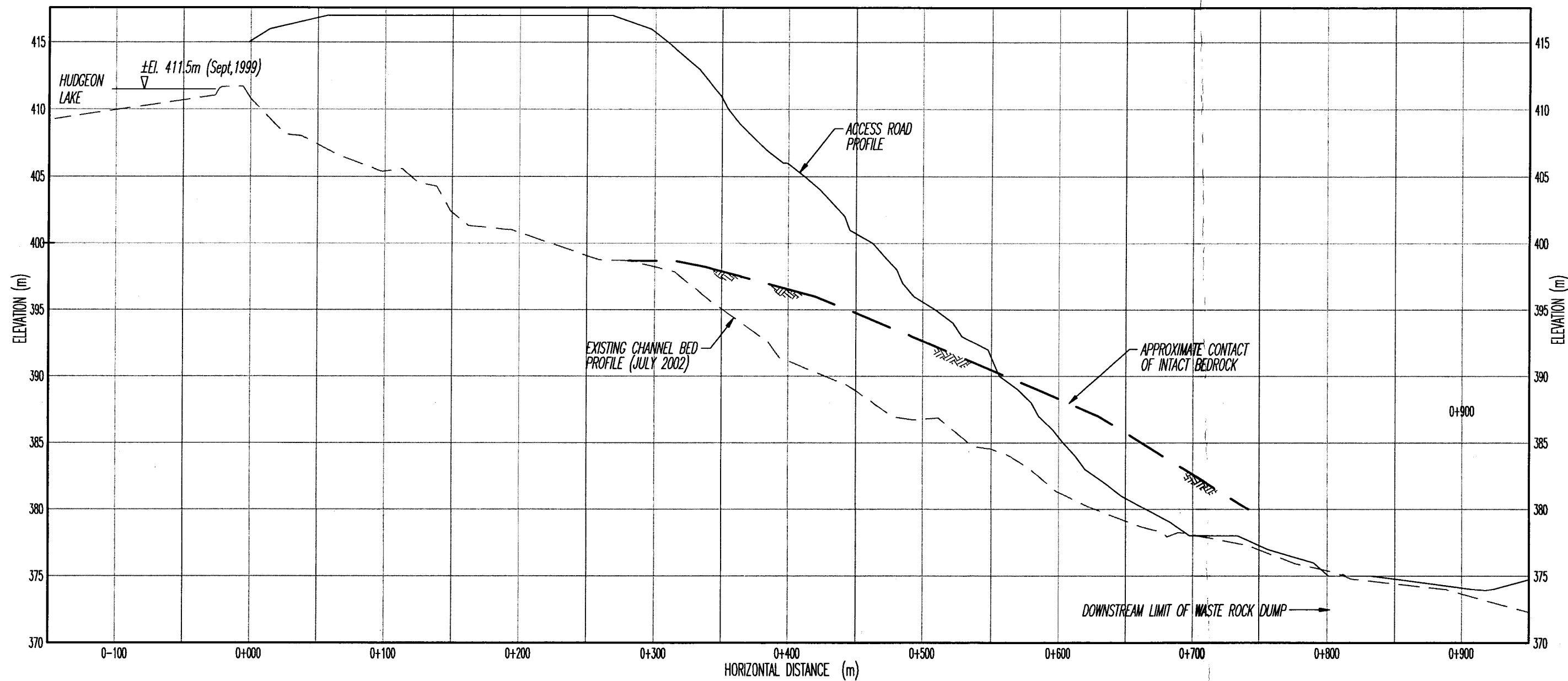
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INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
CLINTON CREEK CHANNEL PROFILES	02 -
DWG. No.	REV.

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VER. SCALE 1:300
HOR. SCALE 1:3000

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REV.	DESCRIPTION	DWN.	APP.	DATE

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INDIAN AND NORTHERN AFFAIRS CANADA	
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CLINTON CREEK CHANNEL APPROXIMATE BEDROCK PROFILE	
03	-
DWG. No.	REV.

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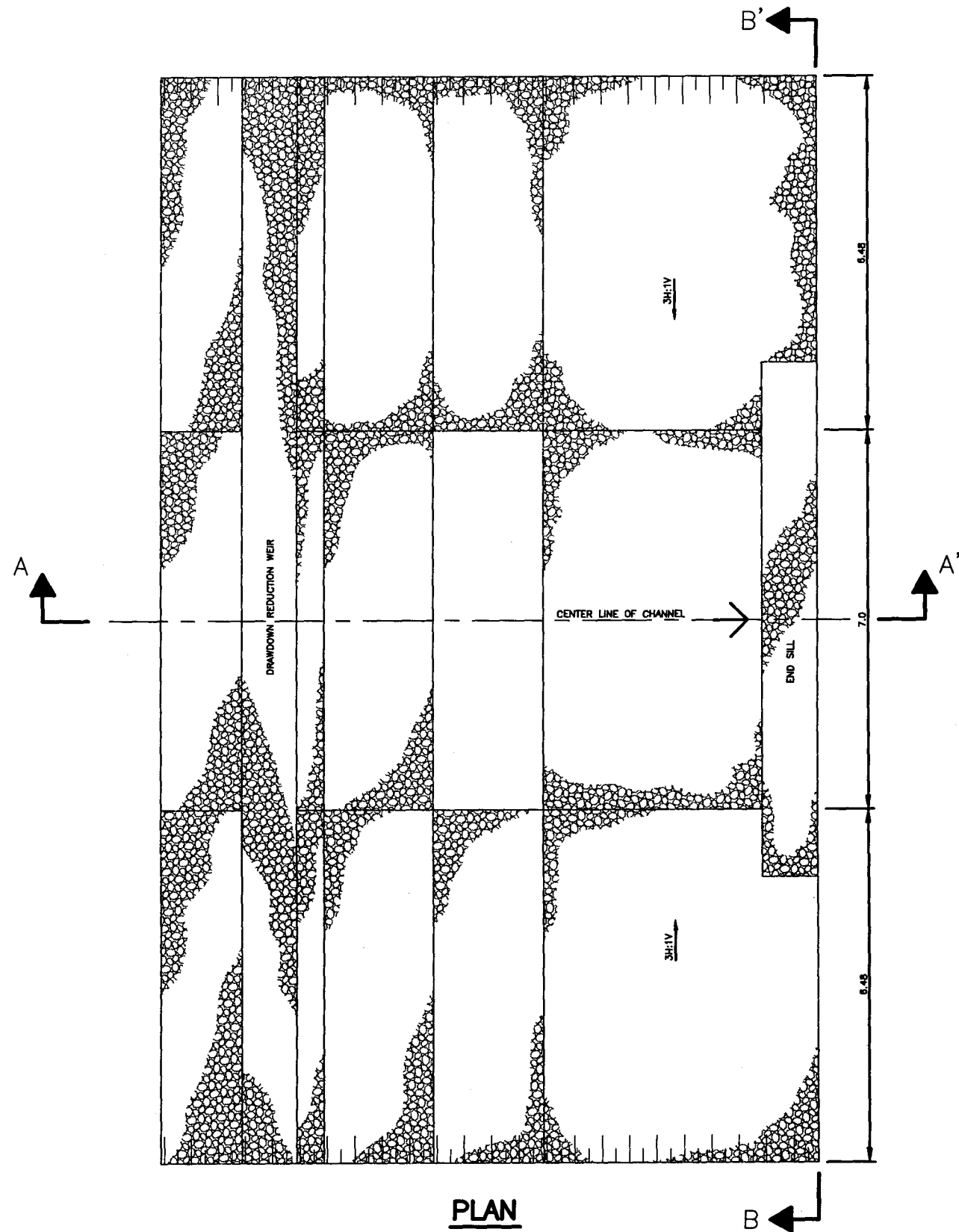
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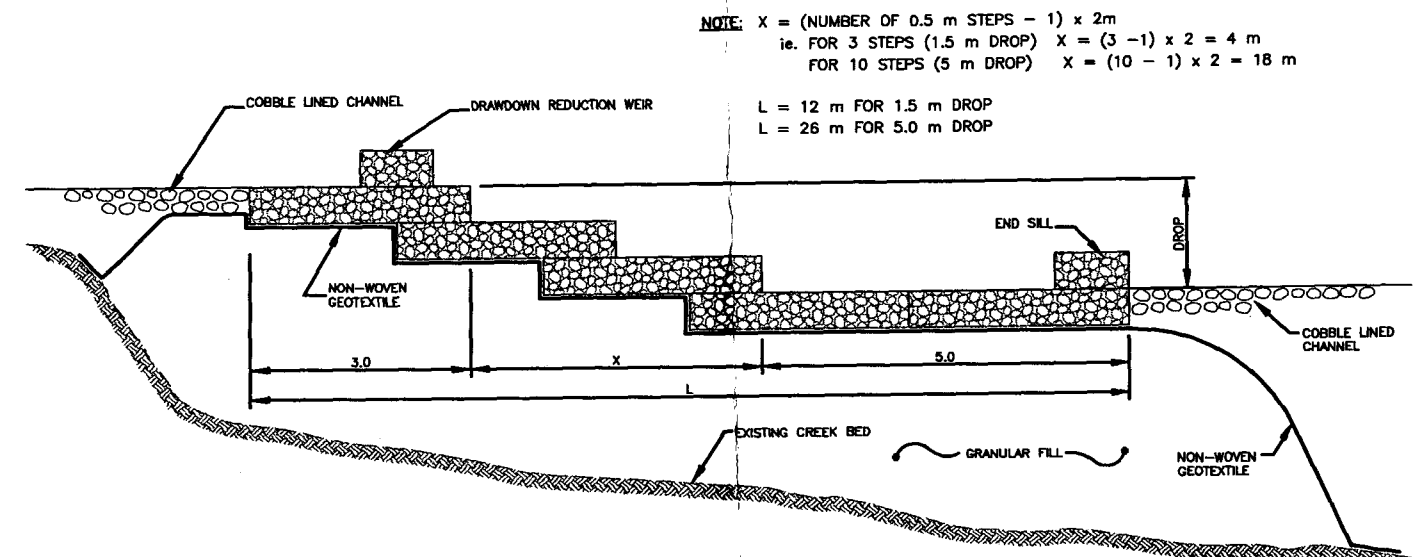
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ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
HUDGEON LAKE OUTLET SITE PLAN	04 -
DWG. No.	REV.

Plot Scale: 1=2
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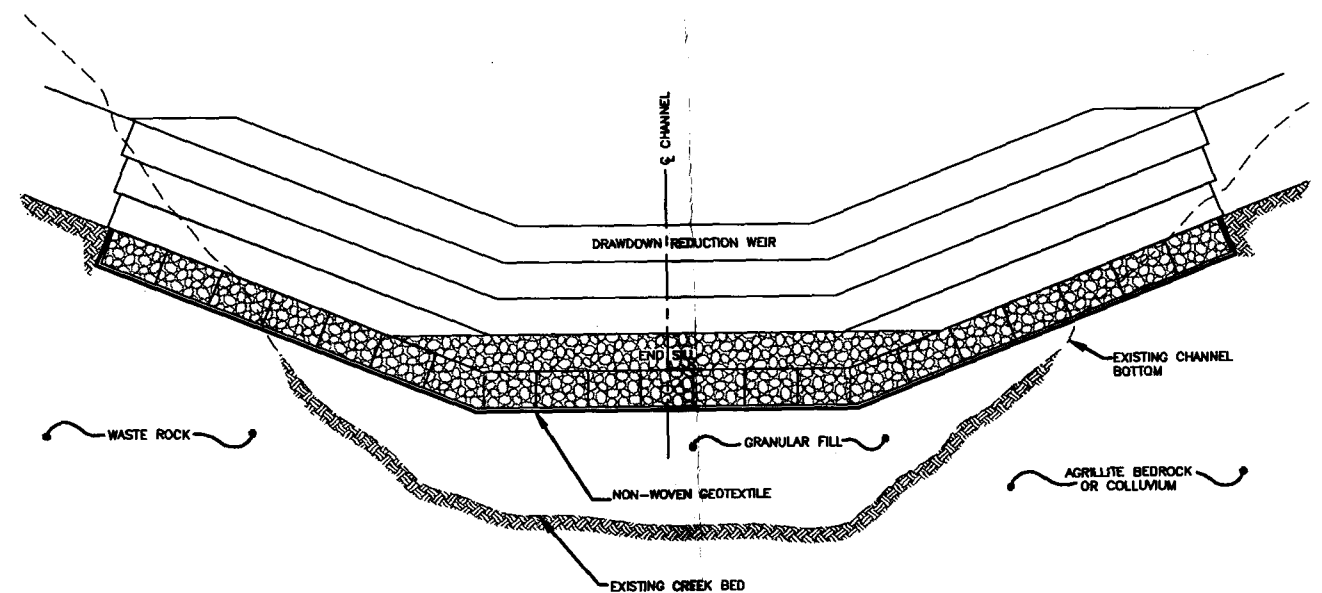


PLAN

DRAFT



CENTERLINE PROFILE A-A'



SECTION B-B'

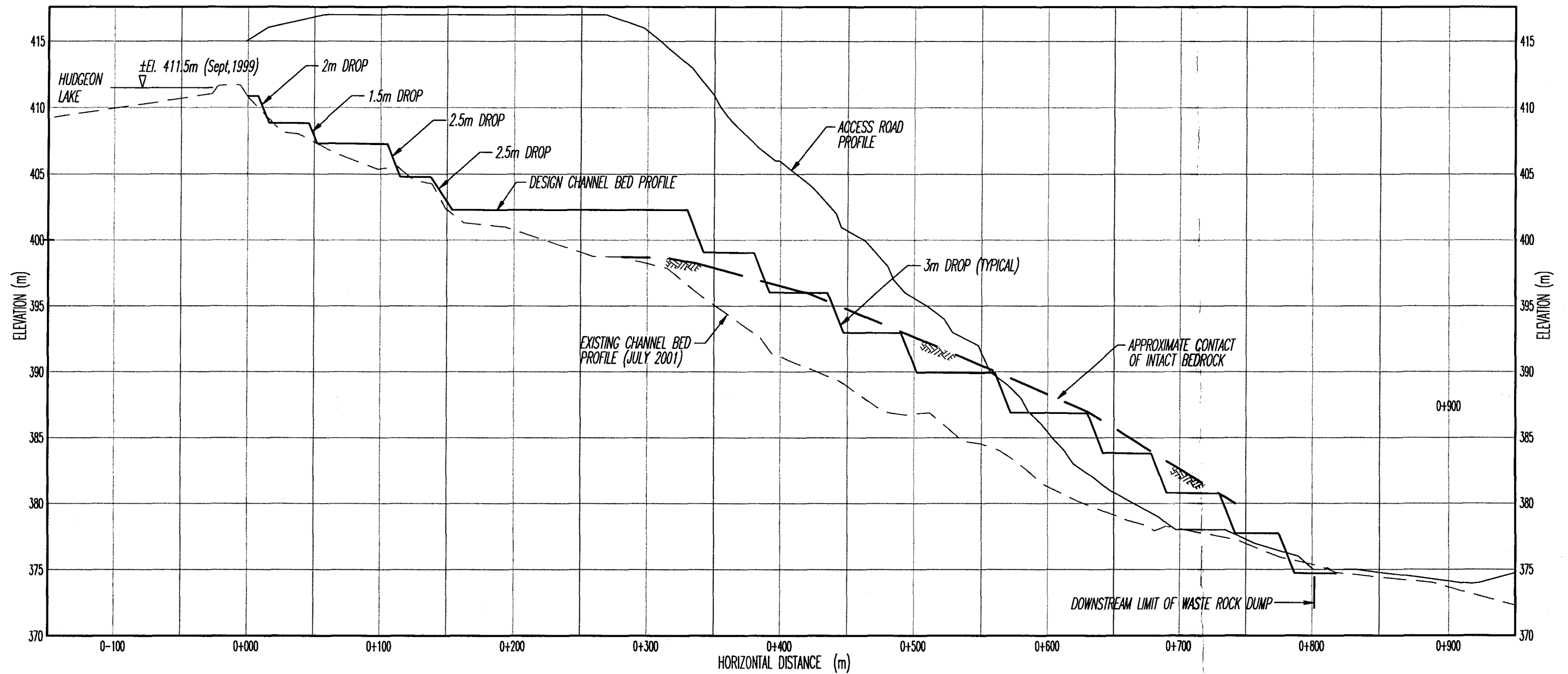
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CHECKED BY: -	CHECKED BY: GR
SCALE: 1:100	JOB No. 4440-038-02

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ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
TYPICAL GABION DROP STRUCTURE	05 -
DWG. No.	REV.

Plot Scale: 1=1
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INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
CLINTON CREEK PROPOSED CHANNEL PROFILE	06 -
DWG. No.	REV.

Plot Scale: 1=1
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INDIAN AND NORTHERN AFFAIRS CANADA

**ABANDONED CLINTON CREEK ASBESTOS MINE
 ENVIRONMENTAL LIABILITY**

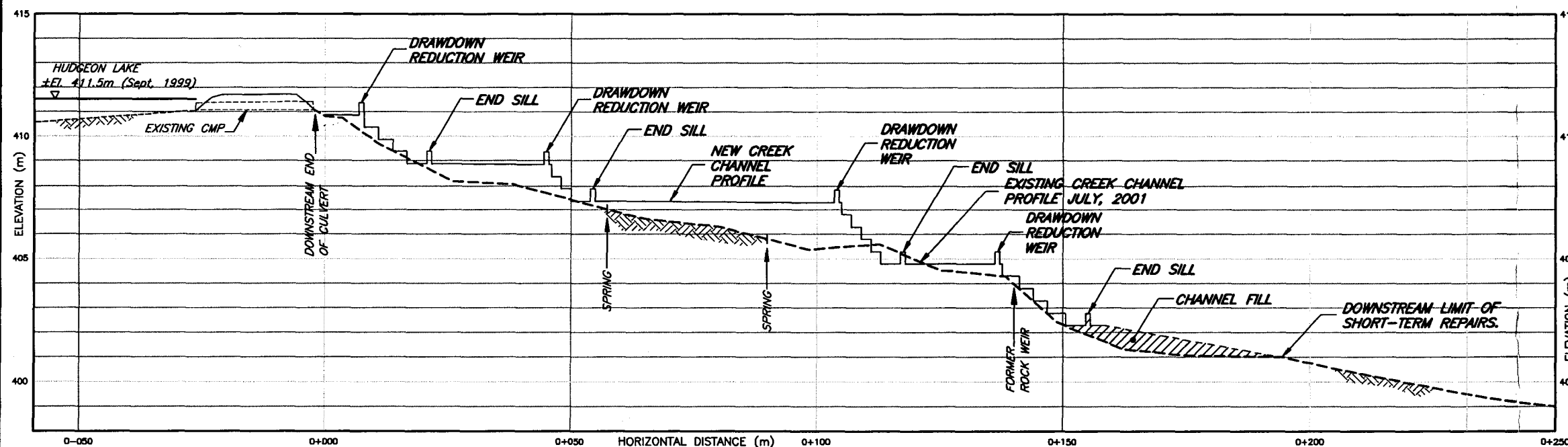
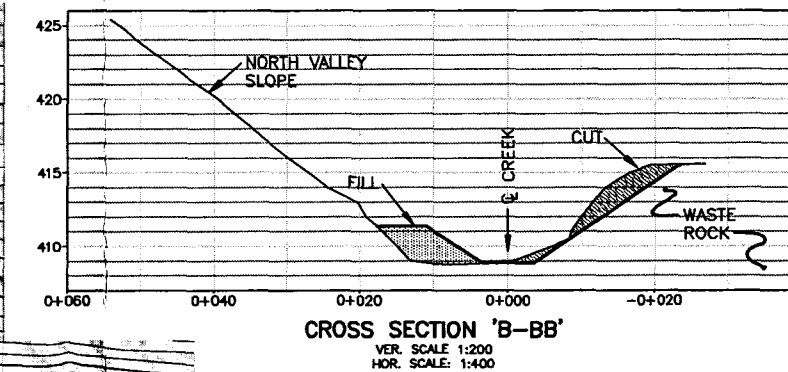
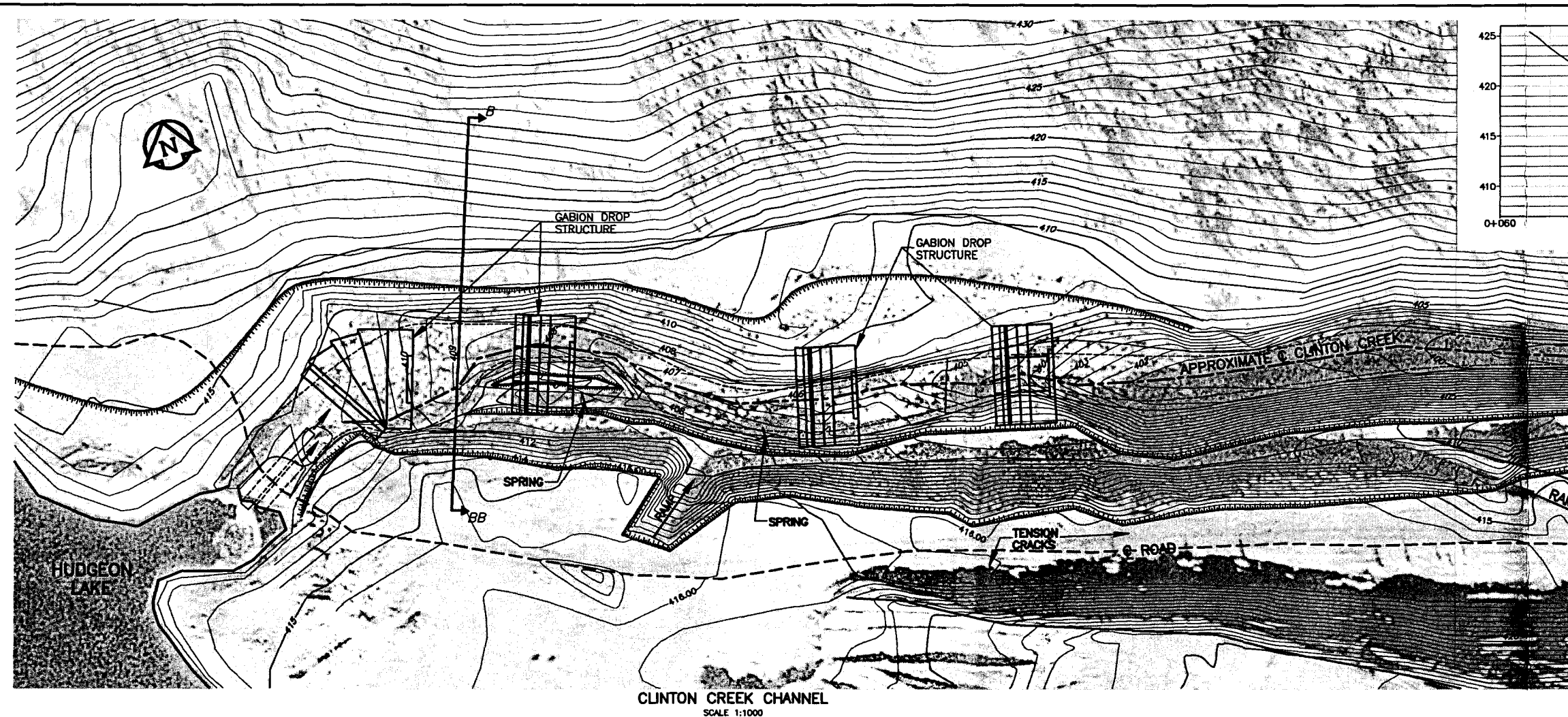
BEDROCK AND GRAVEL PIT LOCATIONS

07

DWG. No.

REV.

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CLINTON CREEK CHANNEL PROFILE
VER. SCALE 1:200
HOR. SCALE 1:1000

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INDIAN AND NORTHERN AFFAIRS CANADA

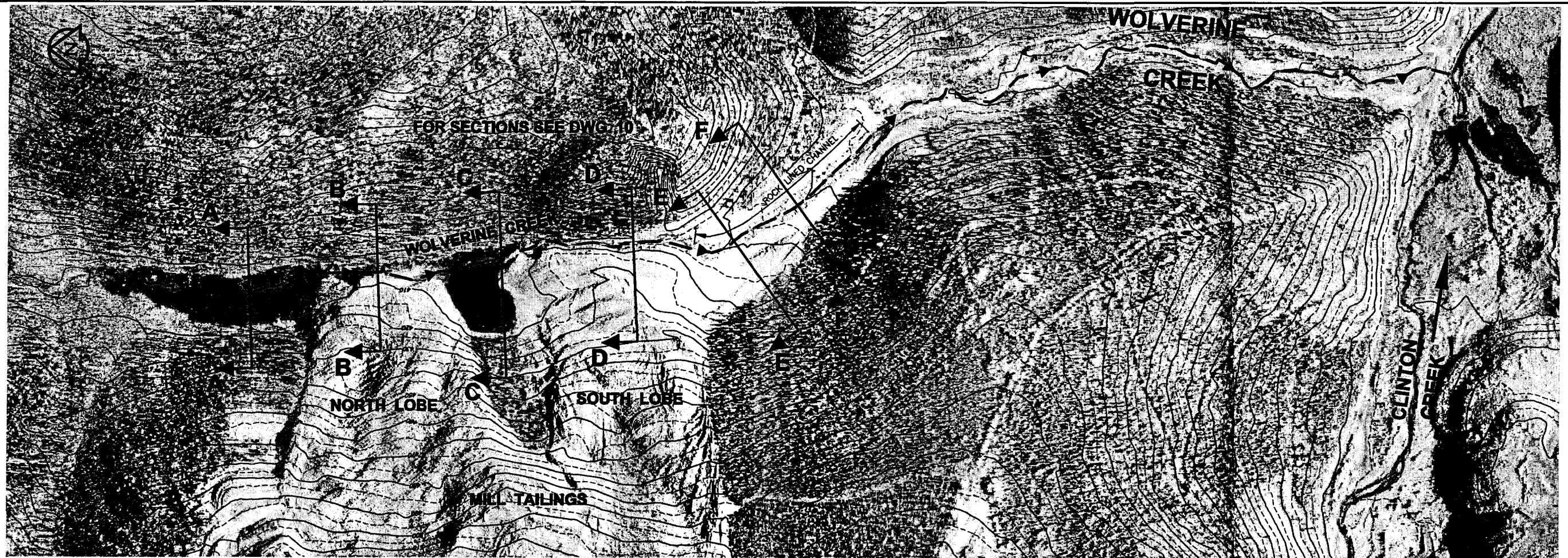
ABANDONED CLINTON CREEK ASBESTOS MINE
ENVIRONMENTAL LIABILITY

HUDGEON LAKE OUTLET AND CLINTON CREEK
SHORT-TERM REPAIRS

08

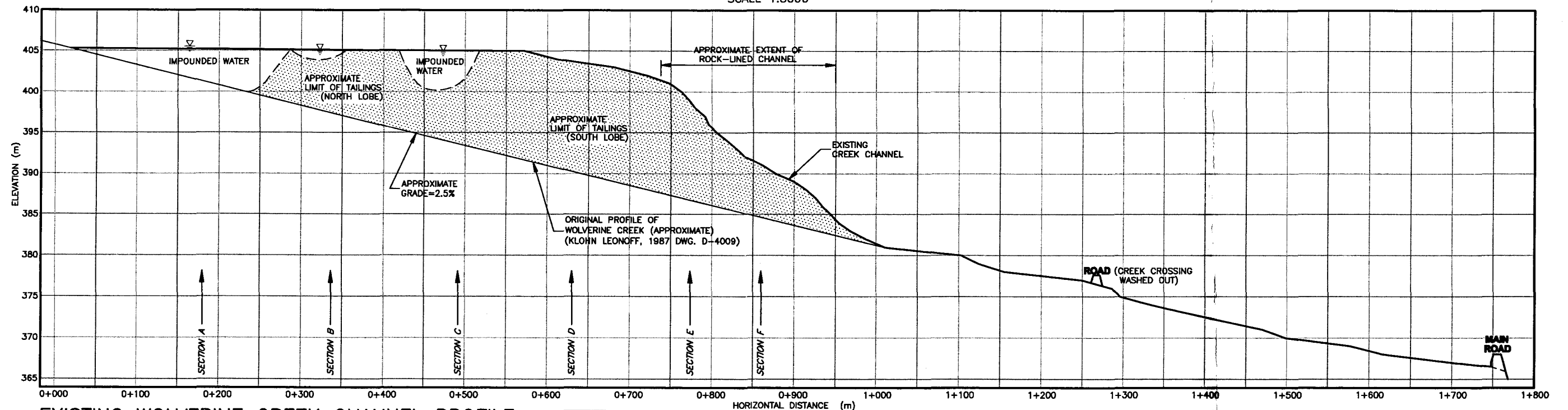
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Plot Scale: 1"=1
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NAD 83 UTM Zone 7
Photography Date: September 1999

WOLVERINE CREEK PLAN
SCALE 1:5000



EXISTING WOLVERINE CREEK CHANNEL PROFILE

VER SCALE 1:500
HOR SCALE 1:5000

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SEAL

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SCALE: AS NOTED	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA

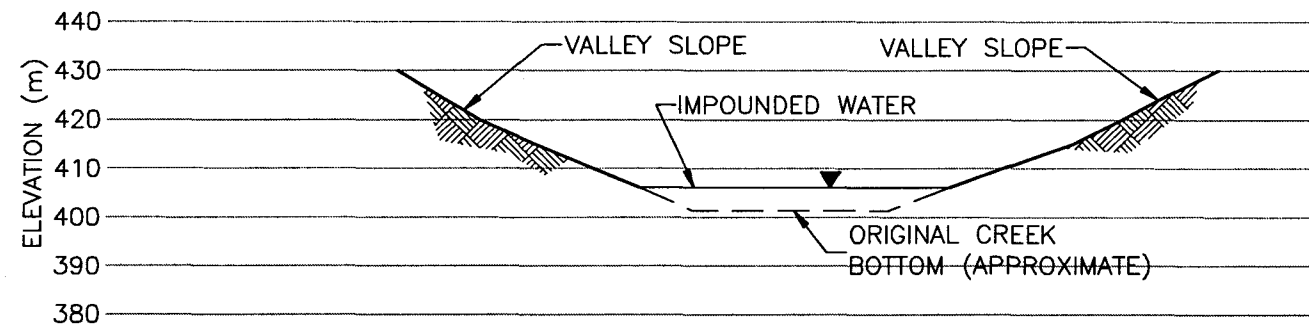
**ABANDONED CLINTON CREEK ASBESTOS MINE
ENVIRONMENTAL LIABILITY**

**WOLVERINE CREEK
PLAN AND PROFILE**

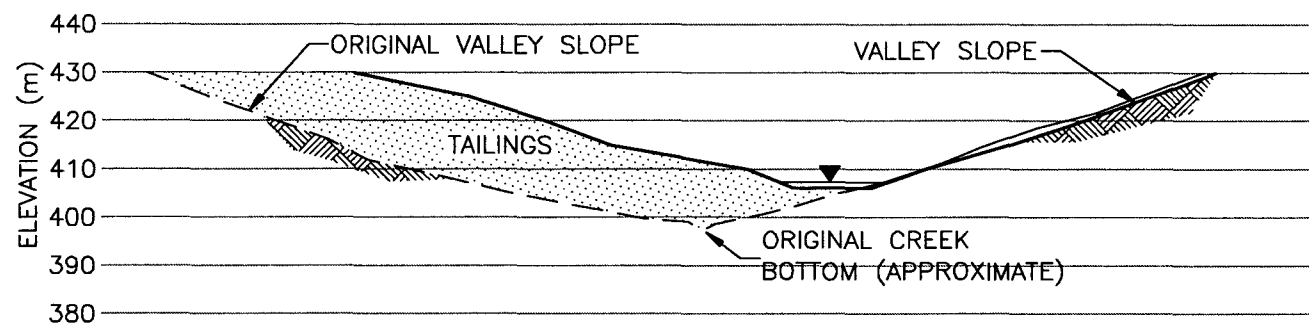
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DWG. No. REV.

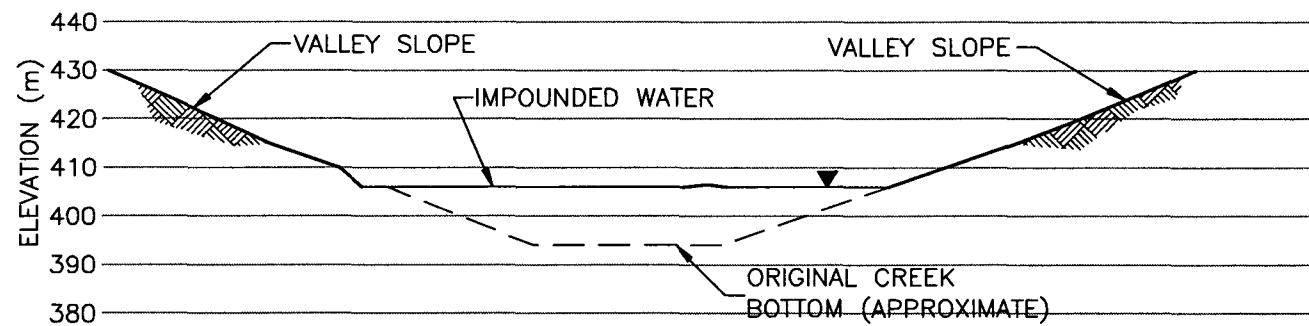
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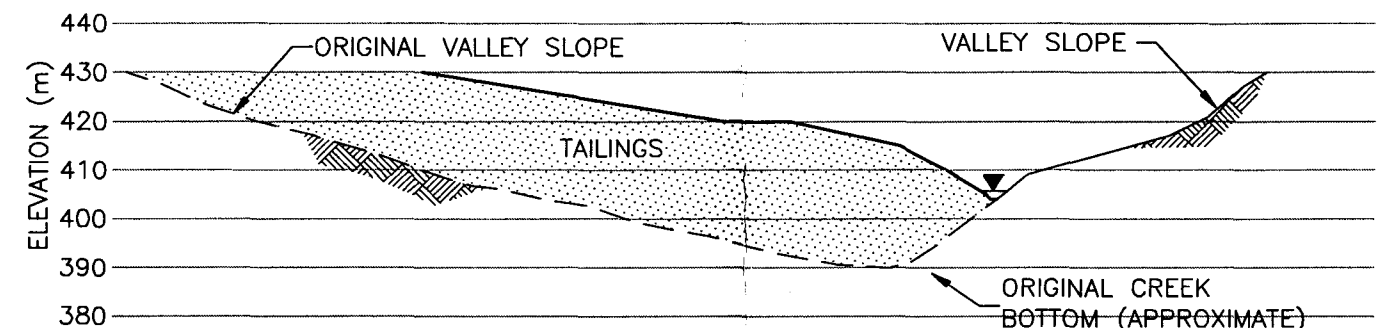
SECTION A (0+180m)



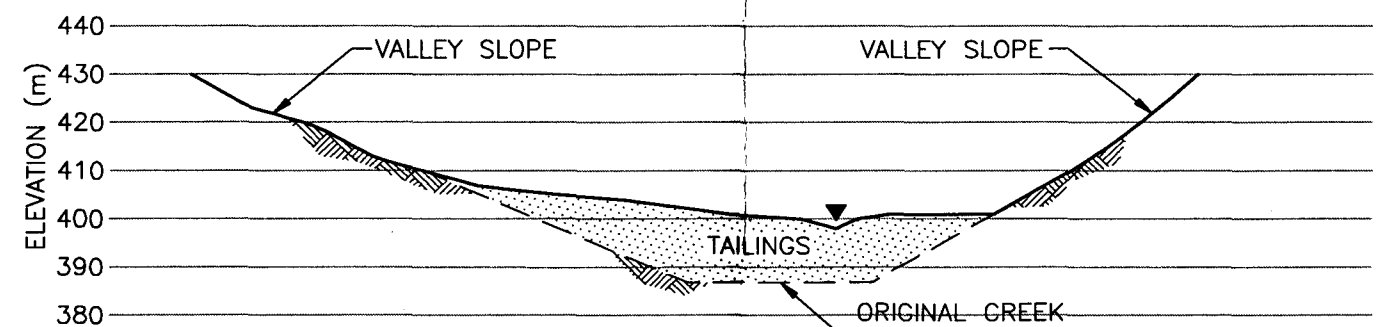
SECTION B - NORTH TAILINGS LOBE (0+337m)



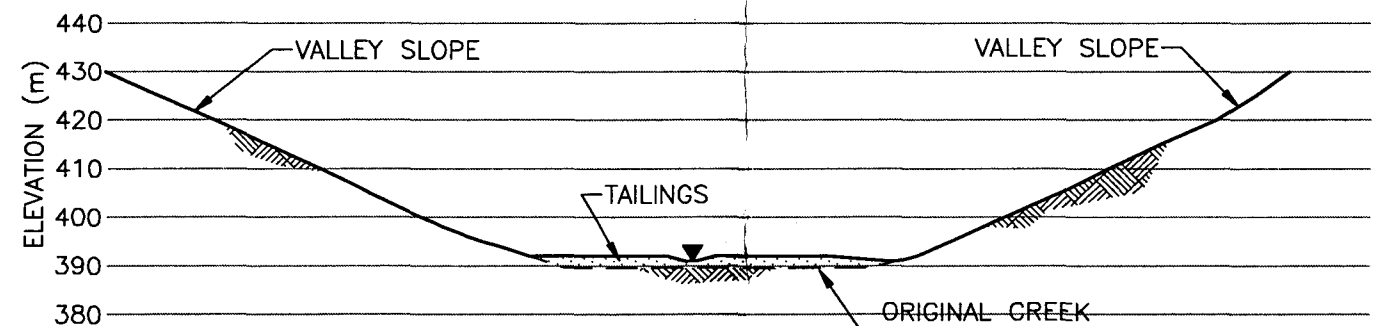
SECTION C (0+492m)



SECTION D - SOUTH TAILINGS LOBE (0+630m)



SECTION E (0+774m)



SECTION F (0+860m)

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REV.	DESCRIPTION	DWN.	APP.	DATE

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• Consulting • Engineering • Construction • Management Services	
APPROVED BY: _____	DATE: MAY, 2002
DRAWN BY: _____	DESIGNED BY: _____
CHECKED BY: _____	CHECKED BY: GR
SCALE: 1:1,500	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE	
ENVIRONMENTAL LIABILITY	
WOLVERINE CREEK EXISTING SECTIONS	
DWG. No.	REV.
10	-

Plot Scale: 1=1
 L:\Earth & Water\Projects\2520 DIAND - Clinton Creek Asbestos Mine\2520-160-04-02\Drafting\April\Environmental Liability\05Bedrock.dwg



LEGEND

- (T5) ⊕ THERMISTOR (GOLDER, 1978)
 BH-15 ⊕ BORE HOLE (GOLDER, 1978)

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SCALE: 1:7500	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA

**ABANDONED CLINTON CREEK ASBESTOS MINE
 ENVIRONMENTAL LIABILITY**

**TAILINGS PILE TEST HOLES
 AND THERMISTORS**

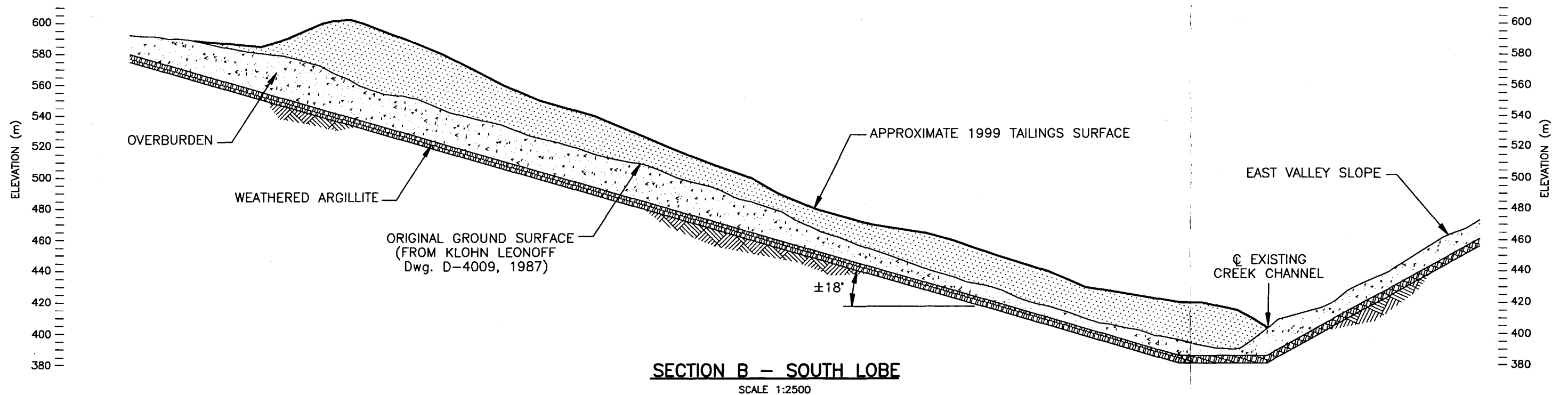
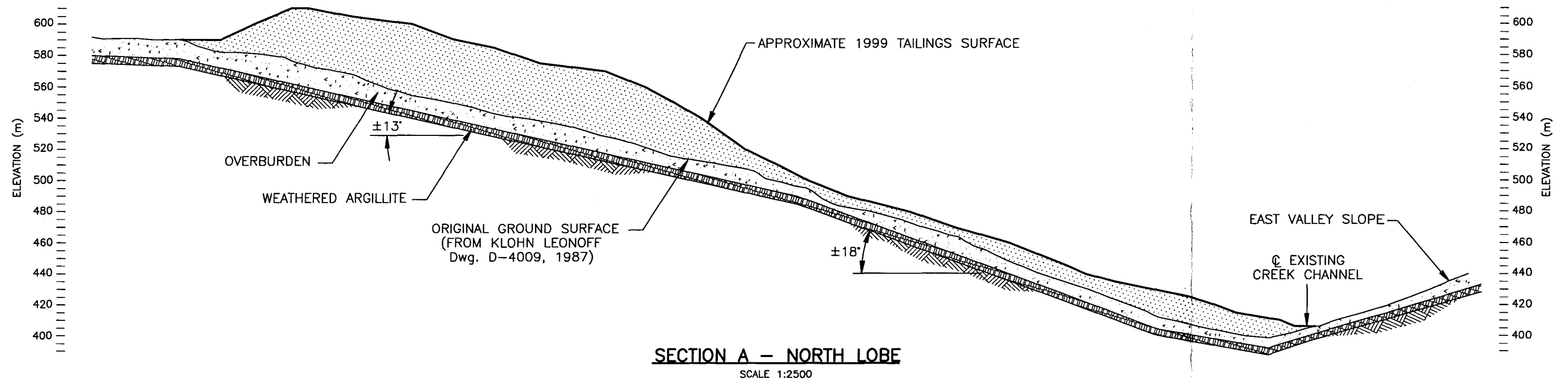
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DWG. No.	REV.

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SCALE: 1:20,000	JOB No. 4440-038-02

12	-
DWG. No.	REV.

Plot Scale: 1=1
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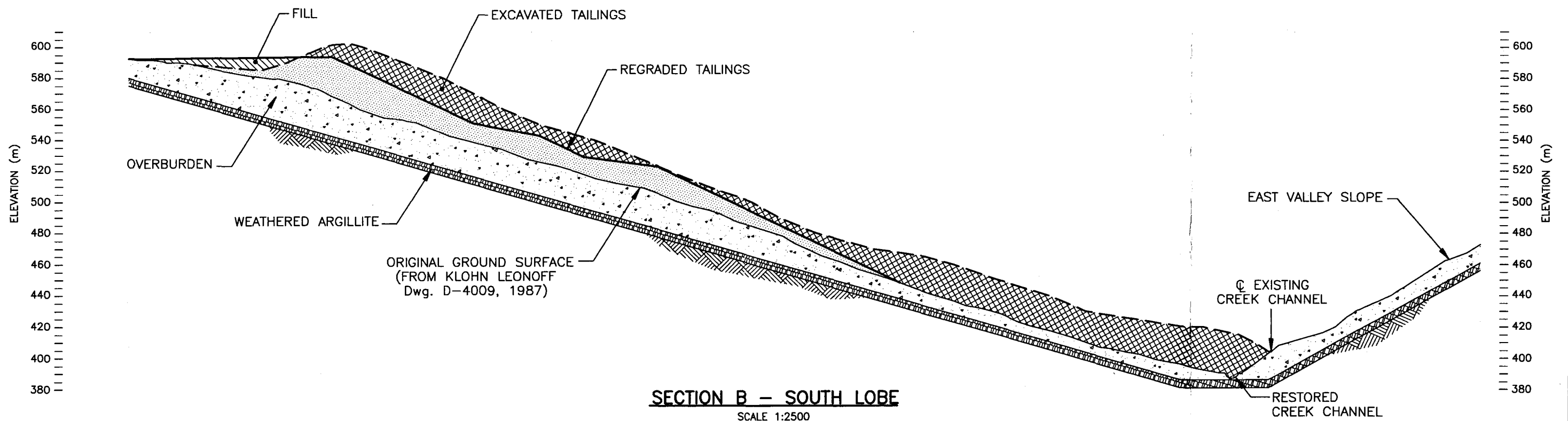
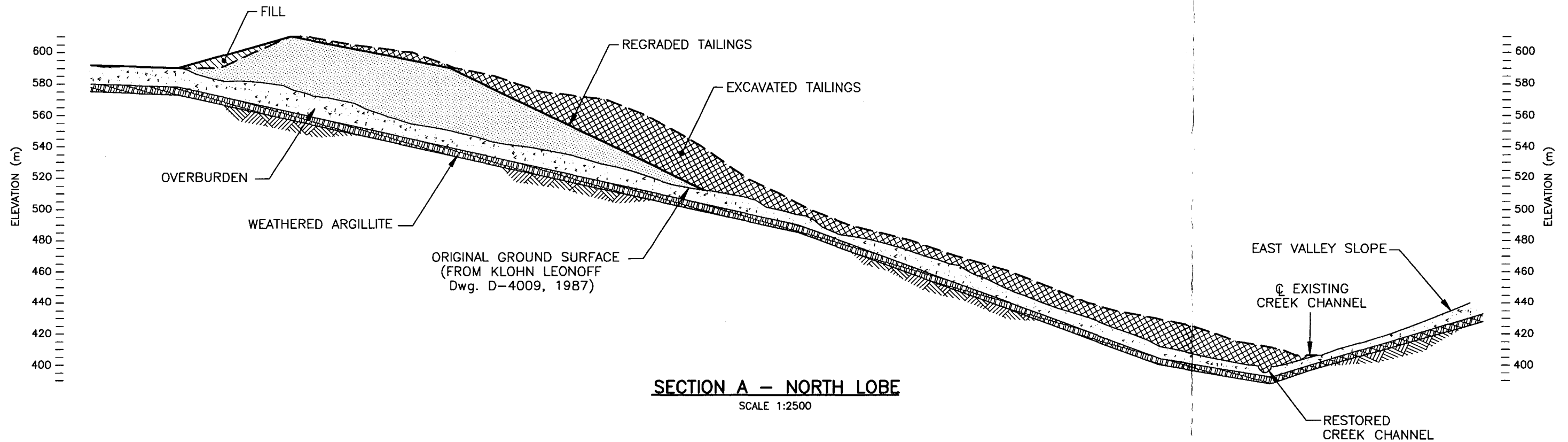
REV.	DESCRIPTION	DWN.	APP.	DATE

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SCALE: AS NOTED	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA		
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY		
WOLVERINE CREEK TAILINGS EXISTING SECTIONS	13	-
DWG. No.	REV.	

Plot Scale: 1=1
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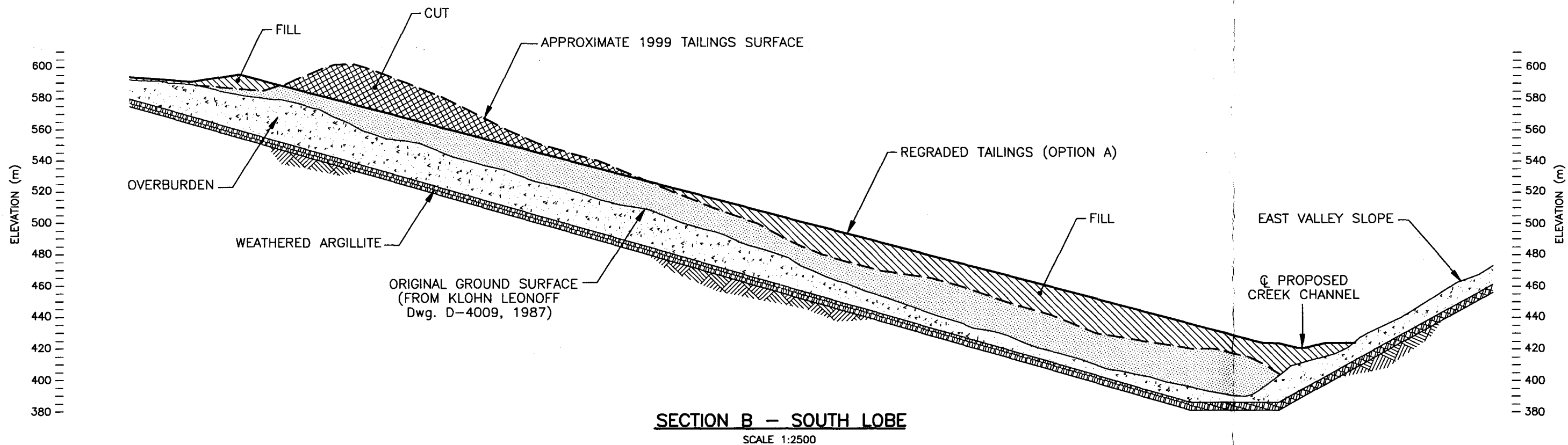
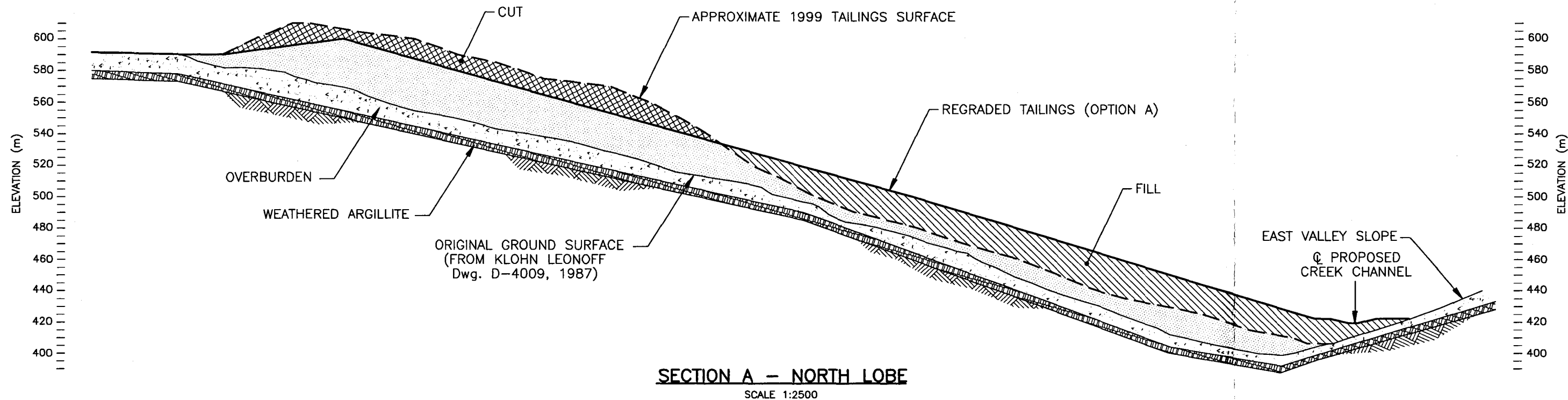
REV.	DESCRIPTION	DWN.	APP.	DATE

SEAL

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MAY, 2002	
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INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
WOLVERINE CREEK TAILINGS VALLEY RESTORATION	14 -
DWG. No.	REV.

Plot Scale: 1=1
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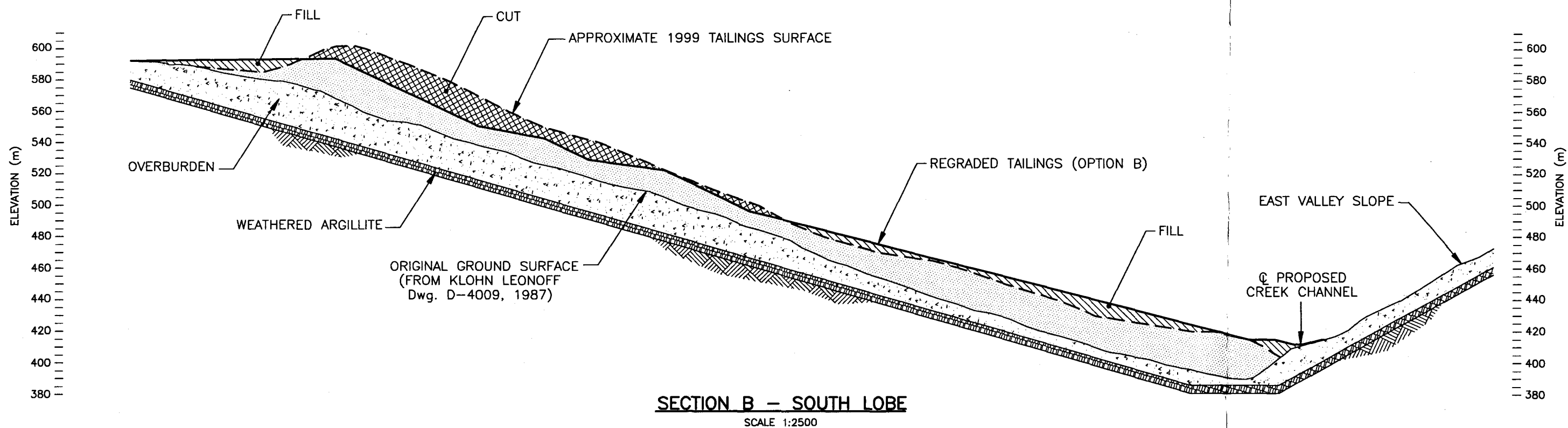
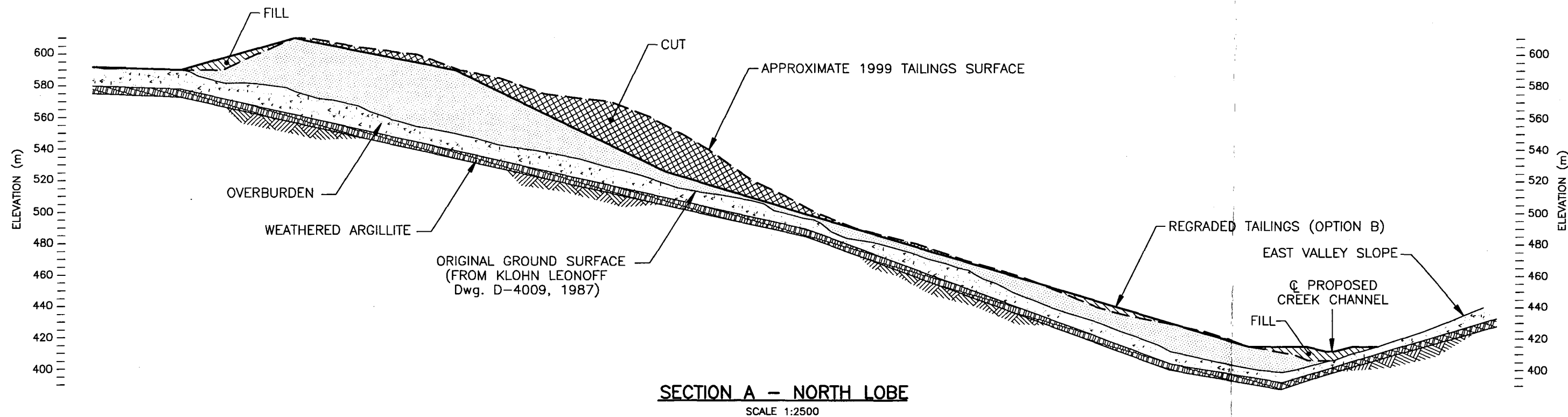
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REV.	DESCRIPTION	DWN.	APP.	DATE

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SCALE: AS NOTED	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
WOLVERINE CREEK TAILINGS REGRADED - OPTION A	15 -
DWG. No.	REV.

Plot Scale: 1"=1'
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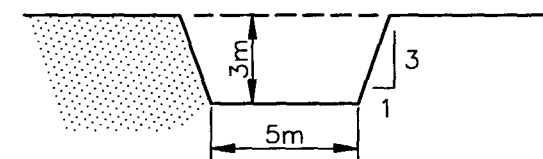
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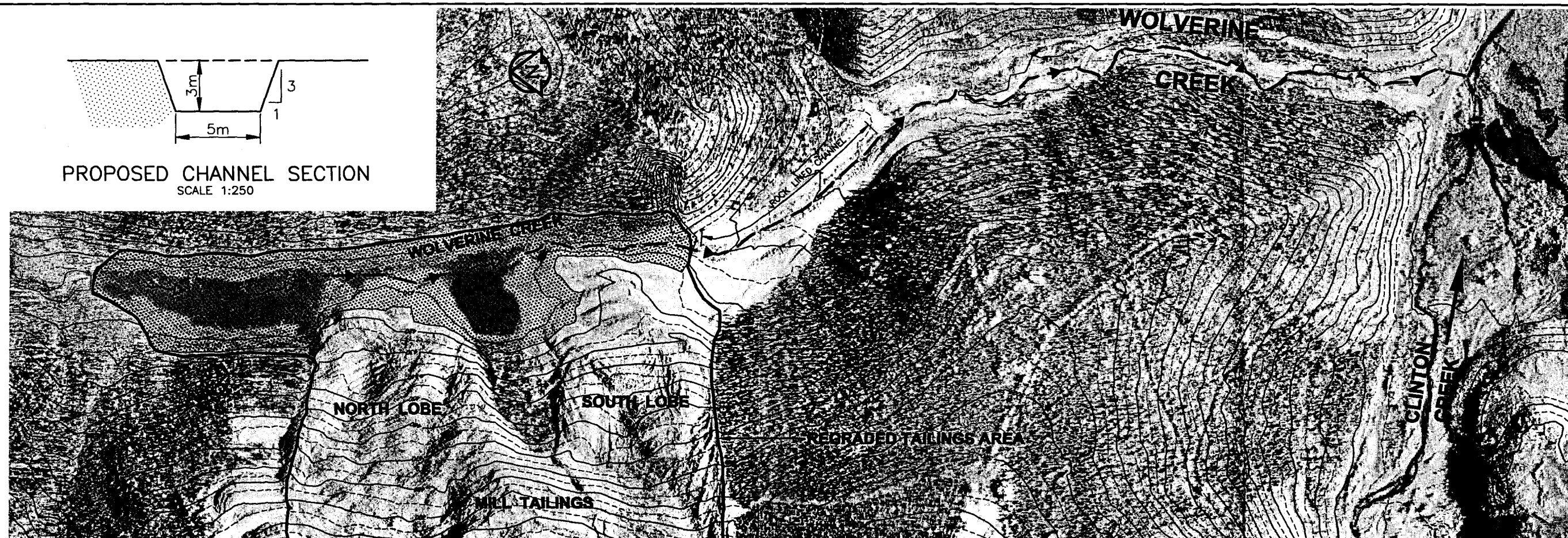
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DRAWN BY: _____	DESIGNED BY: _____
CHECKED BY: _____	CHECKED BY: GR
SCALE: AS NOTED	JOB No. 4440-038-02

INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
WOLVERINE CREEK TAILINGS REGRADED - OPTION B	16
DWG. No.	REV.

Plot Scale: 1=1
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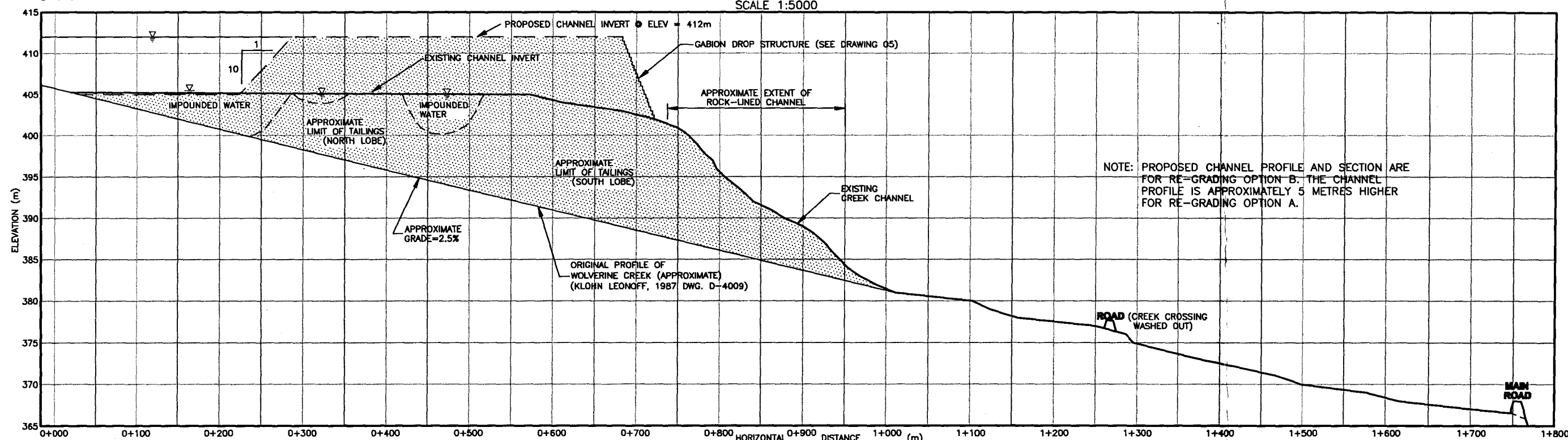


PROPOSED CHANNEL SECTION
SCALE 1:250



NAD 83 UTM Zone 7
Photography Date: September 1998

WOLVERINE CREEK PLAN
SCALE 1:5000



PROPOSED WOLVERINE CREEK CHANNEL PROFILE
VER SCALE 1:500
HOR SCALE 1:5000

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REV.	DESCRIPTION	DWN.	APP.	DATE

SEAL

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INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE ENVIRONMENTAL LIABILITY	
WOLVERINE CREEK PROPOSED PLAN, PROFILE AND SECTION	
DWG. No. 17	REV. -



PROPOSED TUNNEL
ALIGNMENT

WOLVERINE CREEK

NORTH LOBE

SOUTH LOBE

MILL TAILINGS

ROCK LINED CHANNEL

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INDIAN AND NORTHERN AFFAIRS CANADA	
ABANDONED CLINTON CREEK ASBESTOS MINE	
ENVIRONMENTAL LIABILITY	
WOLVERINE CREEK PROPOSED TUNNEL ALIGNMENT	
18	
REV.	

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Construction	Management Services
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SCALE: 1:3000	JOB No. 4440-038-02
SEA	REV.