WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

REPORT ON HYDROGEOLOGICAL SUMMARY AND PRELIMINARY IMPACT ASSESSMENT (REF NO. 1783/3)

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Association of Consulting Engineers of Canada
Association des Ingénieurs-Conseils du Canada

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SECTION 1.0 - INTRODUCTION

1.1 GENERAL

In response to review by government agencies and their consultants, and at the request of Western Copper Holdings Limited, Knight Piésold Ltd. have herein prepared a review and summary of the hydrogeological conditions and preliminary impact assessment for the Carmacks Copper Project. Specifically, the report includes the following:

- Summary and compilation of previous work and existing information for the heap leach pad, open pit, waste rock storage area and water storage dam site.
- Review and description of the groundwater flow conditions at the heap leach pad, open pit, waste rock storage area and water storage dam site.
- Potential impact assessment on the groundwater flow system at the heap leach pad, open pit and waste rock storage area.
- Discussion of mitigative measures and monitoring requirements for final design and operations.
- Recommendations for additional hydrogeological investigations and studies required for final design.

1.2 PREVIOUS WORK

1.2.1 General

Previous field investigations have been carried out at each of the Heap Leach Pad, Open Pit, Waste Rock Storage and Water Storage Dam sites. The work was conducted to provide preliminary information on the geotechnical and hydrogeological conditions at each of the proposed sites, and for baseline environmental studies. The field work was carried out in two separate site investigation programs.

The first field program was conducted from mid August to mid September, 1992 and was intended to examine the preliminary geotechnical and hydrogeological conditions at four potential heap leach pad sites, the open pit, the millsite, the waste rock storage site and the water storage dam site. In addition, the investigations included the delineation of potential borrow source areas for earthworks construction. The field work was carried out by Knight Piésold Ltd. and included test pit excavations, overburden sampling and one (1) oriented diamond core drillhole in the open pit area. Standpipe piezometers and thermistor strings were also installed by Western Copper Holdings Limited site personnel. The results of the oriented drilling are included in the "Report on Pit Slope Stability (Ref. No. 1782/3)" by Knight Piésold Ltd., dated January 1993. Details of the test pit investigations and standpipe installations are presented in the "Report on 1992 Surficial Geotechnical Investigations (Ref. No. 1782/4)" by Knight Piésold Ltd., dated May 1993.

The second field program was carried out from the end of February to mid March, 1995 to investigate the geotechnical and hydrogeological conditions at the preferred heap leach pad site and water storage dam site for preliminary design. The program was carried out by Knight Piésold Ltd. and included overburden drilling and sampling, bedrock coring, the installation of groundwater monitoring wells, and the installation of one (1) thermistor string. The program also included the excavation of trenches and test pits to investigate near surface foundation conditions and borrow materials for construction. Details and results of this program are included in the "Report on Preliminary Design (Ref. No. 1783/1)" by Knight Piésold Ltd., dated May 1995.

The following sub-sections discuss the details of the previous work carried out for each component of the project.

1.2.2 Heap Leach Pad

A total of eight (8) boreholes (DH-A to DH-H) were drilled at the heap leach pad site during the recent site investigations carried out by Knight Piésold Ltd. in February to March, 1995. As previously mentioned, the program included the installation of groundwater monitoring wells and one (1) thermistor string (Th3) in the boreholes, and the excavation of trenches for overburden sampling and testwork. The locations of the groundwater wells and thermistor string are shown on Figure 1. Completion details for the wells are included in Appendix A.

Prior to the program, two (2) standpipe piezometers (RC-92-01 and RC-92-09) and one (1) thermistor string (Th2) were installed in inclined exploration holes. The standpipes and thermistor string were installed by Western Copper Holdings Limited. The locations are shown on Figure 1. Completion details are included in Report Ref. No. 1782/4 and are repeated here in Appendix B.

A water well (WW95-01) was drilled southeast of the leach pad during late August 1995, with the well yield tests carried out in Setember 1995 by Others. The location of WW95-01 is shown on Figure 1. The well information is included in Appendix C.

1.2.3 Open Pit

A total of three (3) standpipe piezometers were installed in angled exploration holes (RC-92-04 to RC-92-06) in the open pit area. These piezometers were installed by Western Copper Holdings Limited. The locations are shown on Figure 1. Completion details are included in Report Ref. No. 1782/4 and are repeated here in Appendix B.

1.2.4 Waste Rock Storage

A total of thirteen (13) test pits were excavated at the waste rock storage site as part of the 1992 site investigations carried out by Knight Piésold Ltd. The test pits are designated TP1A to TP13A and were initially located for the investigation of Leach Pad Site A. One (1) thermistor string (Th1) was also installed by Western Copper Holdings Limited personnel outside the southwest perimeter of the waste rock storage site, as shown on Figure 1. The locations and details of the test pits are included in Report Ref. No. 1782/4. No boreholes have been drilled to date at the waste rock storage site.

1.2.5 Water Storage Dam

Two (2) additional boreholes (DH-1 and DH-2) were drilled at the water storage dam site as part of the recent drill program carried out in February to March, 1995. The purpose of the holes was to determine the preliminary foundation conditions at the dam site and to install groundwater monitoring wells. The locations of the boreholes are shown on Figure 1. Completion details for the wells are included in Appendix A.

SECTION 2.0 - SITE GROUNDWATER CONDITIONS

2.1 GENERAL

The groundwater flow regime at the Carmacks Copper Project site is generally characterized by a deep flow system. The regional groundwater flow likely occurs as an unconfined flow system within bedrock in which groundwater is recharged at higher elevations in the upland areas and flows toward the valleys at lower elevations. The groundwater table likely forms a subdued replica of topography whereby the depth to groundwater increases with increasing elevation. The result of exploration drilling and recent geotechnical site investigations suggest that the groundwater table lies at significant depths over most of the project area. In some areas the presence of permafrost has resulted in the development of perched water tables, however, these are isolated and are likely discontinuous. In addition, minor groundwater flow is evident in the active zone just below the ground surface which occur on a seasonal basis resulting in the development of local swamp areas. The permafrost may also act to reduce infiltration in some areas thereby significantly reducing recharge resulting in the overall depression of the regional groundwater table.

The following sections discuss the hydrogeological conditions at each of the heap leach pad, open pit, waste rock storage area and water storage dam site. This discussion is based on limited information and will require further confirmation prior to final design. Notwithstanding this, however, the available information is sufficient to provide a preliminary evaluation of the existing conditions and for potential environmental impact assessment.

The locations of all monitoring wells and standpipe piezometers installed to date at the Carmacks Copper Project are shown on Figure 1. A summary of the wells and standpipes, including the depths and groundwater levels, are presented in Table 1.

2.2 HEAP LEACH PAD

The groundwater flow system at the heap leach pad is characterized by a thick vadose zone (unsaturated zone above the water table) which overlies the regional groundwater table. The vadose zone typically comprises a section of well graded, low permeability glacial till overlying weathered granodiorite in the lower half of the facility, and weathered, decomposed granodiorite over competent granodiorite bedrock in the upper half. Existing seepage from natural infiltration is transmitted downward through the vadose zone toward the groundwater table, where it enters the groundwater system and flows downgradient within bedrock. Minor groundwater flows also occur within the active zone (annual depth of freeze-thaw) just below the ground surface where seasonal thawing results in the development of local saturated areas. The glacial till which overlies much of the leach pad area acts as a relatively low permeability material which confines groundwater flow to the underlying bedrock and inhibits the downward infiltration of precipitation and runoff. The source of recharge for groundwater flow likely originates from the infiltration of precipitation and surface runoff from higher elevations in the upslope region of the leach pad. The low infiltration rates associated with the low annual precipitation at the site have likely resulted in lowering the regional groundwater table. Geologic/hydrogeologic sections showing the predicted location of the groundwater table and directions of groundwater flow are shown in Figure 2.

Monitoring wells installed in the leach pad area indicate a complex distribution of perched groundwater tables and permafrost lenses. This is evident by the presence of groundwater in shallow wells above the permafrost which overlie dry wells at greater depth in the same drillhole within or below permafrost. The permafrost lenses occur locally in the vadose zone within the glacial till, above the groundwater table. These lenses act as horizontal barriers to the downward migration of seepage and result in the formation of isolated perched water tables above the permafrost.

The results of site investigations at the leach pad suggest that the regional groundwater table lies at significant depth within the granodiorite bedrock. Boreholes RC-92-01 and WW95-01, located southeast of the leach pad, both indicate groundwater levels of approximately 15 to 17 metres below the ground surface which corresponds to approximately 20 to 25 metres above the elevation of Williams Creek. Extrapolation of this groundwater depth from the creek level further upslope results in an average projected depth of from 30 to 50 metres as an estimated depth to the groundwater table under the heap leach pad. This conservatively places the groundwater table just below the boreholes drilled in the lower region of the pad, as shown on Figure 2.

2.3 OPEN PIT

The results of exploration and geotechnical drilling indicate that the regional groundwater table is very deep in the vicinity of the open pit. None of the three (3) standpipes installed at the open pit intersected groundwater. Recent measurements confirm that the wells are dry and that no groundwater was found down to a true depth of approximately 70 metres below the ground surface (RC-92-06). As well, loss of drilling fluids were commonly reported during exploration drilling suggesting that the fluids may be flowing down and recharging a deeper regional groundwater system. The outline of the open pit is shown on Figure 1 along with the locations of the standpipe piezometers.

gw at depth but highly permeable soils

The open pit is located in an upland area at high elevations of from 810 to 900 metres. Consequently, the open pit likely lies in an area of groundwater recharge where surface infiltration must migrate through a significant vadose zone before reaching the groundwater table. Given the location of the open pit, the nature of the surrounding topography, and experience in similar geologic settings, it is likely that the groundwater table forms a subdued image of the topography and dips gently downslope in an east-northeasterly direction.

The average elevation of the open pit is approximately 40 metres higher than the average elevation at the heap leach pad. As an approximation, therefore, the groundwater table at the open pit is estimated to lie at a depth of from 80-100 metres below the ground surface. The average depth of the open pit is estimated to be approximately 125 metres. Consequently, groundwater is not expected to be of significant concern. Notwithstanding this, additional investigations are recommended to confirm the groundwater conditions for open pit stability assessment, evaluation of pit dewatering requirements, and for long-term groundwater quality monitoring.

2.4 WASTE ROCK STORAGE

The proposed waste rock storage area is located north of the open pit. This area was originally selected as a leach pad site (Site A) during initial project evaluation. This site was subsequently rejected for heap leach storage due to permafrost and ice rich foundation soils found at the site. Preliminary surficial (test pit) geotechnical investigations were previously carried out as part of the initial site selection process and are presented in Report Ref. No. 1782/4. The results of the site investigations generally revealed a varied overburden sequence comprising fluvial sands, silts and stratified sands and gravels. The coarse-grained sands and gravels were intersected at varying depths of from 0.5 to 5 metres and were typically overlain by fine-grained silts, fine sands and surficial organics.

The groundwater conditions at the waste rock storage area are characterized by both near surface flow and deeper flow within relatively permeable materials under the permafrost. The near surface groundwater flow occurs within the active layer and results in the ponding (or perching) of groundwater on top of the permafrost. The permafrost, in effect, acts as an impenetrable barrier to downward seepage resulting in predominantly horizontal flow in a downslope direction within the active zone. The permafrost lies at shallow depths of from 0.5 to 5.2 metres over most of the waste rock storage area. Deeper flow systems are also apparent within coarse-grained sand and gravel layers under the permafrost. This flow, however, is likely isolated and discontinuous, and is confined at depth by the overlying permafrost.

The actual depth to the regional groundwater table is not known, however, is expected to lie at significant depths under the waste rock storage area. It is important to note that the location of the regional groundwater table may not be important for impact assessment as the waste rock pile will likely act to insulate the permafrost and restrict groundwater flow to near surface flow only. In any event, additional site investigations will be carried out during final design to determine the groundwater conditions and the potential impacts from waste rock storage. Details of the additional site investigations required are discussed in Section 4.0.

2.5 WATER STORAGE DAM

The results of drillhole and test pit investigations at the water storage dam indicate that groundwater occurs near the ground surface in the valley bottom and increases with depth away from the creek along the abutment slopes. This is typical of a valley system where groundwater flows toward the valley and discharges into the creek in the bottom of the valley.

The water storage dam will be designed to supply water for the project and to provide sediment control for all facilities. The quality of water stored in the dam will be comparable to that in the existing surface waters. The embankment will be constructed from local coarse, durable, free-draining alluvial sands and gravels to accommodate any settlement and to provide stability. Measures will be included to ensure sufficient drainage both within the embankment and foundation in the event that any groundwater seeps or artesian conditions are encountered. Groundwater conditions will not be a controlling factor in the design of the water storage dam.

SECTION 3.0 - HYDROGEOLOGICAL IMPACT ASSESSMENT

3.1 GENERAL

The following sections discuss the factors affecting the potential hydrogeological impacts for each of the project components. Discussion includes mention of the existing measures and design features which are present for the mitigation of the impacts on the groundwater system and recommendations for groundwater monitoring. Particular emphasis is given to the proposed heap leach pad as this structure has the greatest potential for impact. The hydrogeological impact from the water storage dam is expected to be minor and therefore was not included in this assessment.

In general, groundwater impacts at the Carmacks Copper Project are not expected to be significant. This is primarily due to the great depths to groundwater which are expected. This is advantageous in allowing very long travel times to the groundwater system as well as providing significant attenuation of any leakage.

The discussion contained herein is based on preliminary information. As such, more detailed site investigations and studies will be required at the next stage of design. Details on the additional site investigation and studies recommended for final design are discussed in Section 4.0.

3.2 HEAP LEACH PAD

3.2.1 Foundation Conditions

The foundation materials beneath the proposed heap leach pad comprise low permeability glacial till and weathered bedrock. Permafrost exists entirely within the glacial till and comprises well bonded, frozen soil with occasional thin discontinuous ice lenses. The permafrost lies in the draw area in the lower portion of the pad and is absent at higher elevations where well drained conditions predominate. Upslope, toward the northwest and at higher elevations along the ridges to the east and west, the glacial till pinches out and is replaced by weathered bedrock which overlies more competent bedrock at shallow depths.

The glacial till material will act as a natural inhibitor to the infiltration of any leakage from the leach pad. The permafrost, which is characterized by well bonded ice-poor till material, is not expected to significantly increase in permeability upon thawing and consequently will also act to inhibit infiltration of any leakage from the pad. The zones within permafrost which contain excess ice are minor and discontinuous only, and therefore are not expected to affect the overall hydraulic conductivity of the foundation.

For impact assessment purposes a hydraulic conductivity value of 1×10^{-7} cm/s was assumed as an average best estimate for the soil liner and foundation till. This value is based on conservative estimates from laboratory testwork and experience with similar materials from other projects. A conservative worst case hydraulic conductivity value of 1×10^{-6} cm/s was also used in the assessment.

The weathered (residual) bedrock which exists in the upper portion of the leach pad is characterized by a coarse sandy-like material and contains relict jointing from the original bedrock structure. This material grades gradually down to fractured bedrock at depth. The results of site investigations suggest that the weathered bedrock material is relatively pervious and may behave as a preferential path for the transport of leakage. However, this unit is likely discontinuous and pinches out downslope into relatively impervious glacial till and competent bedrock. An average hydraulic conductivity value of 1×10^{-5} cm/s for the weathered bedrock was adopted for the impact assessment.

Granodiorite bedrock underlies weathered bedrock and glacial till over the heap leach pad area. Results of the site investigations indicate that the depth to bedrock varies from approximately 6 to greater than 20 metres and increases downslope. The bedrock is fractured near the overburden contact and likely increases in quality with depth. The hydraulic conductivity of the bedrock will be important in assessing the impacts on the groundwater system. For the purposes of impact assessment hydraulic conductivity values of 1×10^{-5} cm/s and 1×10^{-6} cm/s were used. These values are representative and typical for fractured intrusive rock types.

3.2.2 Impact Assessment

A preliminary impact assessment was carried out for the proposed heap leach pad to predict the potential effects of leakage from the leach pad on the groundwater quality and the long-term impacts on the receiving surface waters in Williams Creek downslope of the pad. The hydrogeological impact at the leach pad will depend on the following important aspects:

- Leakage rate from the leach pad;
- Depth to the groundwater table and the associated travel time of leachate solution transport through the vadose zone;
- Travel time from the leach pad to Williams Creek;
- Attenuation of constituents within the leachate solution as it migrates through the vadose zone;
- Dilution of leachate concentration upon mixing with the natural groundwater flow system; and
- Dilution of leachate from receiving flows in Williams Creek.

(i) Leakage Rates

The leakage rates from the liner system were previously calculated and are included in the Preliminary Design Report (Ref. No. 1783/1). The leakage rate was calculated based on accepted EPA standards for a leak in a composite liner system which specifies that, notwithstanding high QA/QC during installation, one (1) pinhole leak with an area of 10 mm^2 may be expected per acre (4,027 m^2) of geomembrane liner. Using this criteria the leakage rate through the composite liner was computed using the following formula:

$$q = 0.21\ a^{0.1}\ k_n^{0.74}\ H^{0.9}$$

where, q = leakage rate per hole (m^3/s)

a = area of hole (10 mm^2)

k_n = saturated hydraulic conductivity of compacted soil liner (m/sec); and

H = hydraulic head acting on liner (m)

The resulting leakage rate for the liner system was previously calculated for a hydraulic conductivity value of 1 x 10^{-7} cm/s for the compacted till soil liner. Given the entire leach pad area of 310,000 m^2, the total average leakage rate was estimated to be 6 x 10^{-7} m^3/s. This corresponds to a flux leakage rate of 2 x 10^{-12} m^3/s per m^2 of pad.

Leakage rates were also calculated here for a worst case (conservative) hydraulic conductivity value of 1 x 10^{-6} cm/s for the till soil liner. This results in a total leakage rate of approximately 4 x 10^{-6} m^3/s and a flux rate of 1 x 10^{-11} m^3/s per m^2 of pad. This conservative worst case estimate will not significantly increase the impact on the groundwater system.

(ii) Transport Through Vadose Zone

Any leakage which occurs from the leach pad will likely migrate downward through the vadose zone as unsaturated flow then transported downslope as saturated flows within the groundwater system.

In order to assess the potential impact, calculations were performed to estimate both the travel time for leachate transport through the vadose zone, and the travel time for groundwater flow through the saturated zone from the pad to the creek. The calculations were carried out for both the best average estimates of hydraulic conductivity values for all of the materials. Travel times were calculated for both the best estimate and the worst case (conservative) estimate of hydraulic conductivity for the glacial till. It should be noted that these values are based on saturated values and that the hydraulic conductivity values for the till and weathered bedrock may be lower in the vadose zone (due to lower moisture contents) resulting in longer transport times.

The travel times were calculated for each of the following two cases which correspond to the predominant foundation conditions in the upper and lower regions of the leach pad:

Case 1:

- Downslope region of pad.
- Vadose zone comprising 20 m till overlying 10 m weathered bedrock.
- Groundwater table at 30 m depth.

Case 2:

- Upslope region of pad.
- Vadose zone comprising 10 m weathered bedrock overlying 40 m competent bedrock.
- Groundwater table at 50 m depth.

Results of the analysis indicate that, based on the average estimated hydraulic conductivity values and the estimated depths to the groundwater table, the travel times through the vadose zone range from 10 to 60 years (average 35 years) for Cases 1 and 2, respectively. In other words, it will take between 10 and 60 years for any leak which occurs from the pad to reach the regional groundwater table. These travel times approximate or exceed the operational life of the leach pad of 10 years and therefore are not expected to impact the groundwater system during operations. The long travel times and distances to the regional groundwater system are advantageous in minimizing impact to the groundwater system by allowing for the attenuation of leachate constituents within the vadose zone. In particular, the acid-base-accounting testwork previously carried out on the glacial till suggest that this material is highly acid-consuming and therefore may provide significant buffering capacity and neutralization of the leachate solution before it reaches the groundwater table. Further testwork is required to confirm this.

(iii) Dilution

Upon reaching the groundwater table the leachate will be further reduced in concentration by dilutional effects. The amount of dilution depends primarily on the rate of flux leakage from the pad and the hydraulic conductivity of the bedrock. If the bedrock is relatively pervious the dilution factors will be relatively large and will significantly reduce concentrations of the leachate upon reaching the groundwater table. Alternatively, if the hydraulic conductivity is low then the dilution will not be as great, however, transport times will be increased and the attenuation of leachate through the vadose zone will be increased. The dilution was calculated by comparing the flux leakage rate from the pad with the predicted flux rate within the groundwater flow system below the water table. In order to predict the dilution a sensitivity analysis was carried out using two estimated hydraulic conductivity values for the bedrock. In addition, dilution factors were calculated for both the best expected average leakage flux value of 2×10^{-12} m^3/s per m^2, of pad and the worst case leakage value of 1×10^{-11} m^3/s per m^2 from the pad. These values correspond to hydraulic conductivity values of 1×10^{-7} cm/s and 1×10^{-6} cm/s for the till soil liner, respectively.

The results of the analysis indicate that under expected conditions the dilution factor will be in the order of 500. This value is based on an estimated hydraulic conductivity of 1×10^{-6} cm/s for the bedrock and the expected leakage rate. For the worst case leakage rate, the dilution factor will be decreased by an order of magnitude to 50. In the event that the hydraulic conductivity of the bedrock is increased to 1×10^{-5} cm/s the dilution factor will be increased to 5,000 for average leakage conditions and 500 for worst case leakage conditions. From these results it is obvious that as the hydraulic conductivity of the bedrock is increased then the dilution will be increased. Alternatively, if the hydraulic conductivity is decreased then the dilution will be decreased, however, the travel times and attenuation will be increased.

(iv) Transport Through Saturated Zone

The final consideration of hydrogeological impact at the leach pad is the transport time for leachate to travel from beneath the leach pad to Williams Creek. The transport velocity for saturated flow in bedrock is given by:

$$V = \frac{k \times i}{n}$$

where, V = transport velocity
k = hydraulic conductivity of bedrock
i = slope of groundwater table (assumed 10%)
n = porosity (assume typical value of 10%)

The transport time within the groundwater system is given by:

$$t = \frac{d}{v}$$

where, v = transport velocity (calculated above)

d = transport distance (650 metres from pad to Williams Creek)

t = transport time

The transport times were calculated for both the best estimated hydraulic conductivity value of 1×10^{-6} cm/s, and the worst case value of 1×10^{-5} cm/s for bedrock. The results indicate travel times of approximately 2000 years for the best estimate, and 200 years for the worst case. These times are long and will provide significant attenuation of any leakage within the groundwater system prior to reaching the receiving waters in Williams Creek.

(v) Summary

In summary, the expected low hydraulic conductivity of the glacial till and bedrock underlying the leach pad will act to inhibit the rate of seepage and significantly reduce the impact from any leaks which may develop in the leach pad. The low seepage rates will increase the travel times for leachate transport and will allow for the attenuation of constituents within the leachate thereby minimizing impact. In the event that the hydraulic conductivities are much greater than predicted then the dilution effects within the groundwater system will reduce concentrations and impact.

Results of site investigations suggest that there is a possibility for preferential flow within the vadose zone or partial migration of leakage along perched water tables near the toe of the leach pad.

These zones, however, are expected to be relatively thin, discontinuous and limited in extent. Consequently, these features are not expected to affect the overall impact. Notwithstanding this, however, groundwater wells will be installed in the vadose zone downslope of the leach pad to monitor and pumpback any leakage which may occur. Groundwater wells will also be installed in the saturated zone to monitor groundwater quality in the deeper regional flow system.

3.2.3 Mitigating Factors

There are many mitigating factors both in the nature of the foundation materials and in the design features of the leach pad which will be available for minimizing the impact from leakage through the liner system. These include the following:

- Expected low seepage rates and long travel times through the vadose zone due to significant depth to the groundwater table and low permeability nature of foundation materials. Preliminary estimated travel times are from 10 to 60 years, based on conservative estimates of hydraulic conductivity and depth to the groundwater table. The long travel times will provide attenuation of leachate solutions.

- Leaks from composite liners (geomembrane over compacted soil) act as discrete point sources which only affect a small portion of the unsaturated zone beneath the liner. The potential for leakage from composite liners is significantly reduced due to the interaction of the geomembrane with the underlying soil liner. Any leak in the geomembrane will occur as a pinhole resulting in a point source for leakage through the soil liner. This substantially reduces leakage by preventing saturation over the entire surface of the soil liner.

- Reduction in concentration of leachate due to attenuation in soil liner and underlying foundation till material. In particular, the till, which overlies most of the leach pad area, is expected to be strongly acid consuming and therefore has a significant potential for the attenuation of pregnant leachate solution. Further attenuation testing should be carried out to confirm this and to quantify the attenuation capacity of the soil liner and foundation till.

- The underdrainage system and LCRS will prevent the build-up of hydraulic head within the leach pad thereby minimizing leakage rates. The underdrains will be comprised of perforated CPT pipes surrounded by drain gravel and will be installed on top of the liner system. The LCRS comprises a geonet drain between the two HDPE liners in the solution storage area.

All of these factors will result in reducing the hydrogeological impact for the heap leach pad. As previously discussed, if any leaks do develop, the rates will likely not be significant and the impact will be minor due to the factors mentioned above. In any event, groundwater wells will be installed downslope of the leach pad to monitor any leakage, and provisions will be included for installing additional pumpback wells to intercept the leakage and prevent it from migrating further downslope.

3.2.4 Monitoring

Additional drillholes are proposed for final design of the heap leach pad to provide further information on the hydraulic conductivities of the various geologic units and for the installation of groundwater monitoring wells. The drillholes will be located outside and inside the ultimate limits of the leach pad, as shown on Figure 1. This will allow for the monitoring of groundwater in both the vadose zone and the saturated zone below the groundwater table to provide baseline groundwater quality data, and for monitoring during operations and at closure. One (1) well, designated Site A will be installed upgradient of the heap leach facility to provide information on the background groundwater quality, including natural averages and seasonal variations both before and during operations. Wells will also be installed beneath and downgradient of the facility to define the baseline groundwater quality and to trace any changes during operations. These wells will be monitored and may be converted to pumpback wells if leaks are detected. The pumpback wells would then recycle the leakage to the processing plant for copper recovery and subsequent re-application onto the pad. Detailed requirements for the site investigation program to be carried out for final design are discussed in Section 4.0.

3.3 OPEN PIT

A deep groundwater table at the open pit is expected and therefore will not be significantly impacted during mining. Groundwater may be encountered in the latter years of operations which will result in the inflow of groundwater into the pit and the development of a local depression of the groundwater table.

The existing groundwater table likely forms a subdued replica of the ground surface and slopes toward the east. During operations this flow regime will not be significantly affected. The groundwater will be pumped out of the pit to facilitate operations. This groundwater will be used to first supplement the make-up water requirements for leaching operations if required, and may also be temporarily stored behind the water storage dam prior to being released. At closure the groundwater will continue to flow into the pit to a point where the water level reaches the level of the pre-development groundwater table. Further investigations will be carried out to determine the depth to the groundwater table and to allow the installation of groundwater monitoring wells.

3.4 WASTE ROCK STORAGE AREA

The hydrogeological impact at the waste rock storage area is not expected to be significant. Most of the precipitation onto the waste rock will runoff and be collected in drainage ditches along the toe of the pile. The amount of runoff which enters the pile will be insignificant and will flow in the near surface groundwater at the base of the pile for collection in the toe drains and ultimately into the stilling basin for use as make-up water for leaching operations, and for dust control on the roads.

During the initial development of the waste rock storage area the organic layer will be removed thereby initiating thawing of the permafrost. This will result in an increase in the hydraulic conductivity of the thawed soil and the generation of near surface groundwater which will flow downslope and be intercepted by drains along the toe of the dump. These flows will be minor and will be restricted to an estimated thaw depth of 2 to 3 metres below the ground surface. The permafrost underlying the thawed zone therefore will further act to inhibit the downward migration of seepage.

Additional site investigations will be carried out at the proposed waste rock storage area to confirm the hydrogeologic conditions and for the installation of groundwater monitoring wells.

SECTION 4.0 - ADDITIONAL SITE WORK REQUIRED

Additional site investigations will be carried out as part of the final design process to provide further information on the groundwater conditions at the leach pad, open pit and waste rock storage area. The program will include the drilling of an additional eleven (11) drillholes. The locations of the proposed drillholes are shown on Figure 1. General requirements for the program will include the following:

rationale for placement ?

- Detailed overburden sampling and diamond drill coring in bedrock.
- In-situ packer permeability testing in overburden and bedrock.
- Periodic measurement of water levels inside the drill string to determine the depths to perched water tables and the regional groundwater table.
- Installation of 2 inch diameter PVC monitoring wells in each drillhole for water level monitoring, permeability testing and groundwater quality sampling.

Details of the program for each of the heap leach pad, open pit and waste rock storage areas are discussed below.

(i) Heap Leach Pad

Additional investigations are required at the heap leach pad site to determine the depth to the regional groundwater table and to confirm the hydraulic conductivity values and characteristics for each of the glacial till, weathered bedrock and competent bedrock. Preliminary results suggest that the groundwater table is remote from the site, however this must be confirmed.

A total of five (5) additional drillholes, designates Sites A to E, are recommended at the heap leach pad, as shown on Figure 1. These holes will be located to provide additional information on the groundwater conditions as well as to allow for the installation of monitoring wells for the collection of background and baseline groundwater quality. Drillhole sites C, D and E are located outside the limits of the pad and will also act as long-term monitoring wells.

Prior to operations, additional wells will be installed along the downstream toe of the leach pad to monitor potential leakage from the pad. The wells will be installed at various depths in the vadose zone above the groundwater table, and in the saturated zone below the water table. The wells will also be designed as pumpback wells in order to intercept any leakage which exceeds the discharge groundwater quality criteria. This seepage would be recycled back to the process plant for copper extraction and re-used in the leaching process.

(ii) Open Pit

Although the groundwater table at the open pit is expected to lie at significant depths below the ground surface, this must be confirmed. A total of two (2) drillholes, designated Sites J and K, located within the limits of the pit are proposed, as shown on Figure 1. These holes will be vertical HQ size core holes designed to facilitate the installation of 2 inch diameter wells if groundwater is encountered. Both drillholes should extend to the bottom of the pit.

(iii) Waste Rock Storage Area

Additional investigations are required at the waste rock storage area to further investigate the foundation conditions and groundwater characteristics, and for the installation of monitoring wells for groundwater sampling. A total of four (4) drillholes, designated Sites F to I, are recommended as shown on Figure 1. Three of the holes (Sites F, H and I) are located outside the toe of the waste rock storage area and will provide baseline groundwater quality as well as act as long-term groundwater monitoring wells for operations and at closure.

(iv) Water Storage Dam

No additional investigations will be required at the water storage dam. The two existing drillholes indicate that the groundwater occurs at shallow depths at the dam site. However, this is not of concern since the groundwater will not affect the structure nor will the impoundment significantly affect the groundwater flow system. Drillhole DH-2 may be used for monitoring water levels and groundwater quality downstream of the dam.

SECTION 5.0 - REFERENCE REPORTS

"Report on Pit Slope Stability (Ref. No. 1782/3), by Knight Piésold Ltd., January 1993.

"Report on 1992 Surficial Geotechnical Investigations (Ref. No. 1782/4)", by Knight Piésold Ltd., May 1993.

"Report on Preliminary Design (Ref. No. 1783/1)", by Knight Piésold Ltd., May 1995.

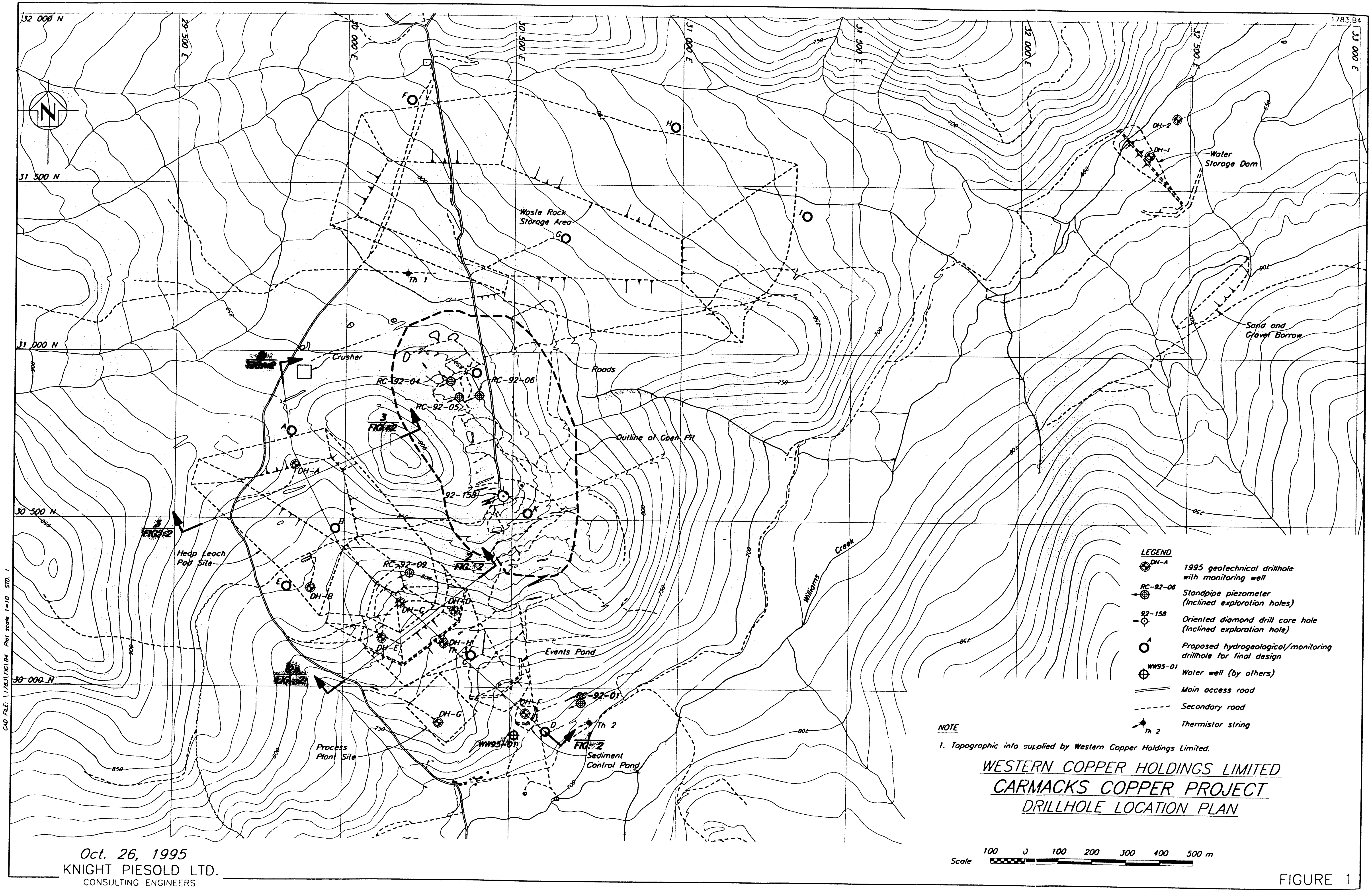
TABLE 1

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT

SUMMARY OF GROUNDWATER MONITORING WELLS AND STANDPIPE PIEZOMETERS

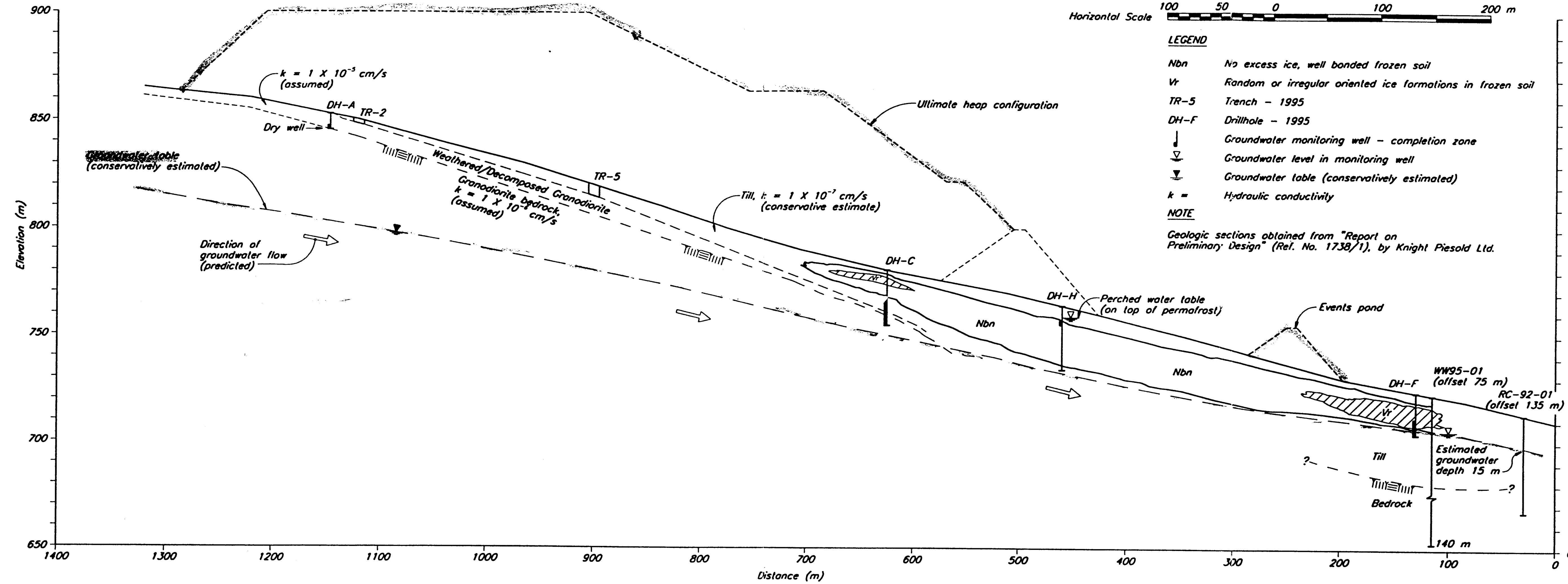
Well/Hole No.	Coordinates (approx.) (m)		Ground Elev. (m)	Well Tip Depth (1) (m)	Geology of Monitoring Zone	Groundwater Level (1)	
	Northing	Easting				Depth (m) (2)	Date
DH-A	30,660	29,850	858	7.32	Wthrd granodiorite	Dry well	15-Aug-95
DH-B #1	30,295	29,900	827	6.1	Wthrd granodiorite	Dry well	15-Aug-95
#2	30,295	29,900	827	2.9	Till	2.01 water (3)	15-Aug-95
DH-C	30,250	30,170	786	25.91	Wthrd granodiorite	7.10 dry (3)	15-Aug-95
DH-D	30,225	30,225	778	7.62	Wthrd granodiorite	Dry well	15-Aug-95
DH-E	30,145	30,115	790	12.6	Wthrd granodiorite	2.30 dry (3)	15-Aug-95
DH-F	29,925	30,545	726	19.81	Till	1.2 dry (3)	15-Aug-95
DH-G #1	29,895	30,285	765	9.14	Till	Dry well	15-Aug-95
#2	29,895	30,285		4.6	Sand and gravel	3.30 water	15-Aug-95
DH-H	30,130	30,300	768	8.84	Till	5.2 water	15-Aug-95
DH-1	31,605	32,380	645	29.6	Till	0.5 water	15-Aug-95
DH-2 #1	31,710	32,460	640	28.6	Till	11.2 dry	15-Aug-95
#2	31,710	32,460	640	3.8	Sand and gravel	Dry well	15-Aug-95
RC-92-01 (3)	29,955	30,710	716	64.8	Bedrock	>21 (6)	15-Aug-95
RC-92-04 (3)	30,910	30,315	856	63.8	Bedrock (open pit)	>30	15-Aug-95
RC-92-05 (3)	30,865	30,340	858	61.9	Bedrock (open pit)	>7	15-Aug-95
RC-92-06 (3)	30,400	30,870	850	121.9	Bedrock (open pit)	>100	15-Aug-95
RC-92-09 (3)	30,340	30,195	800	92.2	Bedrock	No info.	N/A
WW95-01 (5)	29,860	30,510	728	43.3	Bedrock	17	10-Sep-95

Notes:
1. All depths measured relative to ground surface.
2. Depths measured by others (J. Gibson & Associates) except where otherwise noted.
3. Possible sloughing in dry holes DH-B2, DH-C, DH-E and DH-F (J. Gibson).
4. All wells in RC holes installed in angled exploration drillholes by Western Copper Holdings Limited. Depths measured along axis of hole.
5. Depth in WW95-01 provided by Aqua Tech Supplies and Services Ltd.
6. RC-92-01 sampled 15-Aug-95. Groundwater level from previous measurements conservatively estimated at 15 m true depth.


1783 B4
32 000 N
31 500 N
31 000 N
30 500 N
30 000 N
29 500 E
30 000 E
30 500 E
31 000 E
31 500 E
32 000 E
32 500 E
33 000 E
N
Waste Rock
Storage Area
Water
Storage Dam
Sand and
Gravel Borrow
Crusher
Roads
Outline of Coen Pit
Heap Leach
Pad Site
Events Pond
Process
Plant Site
Sediment
Control Pond
Williams Creek
RC-92-04
RC-92-05
RC-92-06
RC-92-09
RC-92-01
92-158
DH-A
DH-B
DH-C
DH-D
DH-E
DH-F
DH-G
DH-H
DH-1
DH-2
WW95-01
Th 1
Th 2
LEGEND
1995 geotechnical drillhole with monitoring well
Standpipe piezometer (Inclined exploration holes)
Oriented diamond drill core hole (Inclined exploration hole)
Proposed hydrogeological/monitoring drillhole for final design
Water well (by others)
Main access road
Secondary road
Thermistor string
NOTE
1. Topographic info supplied by Western Copper Holdings Limited.
WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
DRILLHOLE LOCATION PLAN
Scale 100 0 100 200 300 400 500 m
Oct. 26, 1995
KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS
FIGURE 1

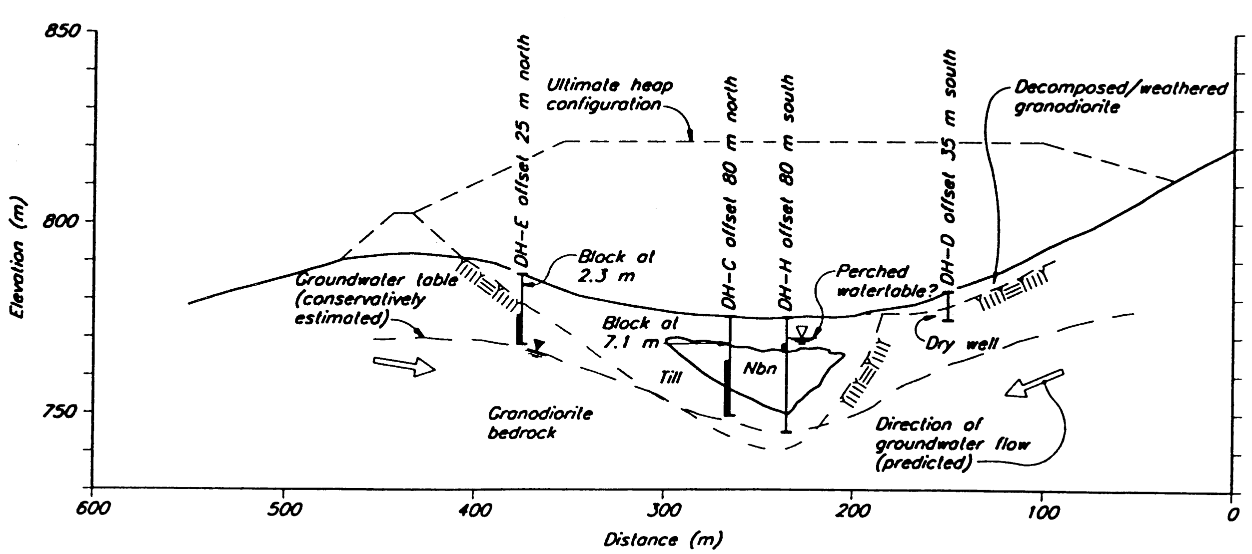
1783.B5

WESTERN COPPER HOLDINGS LIMITED
CARMACKS COPPER PROJECT
GEOLOGIC/HYDROGEOLOGIC SECTIONS



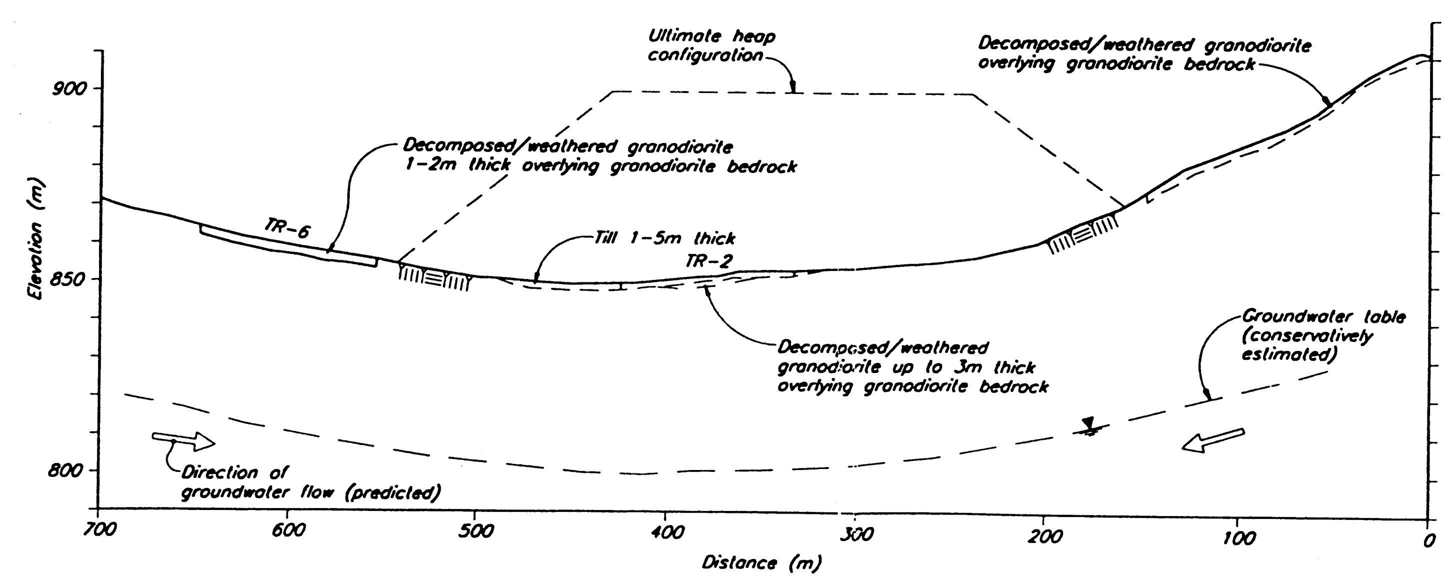
SECTION 1/FIG. 1

(NOTE: VERTICAL SCALE EXAGGERATED 2X)



SECTION 2/FIG. 1

(NOTE: VERTICAL SCALE EXAGGERATED 2X)



SECTION 3/FIG. 1

(NOTE: VERTICAL SCALE EXAGGERATED 2X)

Oct. 26, 1995

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

FIGURE 2

Knight Piésold Ltd.
CONSULTING ENGINEERS

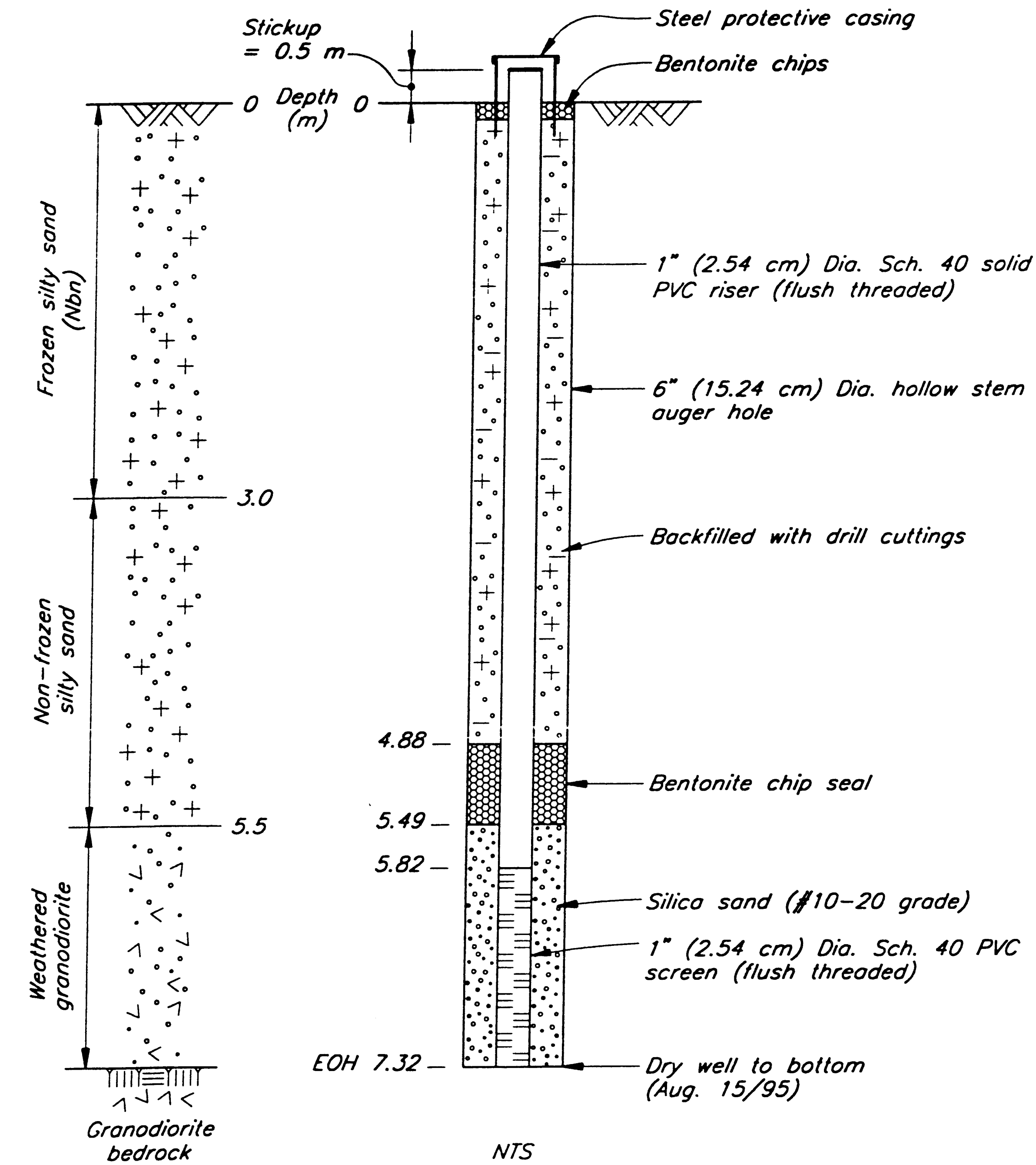
APPENDIX A

GROUNDWATER MONITORING WELL COMPLETION DETAILS

1783.A31

KNIGHT PIESOLD LTD. CONSULTING ENGINEERS	GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Heap Leach Pad Site*	HOLE No. *DH-A*
COMPLETION DATE *FEB. 27, 1995*	GROUND ELEV. *858 m*

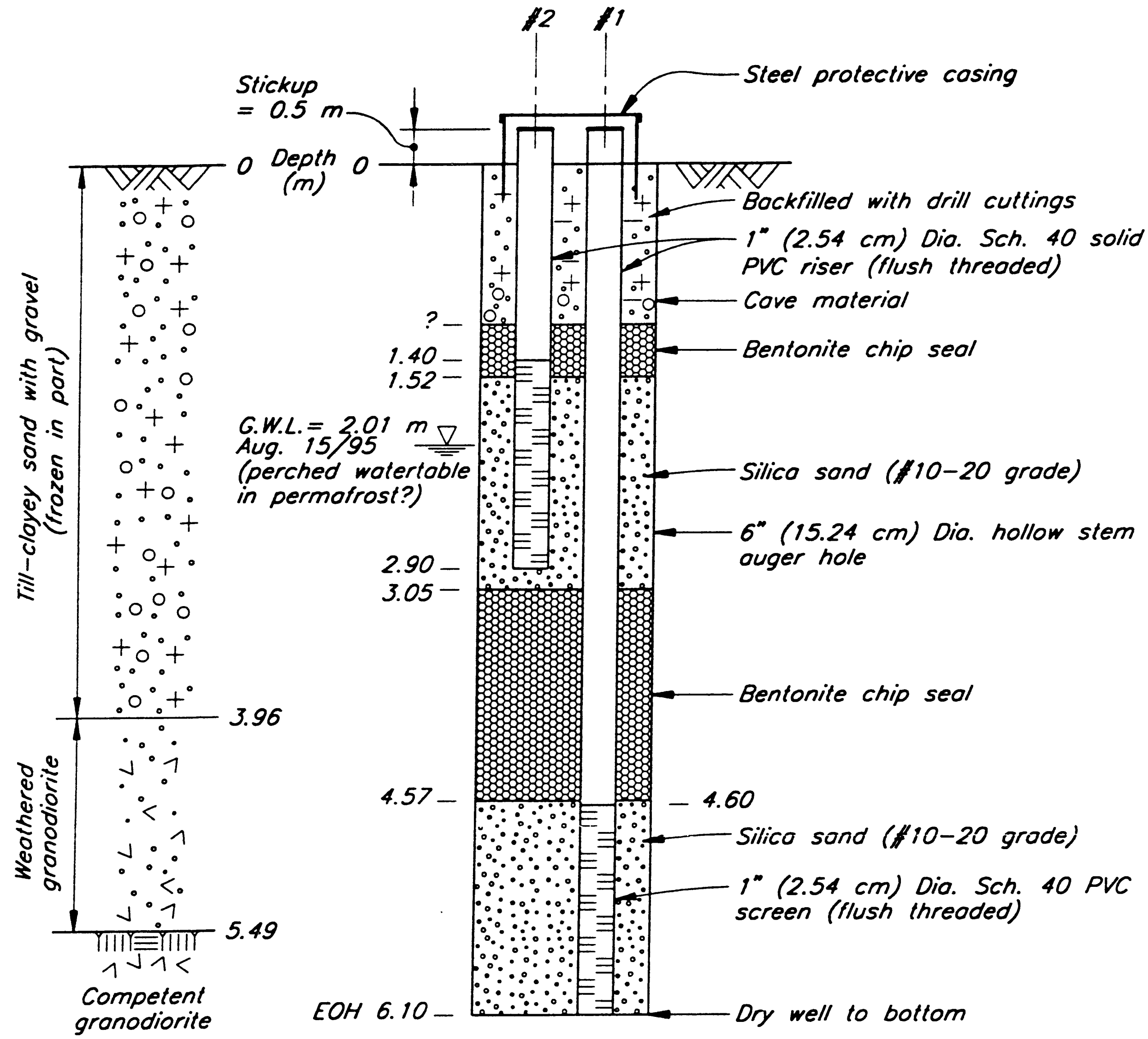


CAD FILE: \PROJECT\1783\FIG\A31 Plot scale 1=1 Oct. 18, 1995

1783.A32

KNIGHT PIESOLD LTD. CONSULTING ENGINEERS	GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Heap Leach Pad Site*	HOLE No. *DH-B*
COMPLETION DATE *FEB. 27, 1995*	GROUND ELEV. *827 m*



NTS

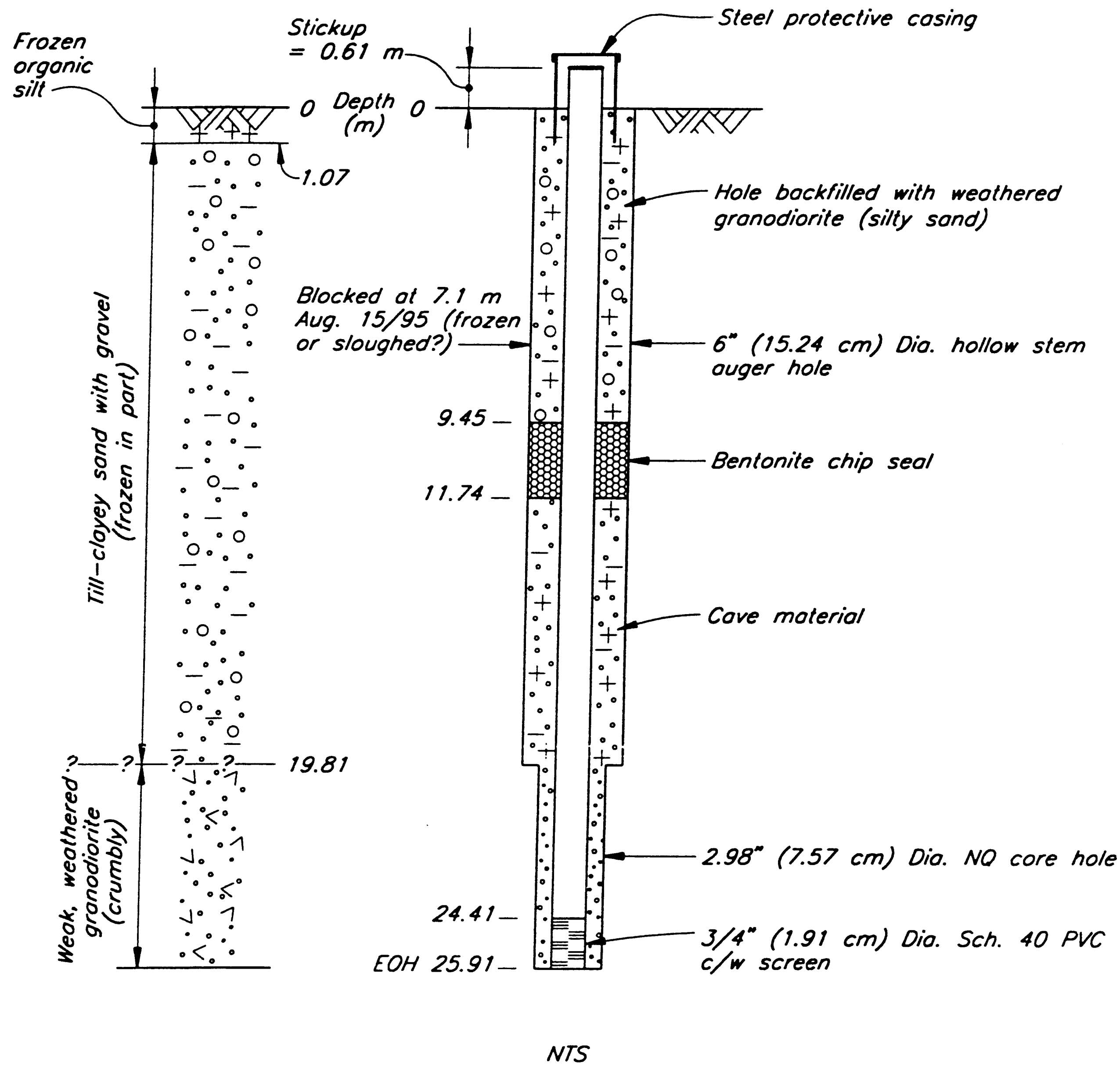
CAD FILE: \PROJECT\1783\FIG\A32 Plot scale 1=1 Oct. 18, 1995

1783.A33

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Heap Leach Pad Site*	HOLE No. *DH-C*
COMPLETION DATE *March 10, 1995*	GROUND ELEV. *786 m*



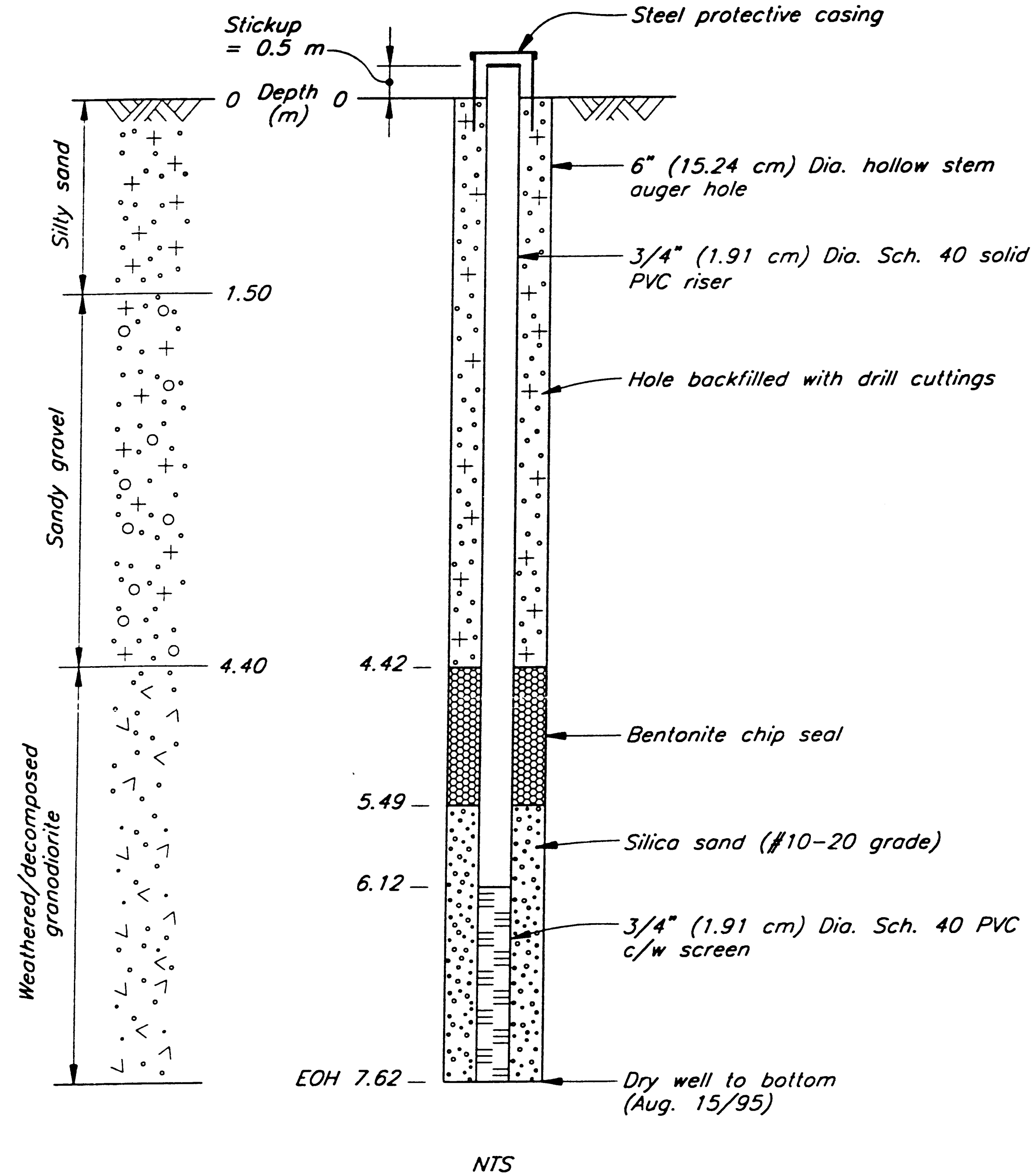
NTS

CAD FILE: \PROJECT\1783\FIG\A33 Plot scale 1=1 Oct. 18, 1995

1783.A34

KNIGHT PIESOLD LTD. CONSULTING ENGINEERS	GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Heap Leach Pad Site*	HOLE No. *DH-D*
COMPLETION DATE *March 8, 1995*	GROUND ELEV. *778 m*



NTS

CAD FILE: \PROJECT\1783\FIG\A34 Plot scale 1=1 Oct. 18, 1995

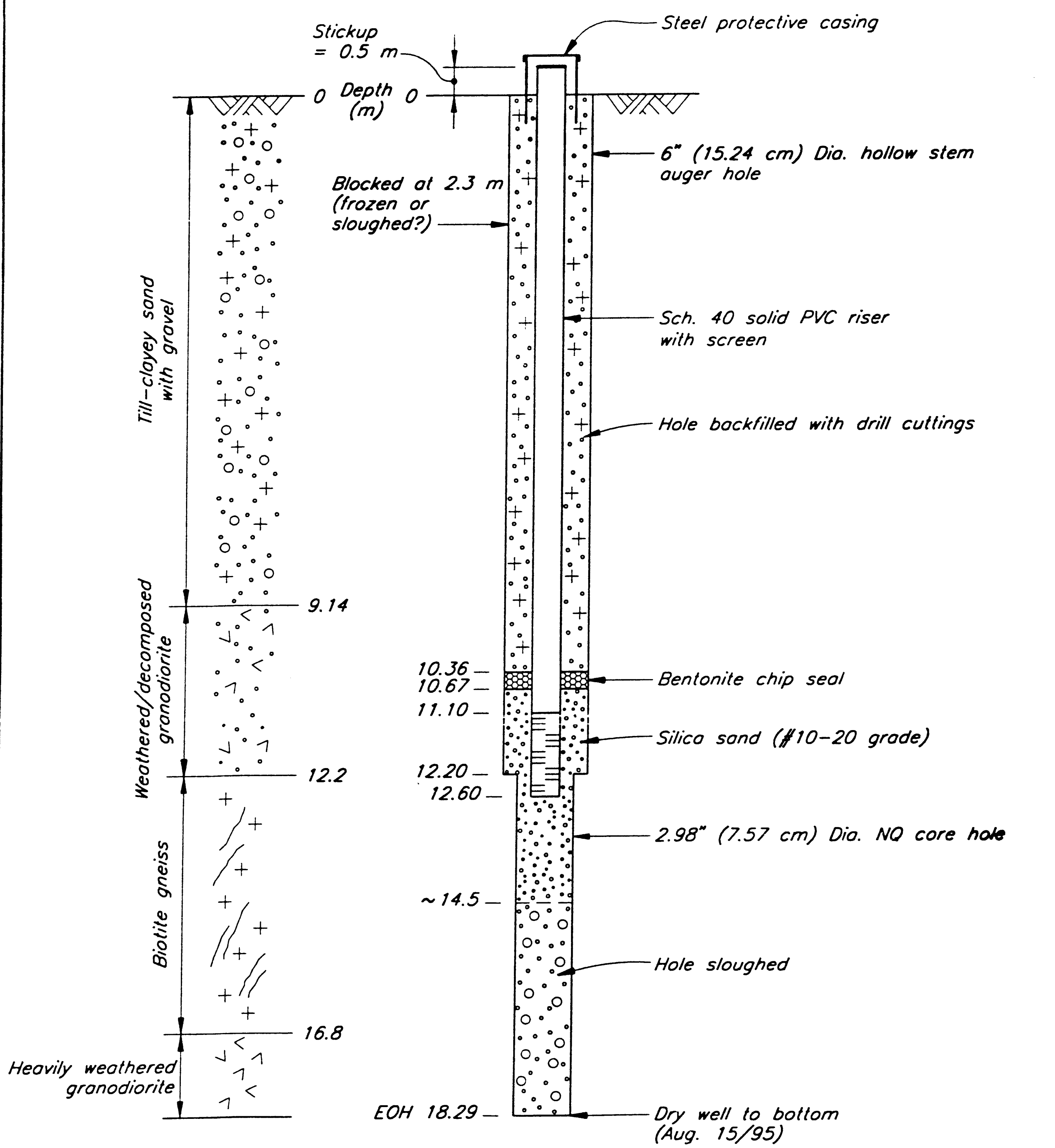
1783.A35

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*
LOCATION: *Heap Leach Pad Site*
COMPLETION DATE *March 7, 1995*

PROJECT No. *1783*
HOLE No. *DH-E*
GROUND ELEV. *790 m*



NTS

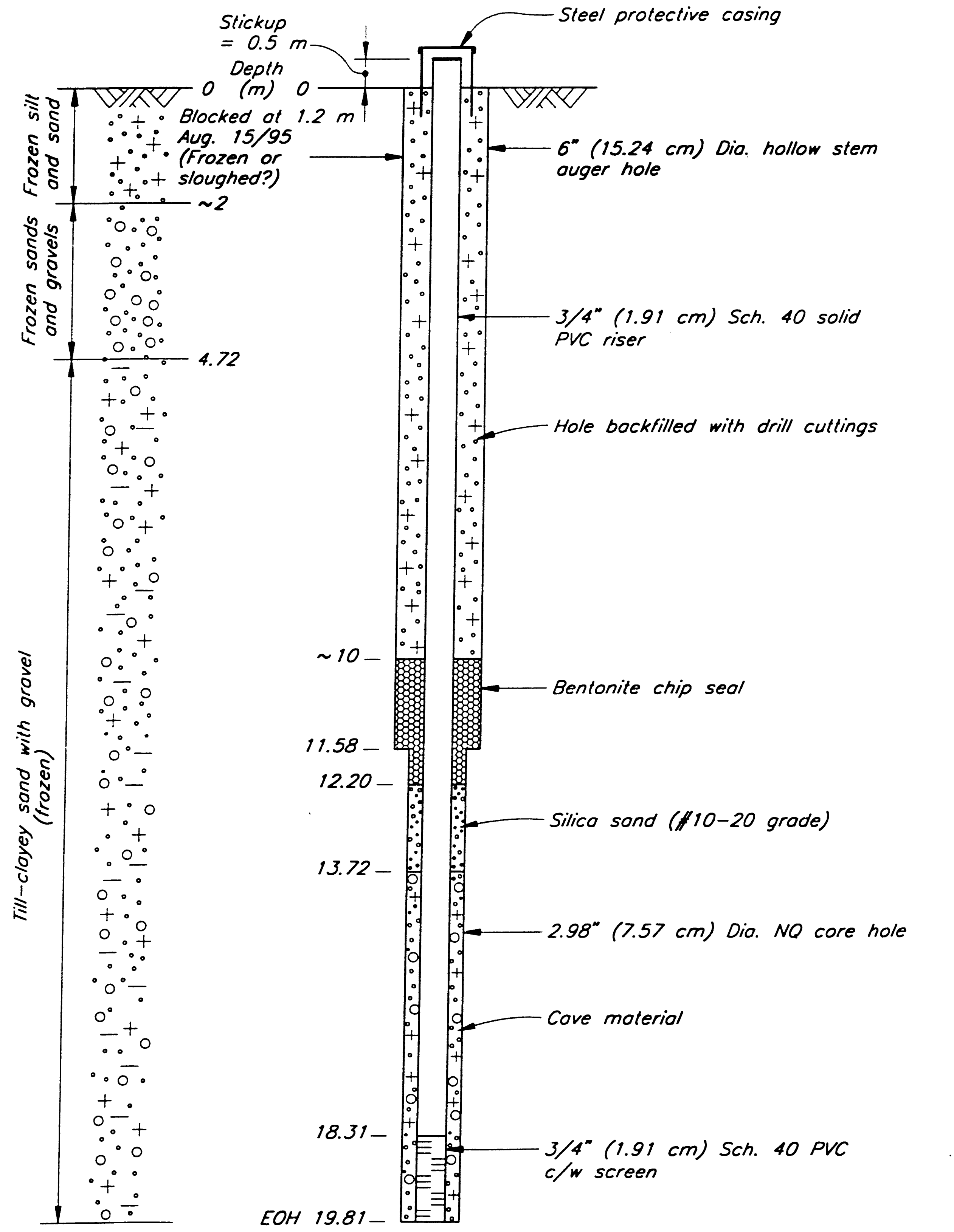
CAD FILE: \PROJECT\1783\FIG\A35 Plot scale 1=1 Oct. 18, 1995

1783.A36

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Sediment Control Pond Site*	HOLE No. *DH-F*
COMPLETION DATE *March 5, 1995*	GROUND ELEV. *726 m*



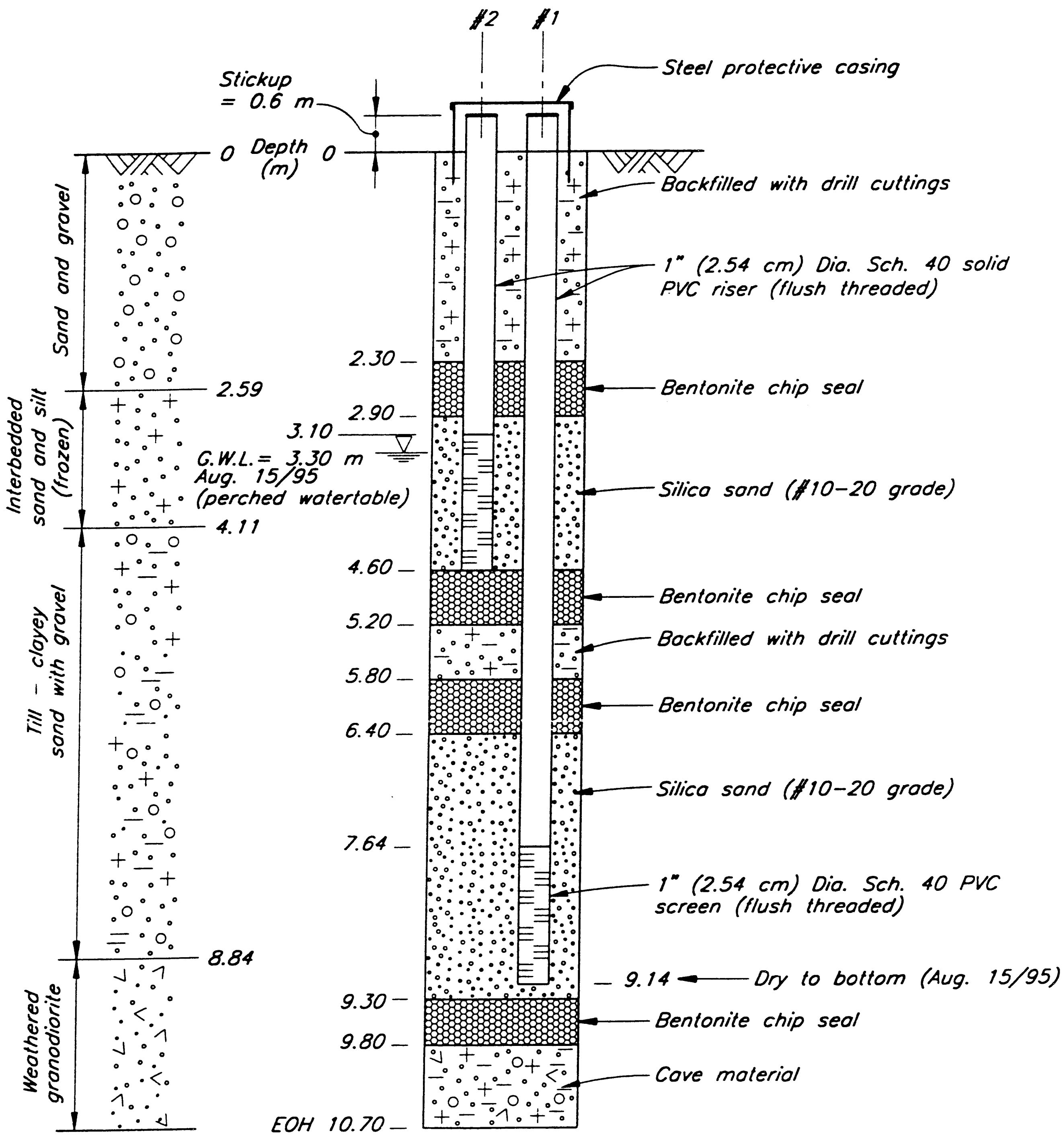
NTS

CAD FILE: \PROJECT\1783\FIG\A36 Plot scale 1=1 Oct. 18, 1995

1783.A37

KNIGHT PIESOLD LTD. CONSULTING ENGINEERS	GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Process Plant Site*	HOLE No. *DH-G*
COMPLETION DATE *Feb. 27, 1995*	GROUND ELEV. *765 m*

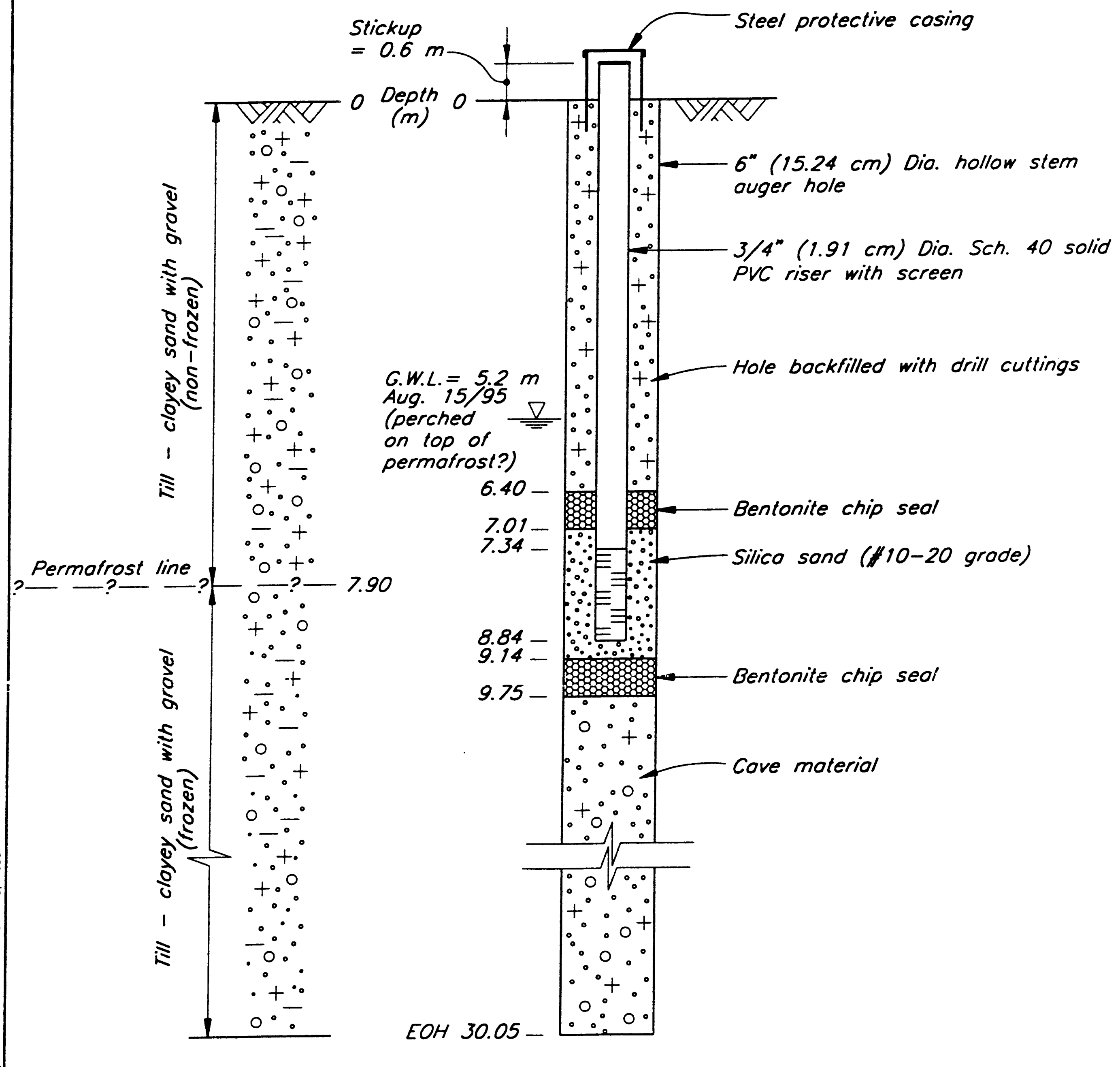


NTS

CAD FILE: \PROJECT\1783\FIG\A37 Plot scale 1=1 Oct. 18, 1995

1783.A38

KNIGHT PIESOLD LTD. CONSULTING ENGINEERS	GROUNDWATER MONITORING WELL COMPLETION DETAILS
PROJECT: Carmacks Copper Project	PROJECT No.: 1783
LOCATION: Heap Leach Pad Site	HOLE No.: DH-H
COMPLETION DATE: March 9, 1995	GROUND ELEV.: 768 m



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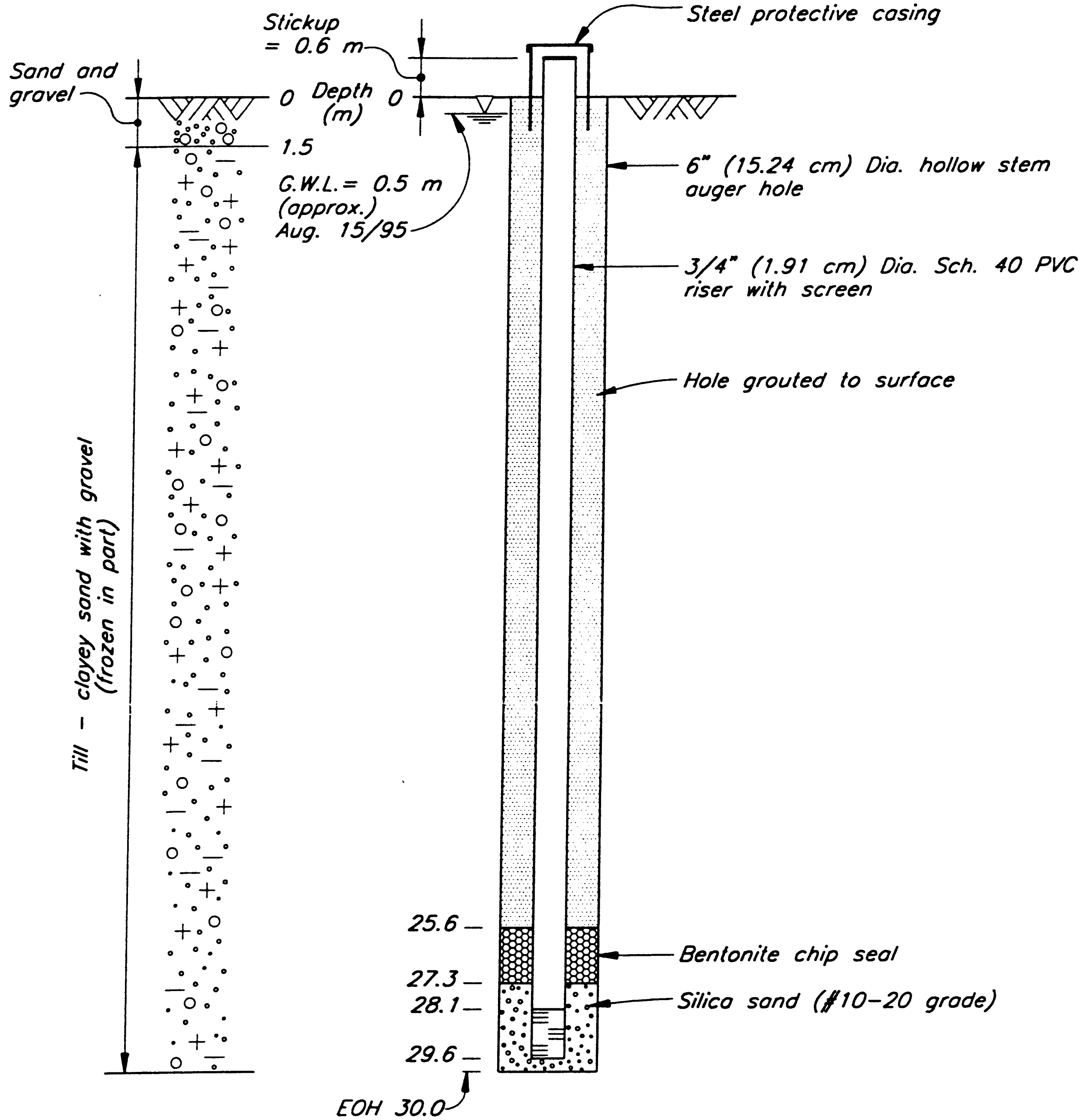
CAD FILE: \PROJECT\1783\FIG\A38 Plot scale 1=1 Oct. 18, 1995

1783.A39

KNIGHT PIESOLD LTD. CONSULTING ENGINEERS	GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Water Storage Dam*	HOLE No. *DH-1*
COMPLETION DATE *March 3, 1995*	GROUND ELEV. *645 m*



NTS

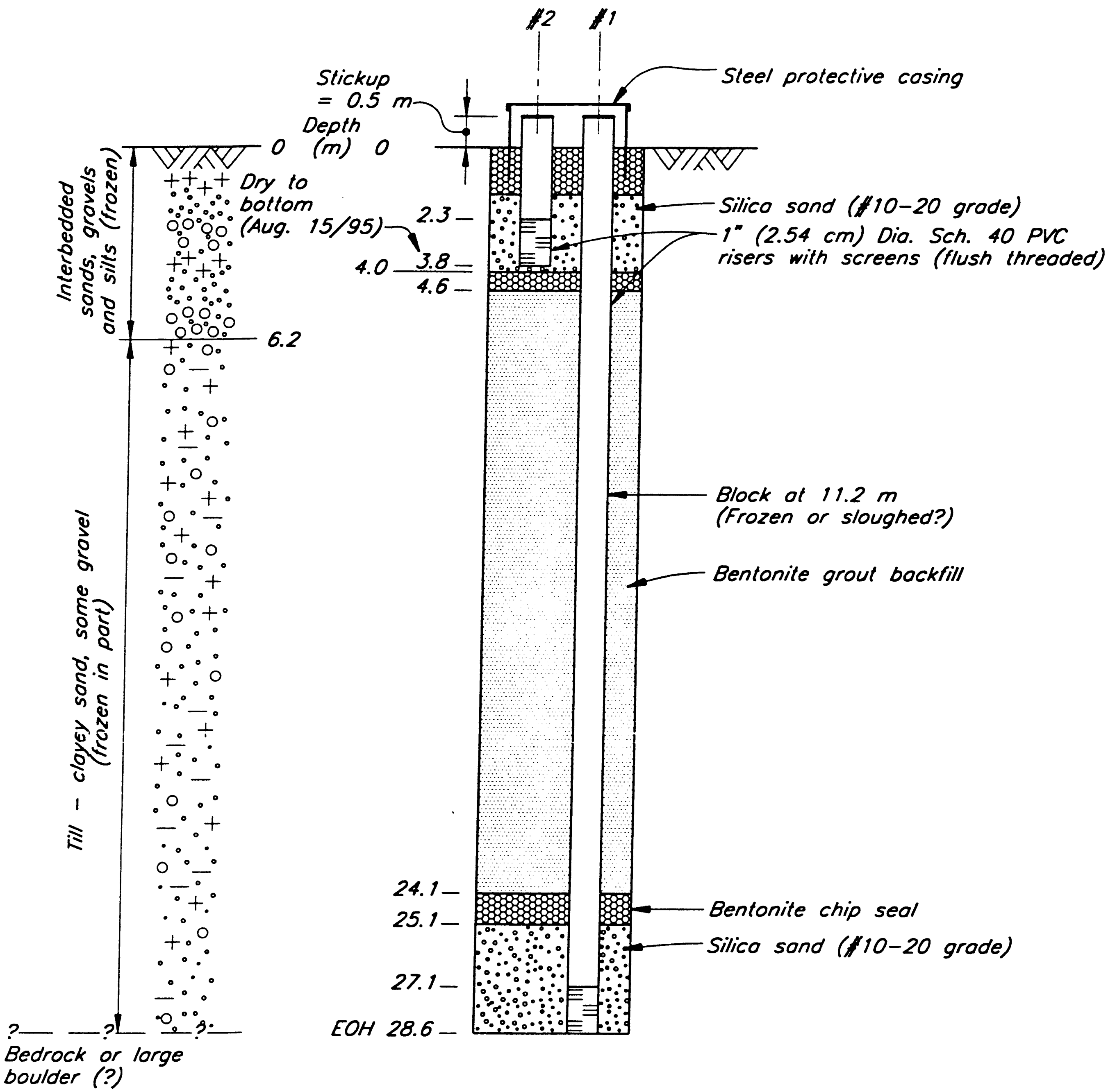
CAD FILE: \PROJECT\1783\FIG\A39 Plot scale 1=1 Oct. 18, 1995

1783.A4C

KNIGHT PIESOLD LTD.
CONSULTING ENGINEERS

GROUNDWATER MONITORING WELL COMPLETION DETAILS

PROJECT *Carmacks Copper Project*	PROJECT No. *1783*
LOCATION: *Water Storage Dam*	HOLE No. *DH-2*
COMPLETION DATE *March 3, 1995*	GROUND ELEV. *640 m*



NTS

CAD FILE: \PROJECT\1783\FIG\A40 Plot scale 1=1 Oct. 19, 1995

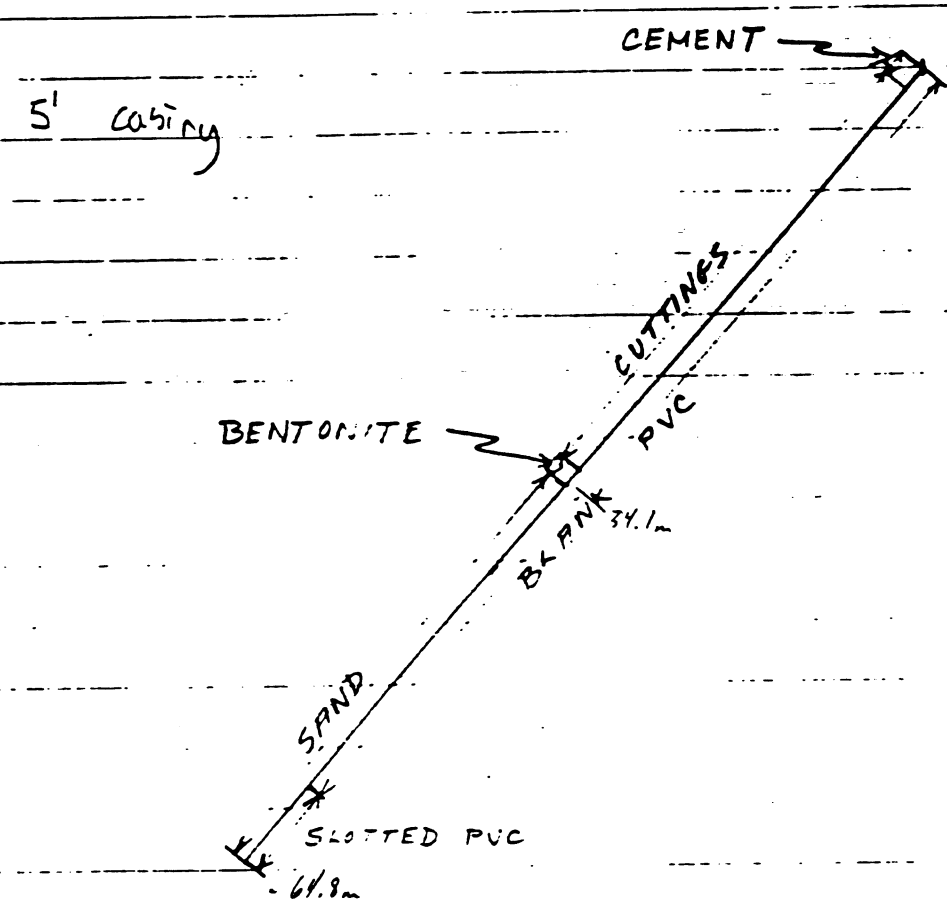
Knight Piésold Ltd.
CONSULTING ENGINEERS

APPENDIX B

STANDPIPE PIEZOMETER AND THERMISTOR STRING COMPLETION DETAILS (COMPLETED BY OTHERS)

STANDPIPE : RC 92-01 1800S-B.L.

247°



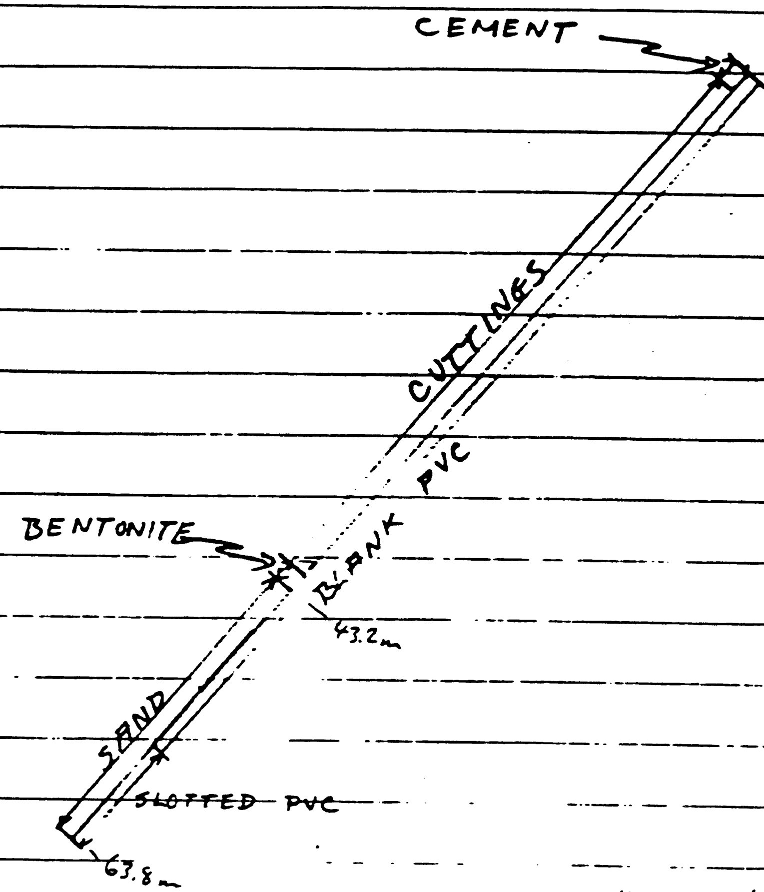
Scale 1" = 40'

2.54 cm = 1219 cm

1:480

STANDPIPE RC 92-04 1500N- 080E

247°

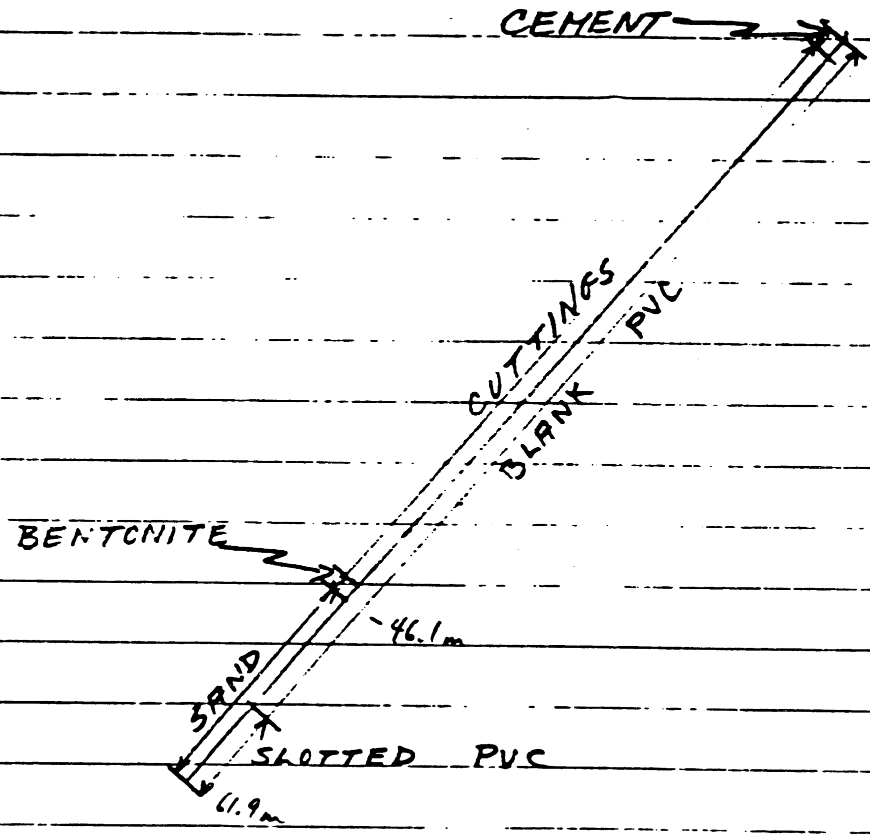


SCALE 1" = 40'

(1:480)

STANDPIPE RC 92-05 1400N-085E

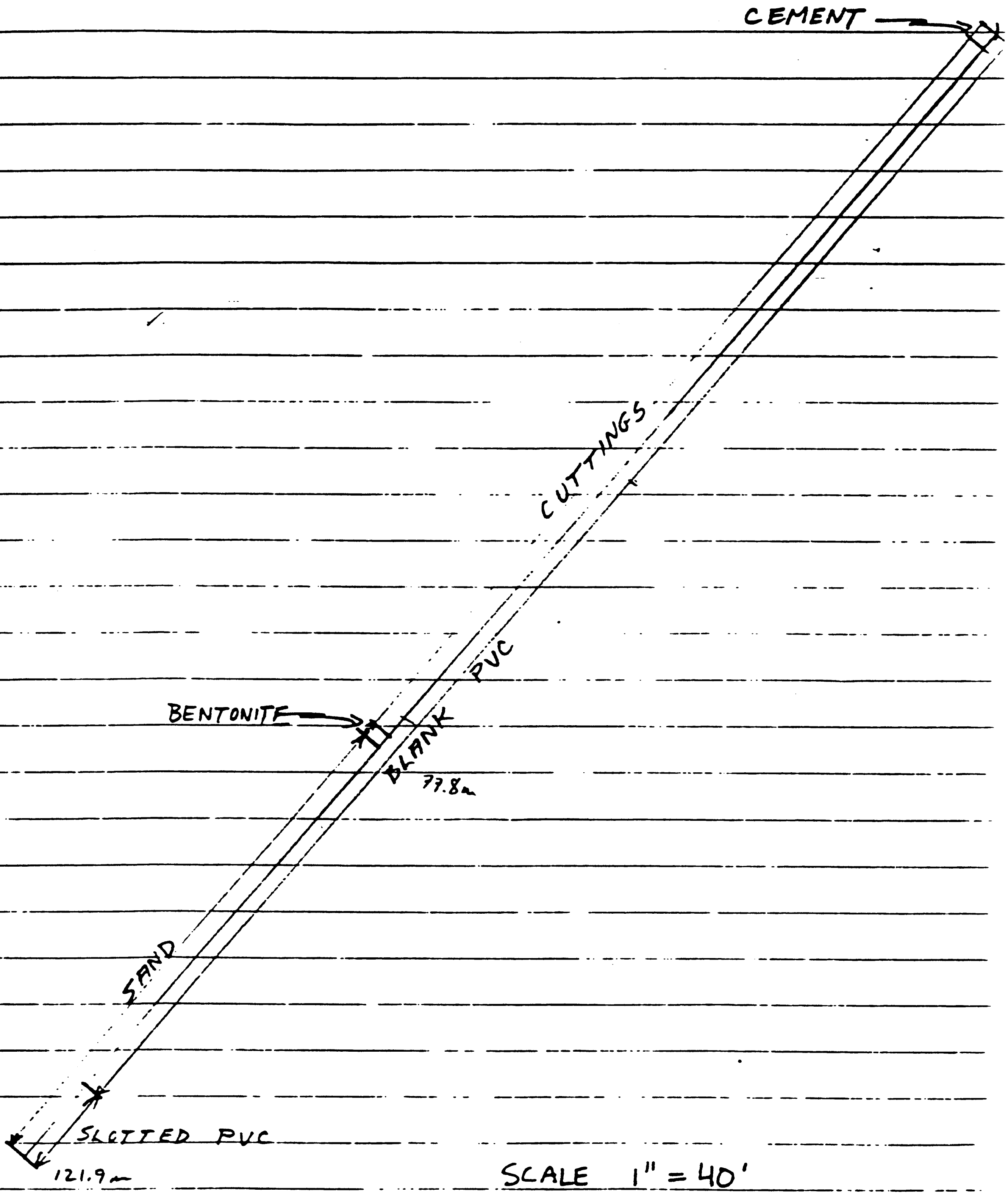
247°



SCALE 1" = 40'

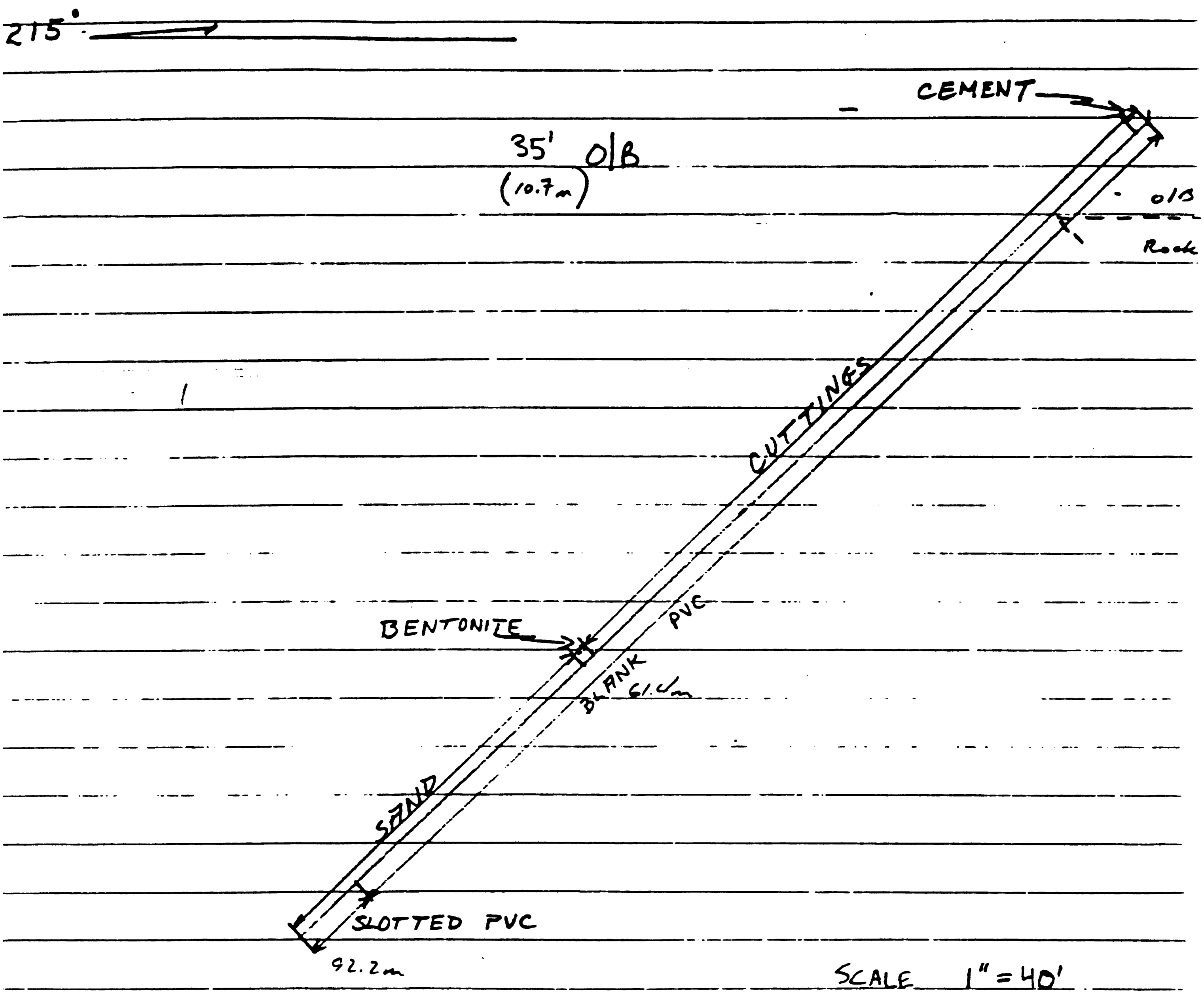
STANDPIPE RC 92-06 1350N - 230E

247°



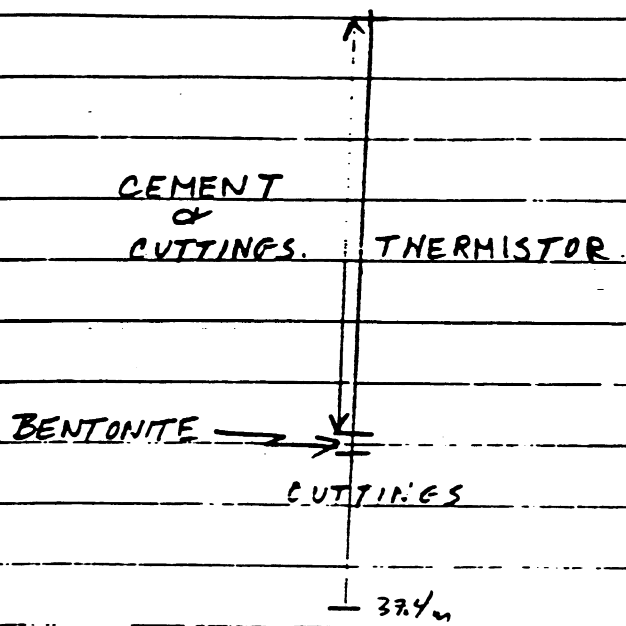
SCALE 1" = 40'

STANDPIPE RC 92-09 ON- 1075W



SCALE 1" = 40'

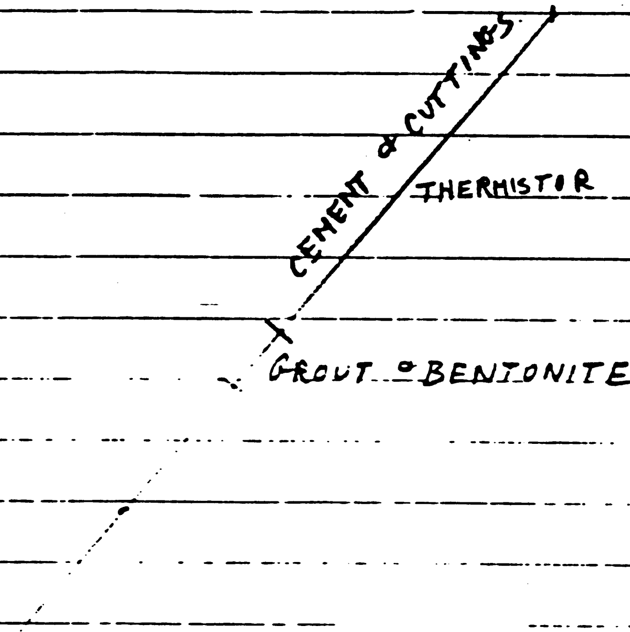
THERMISTOR RC 92-07 2650N - 125E



SCALE 1" = 40'

THERMISTOR RC 92-10 2000S - 0E (B.

47°



SCALE 1" = 40'

COVER SHEET

FAX

To: BRUNO KNIGHT & PIESOLD
Fax #: 1-604-685-0147
Subject: WESTERN COPPER MINESITE, YUKON
Date: October 12, 1995
Pages: 7,including this cover sheet.

COMMENTS:

Further to the telephone request of Ken McNaughton, we enclose the following with respect to the Well Yield Test at the Western Copper Minesite:

1. Two pages Field Report (drill log) for well from Midnight Sun Drilling;
2. Step Rate Test;
3. Constant Rate Test;
4. Recovery; and
5. Map of area.

If any pages are unclear, please telephone and we will retransmit.

KNIGHT PIESOLD LTD.
IN/OUT 10/12/95

NAME	ROUTING	DATE READ	ACTION BY	REPLY DATE
JPH				
	1			
MDG	MDG			
BB	2	BB		

1783.01 Carmacks

From the desk of...

Bert Alblaser
Owner/Manager
Aqua Tech Supplies & Services Ltd.
123 Copper Road
Whitehorse, Yukon Y1A 2Z7

403-668-5544
Fax: 403-668-7182

MIDNIGHT SUN DRILLING CO LTD WHITEHORSE Y.T.

Field Report

(2/2)

13 MacDONALD ROAD
WHITEHORSE, YUKON
Y1A 4L1

PHONE (403) 633-3070
TELEX 036-8496

Started Aug 17 1995
Completed Aug 23 1995

NAME AND ADDRESS OF CLIENT	DESCRIPTION OF WORK	LOCATION OF WORK
western copper Holdings	W/W 95-B-10	

FORMATION LOG FROM	TO	FORMATION	DESCRIPTION OF WORK	TIME DATE	FROM	TO	HOURS
			MOVE				
130	139	Gr. Sand					
139	265	BR					
			Crew Travel	Aug 20	7:00	8:30	1.5
			Crew Travel	Aug 21	6:30	8:00	1.5
265	460	BR		"	8:00	8:00	12
			crew travel	"	8:00	9:30	1.5
			crew travel	Aug 22	6:30	8:00	1.5
			Develop	"	8:00	1:00	5
			Trip out	"	1:00	2:00	1
			move off	"	2:00	4:00	2
			move Rig to Carmacks	"	4:00	6:00	2
			crew travel	Aug 23	8:30	10:00	1.5
			Put diff in #59	"	10:00	1:00	3
			move #59 to carmacks	"	1:00	3:00	2
			travel to whse	"	3:00	5:00	2

Rcrd. of Casing & Pipe Size	Type	Size	Type
6			
Feet	Inch	Feet	Inch
142			

Remarks: 50 GPM
1-drive shoe
200 - 12 GPM
350 - 20 GPM
395 - 22 GPM
420 - 30 GPM
445 - 43 GPM
460 - 50 GPM

Static Level		Total Rig Time	hrs.
Ground Level		Total Standby	hrs.
Top Of Casing		Drilling Mud	sacks

SIGNATURES

MIDNIGHT SUN.............................. CLIENT..............................
TITLE.............................. TITLE..............................

Field Report

(1/2)

13 MacDONALD ROAD
WHITEHORSE, YUKON
Y1A 4L1

PHONE (403) 633-3070
TELEX 036-8496

Started Aug. 17 1995

Completed Aug. 23 1995

NAME AND ADDRESS OF CLIENT	DESCRIPTION OF WORK	LOCATION OF WORK
western copper Holdings	W/W 95-LA-10	

FORMATION LOG FROM	TO	FORMATION	DESCRIPTION OF WORK	DATE	TIME FROM	TO	HOURS
			MOVE				
			Load	Aug 17	8:00	11:30	3.5
			Travel to Carmacks	"	11:30	1:30	2
			moving #59-5 mi from site	"	1:30	4:00	2.5
			crew travel to Carmacks	"	4:00	5:30	1.5
			Travel to whse.	"	5:30	7:00	1.5
			travel to carmacks	Aug 18	6:00	8:30	2.5
			move Rig 1A #59	"	8:30	8:00	11.5
			crew travel	"	8:00	9:00	1
			crew travel	Aug 19	6:30	8:00	1.5
			moving on site setup	"	8:00	7:00	11
0	18	Gr.	sand silt	"	7:00	8:00	1
18	40	silt					
			crew Travel	"	8:00	9:30	1.5
			crew travel	Aug 20	6:30	8:00	1.5
40	46	silt		"	8:00	7:00	11
46	70	Till					
70	130	silt					

Rcrd. of Casing & Pipe

Size	Type	Size	Type
Feet	Inch	Feet	Inch

Remarks:

Static Level

Ground Level

Top Of Casing

Total Rig Time

Total Standby hrs.

Drilling Mud sa...

SIGNATURES

MIDNIGHT SUN..........................

TITLE..........................

CLIENT..........................

TITLE..........................

STEP RATE TEST

CLIENT: WESTERN COPPER, WILLIAMS CREEK PROJECT
WELL IDENTIFICATION: WILLIAMS CREEK PROJECT WATER WELL
STEP RATE TEST STARTED: SEPTEMBER 10, 1995 5:00PM
PRETEST WATER LEVEL: 17.00 M (TOC)

LAPSED TIME	DTW (M)	FLOW (L/MIN)	TOTAL FLOW	REMARKS
1	18.02	90		
2	18.19		157	
3	18.23		253	
4	18.24		348	
6	18.26		529	
8	18.31		710	
10	18.37		890	
11	18.64	110	997	
12	18.70		1105	
13	18.72		1213	
14	18.75		1321	
16	18.80		1538	
18	18.85		1755	
20	18.89		1971	
21	19.24	130	2100	
22	19.28		2229	
23	19.32		2357	
24	19.37		2487	
26	19.42		2748	
28	19.48		3009	
30	19.52		3271	
31	19.87	150	3419	
32	19.93		3571	
33	19.97		3724	
34	20.01		3877	
36	20.08		4182	
38	20.13		4488	
40	20.18		4795	
41	20.47	170	4692	
42	20.53		5131	
43	20.57			
44	20.61		5469	
46	20.68		5805	
48	20.74		6143	
50	20.81		6479	
51	20.97	OPEN WIDE	6656	
52	21.01		6831	
53	21.03		7008	
54	21.07		7184	
56	21.12		7538	
58	21.18		7887	
60	21.22		8240	

STEP RATE TEST RECOVERY

LAPSED TIME	DTW (M)	FLOW (L/MIN)	TOTAL FLOW	
1	18.75			
2	18.55			
3	18.43			
4	18.33			
5	18.20			
8	18.10			
10	18.03			
13	17.94			
16	17.87			
20	17.81			
25	17.73			
30	17.67			
40	17.59			
66	17.47			

CONSTANT RATE TEST

CLIENT: WESTERN COPPER, WILLIAMS CREEK PROJECT
WELL I.D.: WILLIAMS CREEK WATER WELL
CONSTANT RATE TEST STARTED: SEPT. 11, 1995 8:40 AM
PRETEST WATER LEVEL: 16.08 M CASING HEIGTH AGL .62 M

ELAPSED TIME	DTW (M)	FLOW (L/MIN)	TOTAL FLOW	RC-92-01 TIME & DTW DATA
.5	17.93			7:45AM /36.10M
1	18.18	175	180	
2	18.44		356	
[illegible]	[illegible]		531	

45° y 64m T.D. sin 45 = y/38m ∴ y = 26.9m

RECOVERY TEST

CLIENT: WESTERN COPPER, WILLIAMS CREEK PROJECT
WELL I.D.: WILLIAMS CREEK WATER WELL
RECOVERY RATE TEST STARTED: SEPT. 13, 1995 10:40 AM

Depth To Water (?)

ELAPSED TIME (min)	PUMPED WELL DTW (M)	ELAPSED TIME (min)	RC-92-01 DTW DATA DTW (M)	
.5	22.63	.5		
1	22.45	1		
2	22.24	2		
3	22.09	3		
4	21.99	4		
6	21.82	7		
8	21.71	8	38.78	
10	21.60	10	38.78	
13	21.47	13	38.78	
16	21.35	16	38.78	
20	21.24	20	38.78	
25	21.11	25	38.785	
32	20.96	32	38.79	
40	20.82	40	38.79	
50	20.66	50	38.785	
64	20.48	64	38.78	
80	20.30	85	38.755	
100	20.09	105	38.725	
120	19.94	128	38.68	
150	19.72	155	38.62	
180	19.52	185	38.55	
210	19.35	215	38.48	
240	19.19	245	38.42	
300	18.92	305	38.29	
360	18.70	365	38.18	
420	18.48	425	38.07	
480	18.30	485	37.98	
540	18.14	545	37.8	
600	18.00	605	37.83	
660	17.87	665	37.76	
720	17.73	725	37.7	
780	17.65	785	37.65	
840	17.56	845	37.61	
900	17.49	905	37.57	
960	17.43	965	37.53	
1020	17.37	1025	37.49	
1080	17.31	1085	37.45	
1140	17.25	1145	37.415	
1200	17.20	1205	37.38	
1260	17.15	1265	37.35	
1320	17.11	1325	37.33	
1380	17.07	1385	37.3	
1440	0.03	1445	37.275	
1500	16.99	1505	37.25	
1560	16.96	1565	37.23	
1620	16.93	1625	37.21	
1680	16.9	1685	37.195	
1740	16.87	1745	37.17	
1800	16.84	1805	37.155	
1860	16.82	1865	37.14	
1920	16.80	1925	37.12	
1980	16.78	1985	37.105	
2040	16.76	2045	37.09	
2100	16.75	2105	37.075	
2160	16.73	2165	37.06	
2220	16.72	2225	37.05	
2280	16.71	2285	37.04	
2340	16.70	2345	37.02	
2400	16.68	2405	37.01	
2460	16.67	2465	37	
2520	16.66	2525	36.99	
2580	16.65	2585	36.98	
2640	16.645	2645	36.97	
2700	16.64	2705	36.96	
2760	16.63	2765	36.96	
2820	16.615	2825	36.95	
2880	16.6	2885	36.94	
2940	16.59	2945	36.935	
3000	16.58	3005	36.925	

sec/min.?

OCT. -12' 95 (WED) 11:43 AQUA TECH SUP&SERV. TEL:403 668 7182 P. 002

08/25/95 FRI 15:22 FAX 604 689 3847 SILVER STANDARD ⓐ001

Post-it" Fax Note 7671E

To	BERT	Date	# of pages ▸ 1
Co./Dept.	CARMACKS	From	
Phone #	WELL	Co.	COPPER
Fax #	LOCATION	Phone #	
		Fax #