APRIL/1987

Yukon

Department of Community and
Transportation Services

DAWSON CITY
DYKE IMPROVEMENTS

DESIGN BRIEF

KLOHN LEONOFF YUKON LTD.

KLOHN LEONOFF
CONSULTING ENGINEERS

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Our File: PB 3601 0201

April 30, 1987

Yukon Territorial Government
Department of Community and
Transportation Services
P.O. Box 2703
Whitehorse, Yukon
Y1A 2C6

Ms. Glynnis Horel

Dawson Dyke Reconstruction, Design Brief

Dear Ms. Horel:

Further to our Draft Design Brief of February 5, 1987, I am pleased to enclose three copies of the final version for your records.

Yours very truly,
KLOHN LEONOFF YUKON LTD.

C. David Sellars, P.Eng.
Manager, Water Resources Division

Encl.

CDS/tp

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DAWSON CITY DYKE IMPROVEMENTS

DAWSON DYKE RECONSTRUCTION

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APPENDICES

1. GENERAL

1.1 AUTHORIZATION AND TERMS OF REFERENCE

By the "Letter of Award" dated August 13, 1986, the Yukon Department of Community and Transportation Services authorized Klohn Leonoff Yukon Ltd. to carry out the engineering investigations and final design of the Dawson City Dyke Improvements. This letter covers engineering services to be carried out in accordance with a proposal dated July 30, 1986 submitted by Klohn Leonoff Yukon Ltd. to the Yukon Department of Community and Transportation Services, in response to a "Request for Proposal" dated July 14, 1986.

1.2 THE PROJECT

The City of Dawson is constructed on the east bank of the Yukon River near its confluence with the Klondike River. A dyke has been constructed along the river banks to protect the City from flooding which typically occurs during spring break-up due to ice jams forming in the Yukon River. The dyke was built up in several stages over the years and at present carries a road (Front Street) along its crest. Shops and houses have been constructed up to and along the landside edge of the crest of the dyke, and in some areas the riverside edge of the crest has been extended towards the river and these areas developed by substantial structures including the Canadian Imperial Bank of Commerce and the S.S. Keno.

The largest flood on record and also the most recent flood occurred in May, 1979, incurring damage in excess of $10 million. It is estimated that the Yukon River overtopped the dyke by up to 1 m in some places. Since that date the lowest portions of the dyke have been raised by placing fill on the crest such that the dyke now presents a reasonably uniform degree of protection against floods. The results of a recent study (Dawson City Flood Evaluation) indicate that the Yukon River would rise to the level of the crest of the present dyke during a flood with a return period of from 30 years to 50 years. A low area still exists in the vicinity of the S.S. Keno which has a return period of about 20 years.

As a result of potential flooding it was decided to improve the existing flood protection standards by constructing a new dyke.

Klohn Leonoff prepared a Preliminary Report (Report on Preliminary Design and Economic Analysis dated April, 1986) on the dykes which examined the aesthetics and benefit cost ratio of various alternative types of dyke, and recommended an earthfill dyke. The main text of the report is included as Appendix V.

Subsequent to award of the final design, it was agreed that if possible the dyke would be designed to be constructed prior to May 1, 1987 in order to protect the City of Dawson from possible flooding during the break up of the Yukon River in 1987.

Excavation of soft foundation soil and other work which could not be done after the ground became frozen, was carried out in September and October, 1986 (Phase I). Exceptionally mild weather continuing into November, permitted some of the bulk fill for the dyke (Phase I Construction) to be placed during early November.

The final design of the dyke was completed in late January, 1987. Drawings from the Tender Documents for Phase II of the work are included in Appendix III.

Completion of the dyke (Phase II Construction) was scheduled to take place during March and April, 1987.

1.3 SCOPE OF WORK

The scope of work for the engineering services includes the following:

1. Review existing information
2. Survey of the dyke
3. Inspect existing drainage structures
4. Confirm sources of construction materials
5. Carry out geotechnical investigation of the dyke
6. Identify foundation preparation
7. Liaison
8. Carry out the detailed design
9. Prepare cost estimates
10. Prepare a design brief
11. Prepare tender documents
12. Carry out construction monitoring

The determination of the design flood elevations for a range of flood frequencies was specifically excluded from the work. This information was provided to Klohn Leonoff by the Water Resources Division of the Northern Affairs Program, Indian and Northern Affairs Canada (Ref. Dawson City Flood Evaluation).

2. EXISTING DYKE (FRONT STREET)

2.1 CROSS-SECTIONS

The existing dyke is up to 1.5 m in height above the ground surface at the landside of the dyke. The riverside slope of the dyke varies in height up to about 5 m and has been constructed to slopes generally at about 1 vertical to 1.5 horizontal (1V:1.5H).

The crest of the dyke is paved (Front Street) for most of its length and is about 11 m wide.

2.2 MATERIALS

The existing dyke has been constructed with silt, sand and gravel from a variety of sources including river gravel, White Channel Gravel and Moosehide Slide materials (see Section 4). In addition, boreholes through the dyke at the S.S. Keno show the presence of silt, woodchips, peat and other materials.

2.3 FLOOD PROTECTION

The crest of the existing dyke is generally at or just below El. 320 which is sufficiently high enough to provide protection against flooding for the 200-year open water flood event, but it does not provide adequate protection against ice jam related flooding. In April of 1986 a small amount of fill material was placed to raise the north end of the dyke closer to El. 320 to provide a uniform degree of flood protection along the dyke for the 1986 ice jam flood period. Some of this material was removed after spring break up.

3. FOUNDATION SOILS

3.1 GENERAL

The City of Dawson has been built upon a floodplain of the Yukon River and is underlain at depth by coarse sand and gravel similar to that presently found in the river bed. As shown in the permafrost map of Canada, Figure 1, the City is within the "Discontinuous Permafrost Zone". The northern end of the City is built upon fill, peat, and silt deposits which are frozen and which overly the river gravels. A section along King Street has been plotted on Figure 2 which shows the silt falling slightly in elevation as it approaches the Yukon River. The southern end of the City is free from permafrost and the gravels are overlain by sand and silt. It is believed that the permafrost boundary intersects the dyke at about Church Street. Test pits excavated on the riverside of the dyke did not encounter frozen ground.

3.2 SUBSURFACE INVESTIGATION

Thirty-four test pits were excavated in the foundation of the new dyke, in the existing dyke, and on the gravel bar to the riverside of the new dyke at the locations shown on the "Key Plan and Location of Test Pits", Figure 8. Selected soil samples from these test pits were sent to a testing laboratory for determination of grain size distribution. Logs of these test pits and the results of laboratory testing are contained in Appendix I and Appendix II, respectively of this report.

3.3 FOUNDATION CONDITIONS

The results of the investigation show that in general the soils beneath the new dyke are competent sand and gravel, but that a surface layer of firm silt or very fine sand is present in many areas.

This surface zone of weaker material is generally thin and where possible it was removed prior to construction of the new dyke. However, between Station 1+550 and 1+900 (approximately from the Canadian Imperial Bank of Commerce to the ferry haul-out location) the depth of these materials increases to 4 m or more and it was not economical to remove them below the level of the Yukon River. These materials are slightly preconsolidated but nevertheless as discussed in Section 6 of this report and as shown on Figure 3 it was necessary to flatten the riverside slope of the new dyke.

As noted in Section 2.3 of the Preliminary Design report, a ground acceleration of 6% of gravity has been used for an earthquake in this area with a 100-year recurrence interval. It is considered that this could cause liquefaction of the remaining weak silt and fine sand beneath the dyke leading to some damage to the dyke. However, although some slumping of the dyke fill would occur, the probability of this event occurring at the same time as a high flood event is very small and flooding of Dawson is not likely to follow. In addition, liquefaction of the foundation soil could not occur when the soil is frozen, as is likely to be the case during a spring break-up, ice jam induced flood.

4. MATERIALS SEARCH

4.1 GENERAL

As discussed in Section 6, the new dyke is to be an earthfill embankment constructed with sand and gravel and faced on the riverside slope with riprap and filter gravel.

4.2 WHITE CHANNEL GRAVEL

The most suitable local source of bulk fill is that material known locally as White Channel gravel. A thorough inspection of this material was carried out and samples were taken for laboratory testing from the Lovett Gulch deposit owned by Clive Nicholson and the Teck Corporation. It is a clean, well-graded, sand and gravel, containing less than 5% fines and having a significant maximum size of about 75 mm. This deposit is particularly well suited to winter construction due to the fact that its natural moisture content is close enough to optimum water content to permit compaction to the specified degree without the need to add water. This was proven during the Phase I construction of the dyke.

A visual inspection of the Universal (Jackson Hill) Tailings Pits, which also contains White Channel gravel, was also carried out, however, at that time the owners of this material intended to rework the deposit for its remaining gold content and required payment of $2.50/m^3$ for their material compared to $0.06/m^3$ for material from Lovett Gulch. As a result, no further investigations were carried out in the Universal Pit. The ownership of this deposit subsequently changed hands and discussions with the new owners, White Channel Underground Mining Ltd., resulted in the material being available at the same price as the Lovett Gulch material. Further inspections and laboratory testing of White Channel gravel from Jackson Hill indicate that it is suitable for use as dyke fill.

The results of laboratory testing including natural moisture content, particle size distribution, and Compaction Tests are given in Appendix II.

The White Channel gravel appears to have a relatively high thermal conductivity which causes a greater than usual depth of frost penetration. Frost tubes were installed in boreholes in order to monitor the depth of frozen ground between January and March, 1987. The frost tubes were installed during the period January 27 to January 30, 1987. On February 5, 1987, the depth of frost was 2.3 m to 3.0 m below the surface. The results are given on Table 2.

This frozen material must be removed to expose the underlying unfrozen materials for dyke construction during the scheduled winter and spring construction period. The Lovett Gulch deposit is likely to be more economical than the Jackson Hill material because the topography of the pit is more suitable to development of a high working face thereby minimizing the volume of frost to be removed for a given volume of dyke fill.

4.3 RIVER GRAVELS

Test pits were excavated in the bars of the river gravel located adjacent to the new dyke and also on the south side of the confluence of the Yukon and Klondike Rivers. The materials consist of clean sandy gravel and cobbles. The results of laboratory tests to determine particle size distributions are contained in Appendix II.

These materials are suitable for use as a filter between the White Channel gravel and the riprap. A layer of river gravel was placed on the riverside slopes of the backfill placed in Phase I of the dyke construction. Most of the material which was readily available in the area adjacent to the dyke was removed during Phase I.

Further test pits excavated after freeze up of the rivers at the south side of the river confluence, showed that the river level and hence groundwater level in the test pits had risen to an average depth of 0.6 m below the ground surface. The quantity of filter gravel required for Phase II of the work, is available from that gravel bar but the area worked will have to be large. This coincides with the requirements imposed by Federal Fisheries for the excavation of material from the gravel bar.

Access to the gravel bar during March-April is expected to be via an ice bridge over the Klondike River or by a semi-circular route out onto the Yukon River.

4.4 OTHER DEPOSITS

Deposits of granular material were also examined at the West Dawson Gravel Pit operated by Yukon Territorial Government Highways and also at the Cemetery Pit located on the Dome Road at about Station 1.5 km. Both of these deposits consist of clean well-graded sand and gravel as shown on the attached laboratory test results. These gravels will be frozen during the scheduled construction period and are therefore not suitable sources of material for bulk dyke fill. They are also unlikely to be as economical for use as filter gravel as the closer river gravel.

Use of material from the Moosehide Slide was prohibited by the Yukon Territorial Government due to its asbestos content. Nevertheless, the material is not suitable for use as bulk fill material during winter because the full depth of the deposit is frozen during cold weather. Furthermore, except over a small range of moisture contents, its higher silt content would probably make it more difficult to achieve good compaction which would result in a weaker fill. The stability of this borrow area, which represents the toe of a previous slide, should be investigated before large amounts of material are removed from it.

A sample of the Klondike Wash material was taken from the Jackson Hill mining operations. This material forms a cap above the undisturbed White Channel deposits at similar elevations to the Cemetary Pit and West Dawson Gravel Pit. It is however, finer than the other deposits and not suitable as a filter material.

4.5 RIPRAP

The search for an economical source of rock riprap for the dyke included consideration of both blasted rock and existing talus deposits.

Talus deposits were inspected above "Lousetown" and elsewhere along the Klondike River and Bonanza Creek but were judged to be of unsuitable gradation and insufficient in quantity.

Surface exposures of bedrock on Dome Road indicate that this rock would be adequate. It was agreed that Yukon Terrirotial Government Highways would modify the gradient of their proposed new Dome Road to produce a cut yielding the quantity of rock riprap required for the dyke.

5. DRAIN EXTENSIONS

Twelve existing drains were identified for extension beneath the new dyke and are shown on the contract drawings for Phase II construction included in Appendix III. It was also decided to extend the 170 mm diameter pipe located at Station 0+700. In addition, one pipe located near the Northern Canada Power Commission generating station is to be abandoned on instructions from Yukon Territorial Government and will be sealed. Two other pipes designed M and O in the Preliminary Report could not be located but it is likely that these are in fact the two extra pipes found elsewhere at Station 1+806 and Station 2+300, respectively. The pipe designated C at Station 0+794 could not be located and it is conjectured that this pipe does not exist.

Seven of the 13 pipes were extended during the Phase I dyke construction in October and November, 1986. The remaining pipes, located at Station 0+700, 0+784, 0+794, 1+739, 1+806 and 1+810 are to be extended during Phase II of the work.

In view of the greater than normal amount of settlement expected of the new dyke (see Section 6.4) and possibly the stretching of the pipes due to the normal slight spreading of the foundation, it was agreed with the Yukon Territorial Government that annular rivetted corrugated steel pipe would be used for extending the pipe through the new dyke instead of weaker helical pipe.

Manholes were added to most of the pipe extensions in order to permit de-icing of the pipes after winter. Corrugated steel pipe was also specified for the manhole barrels. These are to be surrounded by non-frost susceptible backfill to eliminate the possibility of ice jacking.

Flap gates are to be installed at the discharge end of each pipe. The flap gates are to be able to withstand a head of up to 6 m of water without excessive leakage. The gates are hinged at the top and operate automatically, opening due to the pressure of water inside the pipe and closing by gravity when the water pressure outside the gate exceeds that inside the pipes. The flap gates should be inspected each year at low water to be sure they are operating satisfactorily and are not jammed open.

6. DYKE DESIGN

6.1 DYKE CROSS-SECTION

The basic principle of locating the new dyke to the riverside of the existing dyke was established during the Preliminary Design (see Appendix IV) in order to avoid the access and aesthetical problems of raising the existing dyke.

Determination of the crest elevation was excluded from the Terms of Reference as stated in Section 1.3. The results of the study to determine these elevations were made available in early January, 1987 and are as follows:

RETURN PERIOD (years)	RIVER ELEVATION (m)
10	318.8
50	320.1
100	320.6
200	321.1

The decision of the Steering Committee was to construct the dyke to a final crest height of El. 321.1 m without additional freeboard.

The profile of the dyke was determined on the basis of the recommendtions of this study as follows:

1) From the Water Survey of Canada (WSC) gauging station upstream to King Street (approximate distance 850 m), a slope of 0.0003 m/m.

2) Upstream of King Street a slope of 0.0006 m/m.

A minimum crest width of 3.6 m has been adopted to ensure that access is available for maintenance vehicles and also because of the need to specify a minimum practical fill placement width.

6.2 STABILITY

Side slopes are generally 1 vertical to 2 horizontal which is considered to be the minimum safe gradient for overall stability of the fill material. Where soft foundation soil was encountered between Station 1+525 and Station 1+900, the lower portion of the riverside slope was flattened to 1 vertical to 2.5 horizontal in order to increase base stability. In addition, between Station 1+725 and Station 1+900, a berm at El. 318 m was required to improve stability. This berm is to be made a feature of the area by utilizing it as a pedestrian walkway along the waterfront. A similar berm walkway has been added to the dyke between Station 1+525 and 1+650.

An additional berm was created on the riverside slope when the design was revised after the Phase I construction to allow a lower and therefore narrower dyke section for Phase II of the work. Although not planned initially, this berm adds to the stability of the dyke and also provides a very useful recreational and aesthetic addition to the dyke.

Stability during rapid draw-down conditions, following release of an ice jam flood, will be ensured by rapid drainage of the filter gravel layer and the fact that the bulk of the dyke fill will still be frozen during spring breakup.

Typical sections are given on the Construction Drawings, included in Appendix V, Figures 7 to 17.

6.3 PERMEABILITY

The permeability of the White Channel gravel is estimated to be about 2×10^{-3} cm/s which is sufficient to retard seepage during the short duration of an ice jam related flood, to an extent that seepage through the dyke is not likely to be excessive. In addition, the dyke will be frozen during this period and seepage water will probably turn to ice inside the dyke. However, because of its high content of sand, exposed slopes of the White Channel gravel, including the landside slope, should be protected against surface sloughing caused by saturation during long-term seepage or by rain. This may be achieved by topsoil and seeding, or turf, or by a layer of river gravel.

6.4 FILL ZONES

6.4.1 Bulk Fill

It is recommended that the White Channel gravel be used as bulk fill for the dyke. As noted in Section 4.2, it was possible to compact this material during the cold weather encountered in Phase I of the work to an adequate density without the addition of water. It is a relatively strong material with an effective friction angle in excess of 35° when compacted and is available in large quantities of consistent material.

The fill should be placed and compacted in layers not exceeding 250 mm in thickness to a density of at least 95% of standard maximum dry density. Experience gained during Phase I construction showed that this can be achieved during cold weather provided that material is excavated from a fresh unfrozen face in the pit, and is transported, placed and compacted without delay. In addition, the placement area must be kept as small as possible to ensure compaction is achieved before the temperature of the material falls below zero. It is also recommended that placement should not take place when the air temperature falls below -25° unless it is demonstrated that satisfactory densities can be achieved at lower temperatures.

It was intended to place the material on a continuously advancing inclined slope in order to avoid placing on previously frozen surfaces. However, experience gained during Phase I of the work indicates that this is not practical for this large scale of work. It is not desirable to construct a dyke with frozen discontinuities between each lift but in view of the granular and therefore frictioned nature of the fill, provided that no ice or snow remains on the placement area it is believed that this will not cause stability or settlement problems.

6.4.2 Riprap

The size of riprap recommended by the Preliminary Report has been confirmed. As noted in the Preliminary Report, the riprap is designed to provide protection against water velocity and waves. It is not practical to provide effective resistance against ice scour, and damage caused by moving ice should be repaired in the maintenance program. In view of the maximum size of riprap required, the thickness of the riprap should not be less than 0.6 m. Riprap is to be produced by blasting a rock cut for the new Dome Road.

6.4.3 Filter Gravel

Several Dawson residents and others familiar with the behaviour of White Channel gravel have indicated that this material erodes quickly when exposed to flowing water. This is probably due to the high sand content. As a result of this practical experience and also after a detailed review of the filter requirements of the White Channel gravel and the riprap, it is felt that a filter layer should be placed between these two materials.

The need for a filter zone is demonstrated by Figures 4 and 5 which show the filter criteria for White Channel sand and gravel and for river gravel. The most appropriate parameters for determination of the filter criteria are believed to be those presented by Terzaghi, (Ref. Terzaghi and Peck, Soil Mechanics in Engineering Practice, Table 11.2.). The gradation of the filter material should have a mean size (D_{50}) of between five and ten times the mean size of the material to be protected. It should also be noted that in some areas the bulk fill may be sandier, i.e. finer, than shown and where this occurs adjacent to a coarse area of riprap, loss of material would more than likely occur through the riprap unless a filter between these two materials were provided as proposed.

The use of a filter cloth is considered to be less desirable in view of the consequences of ice damage to the riprap and underlying filter cloth. It is felt that a layer of filter gravel would be more likely to remain in place long enough to protect the White Channel gravel if ice damage were to occur. It is therefore recommended that a 0.6 m thick layer (1.34 m horizontal) of river gravel obtained from the local river bars should be used for filter protection between the White Channel and riprap. A much greater thickness of river gravel was used for this purpose for the Phase I work but at that time the river gravel was also significantly cheaper than White Channel gravel. Only 18 000 m^3 of river gravel are required for Phase II, and it is believed that this quantity can be obtained economically from the gravel bar located to the south side of the Klondike at its confluence with the Yukon River. Only that portion of the gravel above the frozen water table will be excavated.

In view of the limited thickness of the filter gravel, it is not likely to be practical to place this zone at the same time as placing the White Channel gravel and consequently the river gravel will be placed upon the completed slope of White Channel gravel. It is imperative that all ice and snow be removed from this slope prior to placing the filter gravel and riprap.

Filter gravel has been recommended to complete the crest of the dam. This is to provide a seepage resistant surface over the White Channel sand and gravel. Alternatively, this may be completed with reject riprap, which might contain more fines than allowed for riprap.

6.4.4 Alternative Zoning

It is unlikely that the depth of frost in both of the possible borrow pits for White Channel gravel will be so great that it would not be economical to open a pit in March, 1987. However, in the event that the use of White Channel gravel for bulk fill is not economical, the zoning of fill materials will be redesigned. A basis for possible alternative zoning would be as given in the dyke section shown as Figure 6 in Appendix V. This section shows that use of White Channel material is minimized and "Dredge Tailings" are to be used as part of the bulk fill. Test pits in the Dredge Tailings stockpiles at the bottom of Dome Road and in the Callison subdivision show that these stockpiles are highly variable in gradation but generally consist of gravel and cobbles. They are highly permeable and would require a core zone of White Channel gravel. It is understood that these stockpiles frequently become ice bonded by the end of winter and very difficult to excavate. If the White Channel gravel is not economical, a search will be carried out for stockpiles of Dredge Tailings free from this ice bonding. It is also understood that Parks Canada would require that these materials not be removed from areas where original "historic" appearances are considered to be important.

6.5 SEEPAGE

The conclusions made during the preliminary design phase regarding seepage through and beneath the dyke have been reviewed and are considered to be still valid.

Seepage is not anticipated to be significant through the dyke during ice jam related floods due to their very short duration. Nor is it likely to be significant during open water floods because these levels are below the present dyke elevation. Thus, no additional seepage through the dyke is expected to occur at any time of year.

Some increased underseepage may occur during high ice jam flood events due to the greater head difference caused by the new dyke. As stated in the preliminary design report, increased seepage may occur at the southern end of the dyke along the Klondike River where unfrozen sand and gravel form the foundation material. Records of groundwater levels in standpipes (E.W. Brooker & Associates Ltd., Preliminary Report on Subsurface Conditions, Dawson Yukon, June, 1972) indicate that groundwater levels beneath the southern portion of Dawson respond to changes in the level of the Yukon River, indicating that the unfrozen gravel is continuous in the area. Seepage is not expected to exceed about 1500 L/min in this area and this is not likely to occur except in rare high floods and then for only a few hours. This amount of seepage would be handled by construction pumps.

It should be noted, however, that hydrostatic uplift and boiling of the surface soil could occur at the landside toe of the new dyke during high river levels where the new dyke is to be constructed on the gravel bars between Sta. 0+900 and 1+500. This low ground left between the new and old dykes should be backfilled with landscaping fill as soon as possible.

6.6 SETTLEMENT

In view of the proposed winter construction period, it is likely that post construction settlement of the dyke fill will be greater than normal. Case histories of embankment construction during cold weather indicate that settlements of about 5% of the dyke height, i.e. up to 0.35 m, have occurred. This is assumed to be due primarily to the difficulties of proper compaction during winter construction despite the best effort of full quality control of the compaction. In view of the decision to build the dyke to the design crest elevation without provision for freeboard, it is recommended that an observational procedure be established, and that fill be placed on the dyke crest where settlement occurs. This should form part of the scheduled maintenance of the dyke.

6.7 WINTER CONSTRUCTION

The dyke will be constructed in two phases. In the fall of 1986, the foundation was prepared when the water was low and before the weather became very cold. In March and April, 1987 the balance of the construction will be performed. The air temperature will be warmer, but will still likely be below freezing.

Unfrozen White Channel bulk fill will be obtained from the borrow pit and placed and compacted before the material freezes. In order to do this, the work will continue 24 hours per day, 7 days per week until the work is finished. The core of the dyke is expected to remain frozen, an outside layer will freeze and thaw through the winter and summer. Nevertheless, the fill is granular, and is expected to have a very small volume change by freezing and thawing.

6.8 PERMANENT VEHICLE ACCESS RAMPS

Prior to construction of the new dyke there were five vehicle access ramps from Front Street to the Yukon River, as follows:

i) A ramp at Sta. 2+225 provides access to the vehicle ferry "George Black".

ii) Access to the concrete boat-ramp at Sta. 2+078 was available from Front Street.

iii) The commercial fishing boats are generally beached at about Sta. 1+900 to 2+000 and access to this area was available via a ramp close to Sta. 2+000.

iv) A fourth vehicle access ramp was available at Sta. 1+700, close to the S.S. Keno, to allow coaches to drive close to the tourist boat, the M.V. Klondike, and to permit private vehicle access to the other vessels moored at the floating dock.

v) A ramp at about Sta. 1+075 permitted vehicles to drive onto the gravel beach located between Sta. 0+900 and Sta. 1+500.

Three new access ramps as described below are to be provided as shown on Drawings 3008, 3009 and 3010.

i) A new access ramp has been provided for the existing ferry at Sta. 2+300. A maximum grade of 7% was used at the ferry ramp and the existing skew angle to Front Street has been maintained.

ii) A vehicle access ramp has been provided at Sta. 1+925, to allow vehicles to drive down to the commercial beach area and provide access for large vehicles to the new location of the ferry haul-out. Access to the concrete boat ramp is available via the proposed new ferry haul-out location. It is understood that access to that ramp is necessary only for small trucks.

iii) As requested, vehicle access is also provided to the beach at Sta. 1+700 where the M.V. Klondike cruise boat docks. In order to minimize encroachment of the new ramp upon the beach area at this location, the flood protection dyke runs down to existing grade at each side of the new access ramp such that the new ramp does not require any significant fill. As a result it has been agreed that this gap in the dyke protection will be filled with gravel each fall by Yukon Territorial Government after vehicle access is no longer needed. After spring breakup, this temporary gravel plug will be dozed down onto the beach where it will be used for annual beach maintenance. It is noted that such a gravel plug will not prevent access to the beach by "snowmobiles".

Pedestrian access ramps are provided at Sta. 1+125 opposite Church Street and also upstream and downstream of the City of Dawson Pump House at Sta. 0+500.

6.9 FERRY HAUL-OUT

The new dyke fill covers part of the timber "ways" of the present ferry haul-out. Discussions and a site inspection were held with Yukon Territorial Government Highways personnel and a new location of the haul-out was selected at Sta. 2+050. This is the location previously occupied by Frontier Freightlines and appears to provide a reasonable gradient down to the edge of the river. It also permits the ferry to be hauled up to an elevation up to 3 m higher than previously. The new haul-out is shown on Drawing No. 3009, Fig. 15 included in Appendix V.

7. CONSTRUCTION

7.1 FOUNDATION PREPARATION AND PHASE I CONSTRUCTION

Excavation of unsuitable foundation soil, replacement by granular backfill and construction of those portions of the dyke below water were completed by approximately November 1, 1986. As discussed in Section 3, a significant amount of unsuitable silt and fine sand had to be removed. In general, the excavation was backfilled with White Channel gravel but where the excavations extended below the water table, they were backfilled with rock obtained from existing stockpiles produced by placer mining operations in Bonanza Creek. This rock which is also known as De-Rocker Tailing was also used to construct a rock toe along those portions of the dyke between Sta. 1+500 and 1+900 which extended into the Yukon River. The toe serves two purposes, it permits the construction of a strong stable fill zone below water and also acts as erosion protection for the toe of the dyke.

The portion of the dyke between Sta. 0+300 and 0+900 was constructed to above river level by moving river gravel to the dyke from adjacent bars in the Klondike and Yukon Rivers.

Fill placement continued after November 1, 1986 in order to reduce the volume of fill to be placed during Phase II of the work, and hence assist completion of the project before the next ice jam flood.

A total of 21 000 m^3 of excavation was carried out and 79 000 m^3 of fill (White Channel and River gravel) and 16 000 m^3 of rock was placed during foundation preparation and Phase I construction. The cost of these fill materials was calculated to be $7.56/$m^3$ and $9.33/$m^3$ for the bulk fill/filter gravel and the riprap respectively.

The White Channel fill and the rock was hauled by end-dump trucks sometimes assisted by belly dumps. The river gravel was hauled by scraper or by end-dump trucks. Satisfactory densities were achieved and useful experience gained for planning Phase II of the project.

7.2 PHASE II

During the Phase II construction, it is anticipated that in excess of 2500 m^3 of bulk fill will be hauled per shift using end dump and belly dump trucks. At this rate, the total bulk fill of Phase II will be placed in about 40 shifts or 20 days of continuous work. It is to be expected that some delay will be caused by excessively cold weather and the fill placement operation is assumed to require about 30 days or say 35 days allowing for a slow start. Thus the operation is expected to commence no later than March 15, 1987. Prior to this date, it is anticipated that two D8 dozers will have been ripping frozen ground to open up the White Channel borrow pit, this operation should commence about March 1, 1987. The contractor should be mobilizing the remainder of his equipment during this same period.

The filter gravel and riprap are expected to require about 10 days and 15 days, respectively of continuous 24 hour work. These two operations would be carried out simultaneously with each other and with placement of bulk fill. More than 25% of the volume of riprap is to be placed on the Phase I fill and this work could be carried out early in the schedule.

Extensions of the remaining pipes should be done in March in order not to delay dyke fill placement above them but provided they are constructed early, the pipes are not likely to be on the critical path.

Completion of the dyke past the ferry haul-out cannot be carried out until after the ferry is removed which is expected to occur about May 20, 1987. A temporary dyke is to be constructed past the ferry for the duration of 1987 breakup period, as shown on Drawing 3009 in Appendix III.

Placement of the base course and possibly raising of the Klondike Highway past Crocus Bluff could also be delayed until after the ice breakup, provided that provision was made to plug the Klondike Highway in the event of a flood.

7.3 COST ESTIMATE

The cost estimates given in Table 1 are believed to give a realistic cost for the completed Phase II dyke based on current costs and experience gained during Phase I.

The costs include all anticipated direct and indirect costs associated with the work plus overhead and profit. It is noted that there is little precedent for this type of fill construction during winter in the Yukon and unit cost estimates for fill materials should be regarded as approximate. A contingency of 15% has been allowed on the cost of the project.

PROFESSIONAL YUKON C.T. LUMB TERRITORY ENGINEER

KLOHN LEONOFF YUKON LTD.

C. Trevor Lumb, P.Eng.
Project Manager

C. David Sellars, P.Eng. (B.C.)
Manager, Water Resources Division

TABLE 1

ESTIMATE OF COSTS

ITEM	QUANTITY	RATE	TOTAL
Phase II Construction			
1. Mobilization	-	-	$ 60,000.00
2. Bulk Fill	96 731 m^3	8.70/m^3	841,559.00
3. Filter Gravel	18 506 m^3	7.00/m^3	129,542.00
4. Riprap, Stockpile	21 485 m^3	Highways Contract	366,864.00
Riprap, Place	21 485 m^3	7.45/m^3	160,063.00
5. Basecourse	412 m^3	35.00/m^3	14,420.00
6. Chip Seal	200 m x 7 m	LS by YTG	10,000.00
7. Pipes, installation	165 m	142/m	23,430.00
8. Flapgates, purchase	12	Supply Contract	10,417.00
Flapgates, install	12	420 ea	5,040.00
9. Manholes, installation	5	1,450 ea	7,250.00
Manholes, top, frame and grate, supply	9	680 ea	6,120.00
10. Ditch Backfill	400 m^3	5.00/m^3	2,000.00
11. Ferry Haul-Out	-	L.S.	20,000.00
12. Royalty	100,000	0.06	6,000.00
13. Contingency (15%)	-	-	249,405.00
14. Engineering Inspection	-	-	123,910.00
SUBTOTAL			$2,036,020.00
Phase I Construction			
Construction and Engineering			$1,191,250.00
TOTAL			$3,227,270.00

TABLE 2

RESULTS OF INVESTIGATIONS
TO DETERMINE DEPTH OF FROST

1. Four frost tubes were installed to measure the depth of frozen soil in the potential borrow pits. The results are as follows:

FROST TUBE NUMBER	LOCATION	INSTALLED	DEPTH OF FREEZING BELOW GROUND SURFACE			
			JAN 29	JAN 31	FEB 5	FEB 17
1	Lovett Gulch	January 27	2.7 m	2.7 m	2.5 m	2.8 m
2	Lovett Gulch	January 29	-	2.1 m	2.55 m	3.01 m
3	Jackson Hill	January 30	-	2.7 m	2.3 m	2.7 m
4	Jackson Hill	January 30	-	3.0 m	2.8 m	3.1 m

APPENDIX I

APPENDIX I

TEST PIT LOGS

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV	O.D. / I.D.	BLOWS 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD1 — Station 0+26.5
O/S 18.0L
"0" elev 317.14

0 - 1.5m — Sand and gravel, some cobbles poorly graded max size 8" trace of organics, some roots gravels round to subround.

1.5m - 1.8m — Sand and gravel, well graded max 3" trace of - #200

1.8m - 2.1m — Silty fine sand trace clay, dark brown/black, highly organic, slightly micaceous soft.

Water table @ 0.4m.

unable to dig beyond 2.1m pit sloughing.

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CONSULTING ENGINEERS

JOB No. 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dykes
HOLE No. DD1
DATE Aug 27, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD1A — Station 0+32.6
O/S 5.3L
"O" elev 318.92

0 - 0.8m	Sand & Gravel, silty trace of clay brown, occasional roots organic est 10% -200 Max 4"
0.8m - 1.4m	White Channel sand & gravel 2% -#200 max 4" dense
1.4m - 1.7m	Gravels & Cobbles 3/4" to 8" poorly graded, loose voids throughout
1.7m - 2.6m Sample taken @ 2.0m M.C.= ___ % GS	Silty fine sand, trace clay dark brown, black Soft, slightly micaceous, contains roots, highly organic est +30% M.C.
2.6m - 2.8m	Sand and Gravel minus 3" round to subround dense.

Water table 2.3m.

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JOB No 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD1A
DATE Aug 27, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH ELEV.	O.D. I.D.	BLOWS 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD2 — Station 0+084

O/S 12.7 L

"0" elevation 316.78

0 - 0.5m — Silty, black, fine sand, highly organic, large roots, slightly micaceous soft.

0.5m - 2.0m — Sand and gravel well-graded minus 3", less than 5% -200 gravels round to subround occasional 6" max dense

Water table @ 0.1m.

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JOB No. 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 2
DATE Aug 27, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD2A
Station 0+075.0
O/S 4.8L
"O" elevation 318.88

0 - 0.1m White Channel Sand & gravel overlying slope loose.

0.1m - 1.1m Sand and gravel, silty trace clay, Brown, some organics, roots max 4" gravels round to subangular dense

1.1m - 2.6m White channel sand and gravel reworked with other gravels contaminated with traces wire, paper debris. dense.

2.6m - 2.8m Coarse Sand and Gravel, cobbles subround to Subangular Max 6" dense

Water table @ 2.0m.

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JOB No 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD2A
DATE Aug 27, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 3A   Station 0+189.1
O/S 6.0 L
"0" elev 318.16

0 - 1.0m   Sand and Gravel, silty, trace clay, brown, some organics, roots gravels round to subround max 6"

1.0m - 1.2m   Rock layer, sharp angular, clean, max 6"

1.2m - 2.1m   Silty fine sand, trace clay dark brown, black, soft, slightly micaceous, contains roots, highly organic est +30% M.C.

2.1m - 2.8 m   Rock, sharp angular extremely dense max 6"

Water table @ 2.0m.

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JOB No. 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 3A
DATE Aug 27 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD4 — Station 0 + 527.5
O/S 45.0 L
"O" elev 317.45

0 - 1.0m — Silty fine sand, trace clay soft, highly organic, slightly micaceous (dark brown)
est +30% M.C.
0-1.0m cable, brick, wire, angle iron, bottles, plate steel rail steel, timber debris.
(Possible old Powerhouse site?)

1.0m - 2.7m — As above Silty fine sand trace clay highly organic slightly micaceous, brown.

a few bricks exposed @ 2.6m

2.7m - 2.9m — Sand and gravel minus 4" well graded, subround to subangular
extremely dense

Water ~~table~~ seepage @ 2.8m.

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JOB No 3601-02-05 TECH. EdS
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD4
DATE Aug 28, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV	O.D. / I.D.	BLOWS 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 4A — Station 0+527.5
O/S 28.0 L
"O" elev 319.19

0 - 1.1m — mixture of moosehide slide rock, white channel and river sands and gravels minus 8" some sliderock max 15"

6" black organic layer @ 1.0m

1.1m - 2.6m — Silty fine sand, trace clay firm, brown, organic slightly micaceous

Sample #1 taken @ 1.5m
M.C. = ____ %
G.S

2.6m - 2.9m — Sand and gravel minus 3" Well graded, subround to subangular est 10% - #200 extremely dense

Sample #2 taken @ 2.8m
G.S. only

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JOB No. 3601.02.05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 4A
DATE Aug 28, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD5 — Station 0+580.0
O/S 13.3 L
"O" elev 317.91

0 - 1.0m — reworked Silt Sands and gravels brown roots, organics 10% minus #200

1.0m - 2.6m — Silty fine sand, trace clay Soft, brown organic, roots slightly micaceous. occasional coarse gravels cobbles.
Iron strapping exposed @ 1.2m

2.6m - 2.7m — Sand and gravel minus 3" well graded subround to subangular extremely dense 5% - #200

pit bottom dry / water seeping in @ 2.6m

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JOB No. 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 5
DATE Aug 28, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA		SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER			ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP			CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID

DEPTH / ELEV	O.D. / I.D.	BLOWS / 3"	NO.	DESCRIPTION OF MATERIAL - DRILLING NOTES
				DD5A — Station 0+578.6
				O/S 8.0 L
				"O" elev 318.96
				0 - 1.5m — mixture of moosehide slide rock, white channel and river silt, sands and gravels, brown roots and organics. black silty fine sand organic layer 8" thick @1.0m.
				1.5m - 1.7m — Sand and gravel, round to subround minus 3"
				1.7m - 3.8m — Silty fine sand trace clay Soft ~~firm~~, brown, organic, roots slightly micaceous occasional coarse gravel & cobbles throughout.
				3.8m - 3.9m — Sand and gravel minus 3" well graded, subround to subangular, dense ~~>~~5% minus #200

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PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD5A
DATE Aug 28, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV	O.D. / I.D.	BLOWS / 3"	NO		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 6

Station 0+917.0
O/S 19.5 L
"O" elev 314.97

0 - 0.5m Silty fine sand, organic micaceous, brown, Soft
Note river bar sands as above checked for random depths and vary from 0.5m to 1.5m. station 0+950 to 1+350

0.5m - 1.7m Sand and Gravel well graded round to subround minus 6" extremely dense 2% - #200 occasional 10" boulder.

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JOB No. 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 6
DATE Aug 29, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV	O.D. / I.D.	BLOWS / 6"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 6A — Station 0+913.0
O/S 10.0 L
"0" elev 316.42

0 - 2.0m — Silt, fine sand, organics roots throughout brown soft

2.0m - 2.6m — Coarse Sands and fine gravels subround to subangular minus 4" 2% - #200 extremely dense

unable to get to toe of old dyke,

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JOB No. 3601.02.05 TECH. EdS
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 6A
DATE Aug 29, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 7 — Station 1+097.3
O/S 19.0 L
"O" elev 316.03

0 - .9m — Sand and gravel, silty, mixture of white channel and river materials 12% - #200 minus 6" round to subround

0.9m - 1.0m — Silty fine sand brown soft, slightly micaceous contaminated with roots and metal debris.

1.0m - 2.0m — Coarse Sands and fine gravels, subround to subangular minus 1 1/2" 2% - #200 extremely dense

Sample #1 taken @ 1.5m. G.S. only

Water table @ 2m.

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CONSULTING ENGINEERS

JOB No. 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 7
DATE Aug 29, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 7A — Station 1+~~097.3~~ 108

O/S 6.0 ~~19.0~~ L

"O" elev ~~316.025~~ 317.36

0 - .5m — Silty fine sand, organics & roots brown Soft

.5m - 1.0m — Sand and gravel, Grey mixture of moosehide, white channel river material minus 6" contains roots

1.0m - 3.1m — Silty fine sand, organic brown, Soft

3.1m - 3.3m — Sand and gravel, round to subround minus 6" extremely dense

Water seeping in @ 3.1m

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JOB No. 3601.02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 7A
DATE Aug 29, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD8 — Station 1+302.0
O/S 64.0 L
"0" elev 315.13

0 - 0.5m — Silty fine sand, brown organic, slightly micaceous, soft. high M.C.%

0.5m - 1.2m — Coarse Sands and fine gravels minus 3" 2% -#200 subround to subangular. extremely dense.

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JOB No. 3601-02-05 TECH. EdS.
PROJECT Foundation Investigation
LOCATION Dawson Dyke.
HOLE No. DD8
DATE Aug 29, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 9

Station 1+654.0
O/s 454 L
"O" elevation 315.52

0 - 2.0m.

mixture of white channel, river sands ond gravels and moose hide slide rock angular slide rock max 24"
est 12-15% - #200 dense
pit badly contaminated with timbers, steel cable, wood piles (possible old dock.)

Water seeping in @ 1.0 m.

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JOB No. 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dykes
HOLE No. DD 9
DATE Aug 29, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD10

Station 1+720.5
O/S 24.0L
"O" elev 316.5

0 - .5m White channel sands and gravels overlying area.

.5m - 2.7m Silty fine sands, grey brown soft, organics, slightly micaceous entire pit contaminated with wood piling, lumber

Sample taken @ 2.0m for M.C. = ____ % G.S.

Note at 1.1m it appears like an old wood tongue & groove platform (dock?)

2.7m - 2.9m Sand & Gravel max 6" round to subround extremely dense. attempted to obtain a representative sample but not possible.

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JOB No. 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 10
DATE Aug 30, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 11 — Station 1+880.8
O/S 24.8 L
"O" elev 317.03

0 - 3.4m Silty fine sands, grey brown Soft, slightly micaceous organic, roots
entire pit contaminated roots organics.

3.4m - 3.9m Silty fine sand, trace clay grey contained a board with nail and some wire @ ± 3.6 m.

Sample taken @ 3.5m for
M.C ____ %
GS

Note unable to excavate further maximum reach of boom.

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JOB No 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 11
DATE Aug 30, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA	SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER		ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP		CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID

DEPTH / ELEV	O.D. / I.D.	BLOWS / 3"	NO	SYMBOL	DESCRIPTION OF MATERIAL - DRILLING NOTES

DD12 — Station 1+969.8

O/S 39.0 L

"0" elev 315.15

0 - 3.5m Silty fine sands grey brown soft, slightly micaceous, organic entire excavation contaminated throughout with metal, roots lumber, tin cans to a depth of 3.5m.

water seepage @ 3.5m.

Note - first evidence of frost a few lumps were -1°C, which were taken at 3.5m

Ed S.

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CONSULTING ENGINEERS

JOB No. 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD 12
DATE Aug 30, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD 12A

Station 1+972.7
O/S 20.6L
"O" elev 315.98

0 - 0.3m Sand and Gravel minus 3"
(mixture of white channel and
silt) est 12-15% - #200

0.3 - 3.5m Silty fine sands grey brown
soft, slightly micaceous, organics
entire excavation
contaminated with rope,
broken glass, cans, roots

trace of fine gravels @ 3m.
water seepage @ 2m and 3.3m

~~Note - First evidence of frost
a few lumps were -1°C from
bottom of pit 3.5m.~~

Note is for note 12

This note should be on
log DD 12
Ed S.

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. 3601-02-05 TECH. Ed S.
PROJECT Foundation Investigation
LOCATION Dawson Dykes
HOLE No. DD 12A
DATE Aug 30, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

DD13 — Station 2+103.7
O/S 19.0 L
"O" elev 315.33

0 - 3.3m Silty fine sands, grey brown soft, slightly micaceous, organic entire excavation contaminated throughout glass, boards, organics, roots, wood chips.

6" pocket of white channel gravels @ 0.4m.

Note

There is a 0.2m thick layer of wood planks, roots, broken glass, a bone at 2.0m depth.

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No 3601-02-05 TECH. Ed S
PROJECT Foundation Investigation
LOCATION Dawson Dyke
HOLE No. DD13
DATE Aug 30, 1986 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA	SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER		ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP		CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID

DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.	DESCRIPTION OF MATERIAL - DRILLING NOTES

TEST PIT 86-20 ~STA 1+038
30m out from exist dyke

0-0.5m SILTY FINE SAND, organics, roots, brown, loose, fine (clean) sand layers thickens to 0.8m on dyke side of pit

0.5m-2.6m SAND AND GRAVEL, occassional cobble, brown, wet, loose, rounded to subround gravel.

Abandon pit at 2.6m - caving
Water table ~ 1.6m

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. DMRS
PROJECT DAWSON DYKES
LOCATION DAWSON, YT.
HOLE No. TP-20
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

TEST PIT 86-21 ~STA 0+800
5m out on gravel bar

0 - 3.5m SAND AND GRAVEL, abundant cobbles to 20cm ∅, well graded from med to coarse sand up to cobble size, no silt or silt layers, brown, loose, no foreign mat.

Pit abandoned @ 3.5m - caving
High rate of water inflow - water table ~ 1m

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. DMRS
PROJECT DAWSON DYKES
LOCATION DAWSON, Y.T.
HOLE No. TP 86-21
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA		ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER	SYMBOL	ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP		CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID

DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.	SYMBOL	DESCRIPTION OF MATERIAL - DRILLING NOTES
					TEST PIT 86-22 ~STA 0+690
					20m out on gravel bar
					0-3m GRAVEL AND COBBLES, with coarse sand, coarse round gravels, rounded cobbles to 20 cm ø, one thin silty sand layer ~3cm thick. but layer is primarily med. sand, brown, loose
					Pit abandoned @ 3m - caving
					High rate of water inflow - water table ~ 1m

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. DMLS
PROJECT DAWSON DYKES
LOCATION DAWSON, Y.T.
HOLE No. TP 22
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

TEST PIT 86-24 ~STA 1+440

5m from toe of new fill

0-0.6m SILTY FINE SAND, stratified with beds of clean fine sand up to 15cm thick, some organics, roots, brown color, loose, damp

0.6m - 0.75m FINE GRAVEL AND SILT, rounded gravels, matrix of silty or fine silty sand, bed is predominantly rounded gravels, loose

0.75-2.3m SAND AND GRAVEL, med to coarse sands and gravels, brown color, loose.

2.3m - 3.5m FINE SAND AND SILTY SAND, stratified, fine sands are orange (oxidized), silty sand is grey color, silt layers up to 10cm thick. -- NOTE that this layer is primarily clean fine sand.

Wooden piles encountered at base of pit

Pit abandoned at 3.5m - caving
Water Table ~ 1.5m

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. DMRS
PROJECT DAWSON DYKES
LOCATION DAWSON, Y.T.
HOLE No. TP-24
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA	SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER		ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP		CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID

DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO	DESCRIPTION OF MATERIAL - DRILLING NOTES

TEST PIT 86-25 ~STA 1+550

~5m from exist dyke toe.

0-0.5m SILTY FINE SAND, stratified with clean fine sand, includes layers of sand and gravel up to 5cm thick, layer thickens to 0.7m towards existing dyke, alternating colors of orange (fine sand) and grey (silty fine sand), roots, occasional cobble to 10 cm ø.

0.5-1.5m SAND, some gravel, sand is coarse, gravels are rounded and med to coarse, includes some dyke rip rap

1.5m-2.0m SAND, fine to med. grey, loose, no gravel or silt, top of this layer has abundant wood debris, cans, lumber, wire etc and is likely ground level when dyke was built.

2.0m-3.5m SAND AND GRAVEL, cobbles to 20 cm ø, rounded med to coarse gravel, black color (marker bed). loose, no silt

Pit abandoned at 3.5m - caving
Water Table @ 1.7m

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. DMcS
PROJECT DAWSON DYKES
LOCATION DAWSON, Y.T.
HOLE No. TP 86-25
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

TP 86-26 ~STA 1+600

toe of exist. dyke

0 - 0.8m FILL - sand, gravel, silts, silty sands, wood debris, lumber, piles, tires, cans, rip rap (from dyke) brown color, loose - a real mess!

0.8m - 2.6m SILTY SAND - grey color, spongy feel (soft?), occassional gravel layer

VANE in "soft" zone gave rdg's ~~E~~ 1.4 T/m² @ 1.3m depth

2.6m - 4.0m SAND AND SILTY SAND, stratified, clean fine sand layers and silty sand layers, abundant wood debris, glass, cans, etc. Top of layer has a layer of wood and debris with organics and thin peat like layer (likely the old ground level when dock existed)

4.0m - 4.2m SAND AND GRAVEL, with cobbles to 20 cm Ø, black color (marker bed).

Pit abandoned at 4.2m - intersected a water bearing layer with high water inflow into pit

Water piping sand at pit floor

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601	TECH DMRS
PROJECT DAWSON DYKES	
LOCATION DAWSON, Y.T.	
HOLE No. TP 26	
DATE Sept 23/86	PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

TP 86-27 ~ 1+730

~2m above present river level.

0–0.3m WHITE CHANNEL GRAVEL – parking lot surfacing fill.

0.3m – 5.5m SILTY FINE SAND, and sandy silts, brown color, firm to stiff, sandy layers, abundant wood and debris, wooden piles, other garbage.

No "soft" zones → vane rdg's 7.2, 5.2 & 4.0 T/m² @ 2.4m

Bottom pit hit a highly permeable sand and gravel layer and pit flooded rapidly – likely hit marker bed (see 86-26)

Abandon pit @ 5.5m – caving – flooding

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. DMRS
PROJECT DAWSON DYKES
LOCATION DAWSON, Y.T.
HOLE No. TP 27
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

Test Pit 86-28 ~STA 1+750

0-6.7m SANDY SILT, silt and very fine sand, fine (clean) sand layers, mostly feels "firm" with "soft" zones that feel spongy, brown color, no gravel, abundant wood and other debris, encountered a number of wood piles

Vane shear on "soft" zones - low 2.1 T/m², high 3.8 T/m²

6.7-7.1m SAND AND GRAVEL, rounded med. to coarse gravel, coarse sand, occassional cobble to 15cm ø, black, water bearing (marker bed)

Pit abandoned @ 7.1m - maximum reach of machine
High rate of water inflow from S+G at pit bottom

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601 TECH. [illegible]
PROJECT DAWSON DYKES
LOCATION DAWSON, Y.T.
HOLE No. TP-28
DATE Sept 23/86 PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA	SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER		ELEV. GROUND	DIA. CASING " RODS	DRILL TYPE
HEIGHT DROP		CO-ORD. LOCATION	" BIT " CORE	DRILLING FLUID

DEPTH / ELEV.	O.D. / I.D.	BLOWS 3"	NO.	SYMBOL	DESCRIPTION OF MATERIAL - DRILLING NOTES
					Test Pit 86-29 ~ STA 1+915
					0-0.2m FILL, white channel gravel, parking lot surface.
					0.2m-3.6m SANDY SILT/SILTY SAND, stratified with clean fine sand, no gravel, brown color, trace organics, wood debris
					3.6m-4.5m SAND AND GRAVEL, mostly coarse sand with fine gravel, few cobbles, black color, water bearing
					Pit abandoned @ 4.5m - high rate of water inflow

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No.	TECH.
PROJECT	
LOCATION	
HOLE No.	
DATE	PLATE No.

FIELD TEST HOLE LOG

SAMPLE DATA				SYMBOL	ELEV. COLLAR	DRILLING DATA	
WEIGHT HAMMER					ELEV. GROUND	DIA. CASING / " RODS	DRILL TYPE
HEIGHT DROP					CO-ORD. LOCATION	" BIT / " CORE	DRILLING FLUID
DEPTH / ELEV.	O.D. / I.D.	BLOWS / 3"	NO.		DESCRIPTION OF MATERIAL - DRILLING NOTES		

GRAVEL BAR INVESTIGATION
(STA 0+400 TO 0+600)

T.P. 30 ~ STA 0+575

0-1.8m SAND AND GRAVEL with cobbles, coarse clean sand, abundant cobbles to 30 cm ∅, no silt or silt layers or other foreign material, cobble layer near bottom of pit, est. 60% gravel, 40% sand.

T.P. 31 ~ STA 0+ ~~[illegible]~~ 525

0-1.5m SAND AND GRAVEL WITH cobbles, clean sand and rounded gravel, cobbles to 30 cm ∅, sand is coarse, no silt or silt layers, est. ~~[illegible] cobbles~~ 65% gravel and cobbles, 35% sand.

T.P. 32 ~ STA 0+450

0-2.0m GRAVEL AND COBBLES WITH sand, cobbles to 40cm, clean coarse sand and gravel, est. 30% cobbles, 40% gravel, 30% sand, no silt or silt layers
- ground is littered with cobbles for a large area around pit

All pits abandoned at about water table - caving

KLOHN LEONOFF
CONSULTING ENGINEERS

JOB No. PB 3601	TECH DAS
PROJECT	DAWSON DYKES
LOCATION	DAWSON, Y.T.
HOLE No.	TP 30-32
DATE Sept 25/86	PLATE No.

APPENDIX II

APPENDIX II

RESULTS OF LABORATORY TESTING

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: DD1A S #1 Depth: 2.0 Project: Dawson Dyke

Location: DD1A Made by: LK & BK Job. No. 8001

Ck'd by: [signature] Date: 1986.09.04

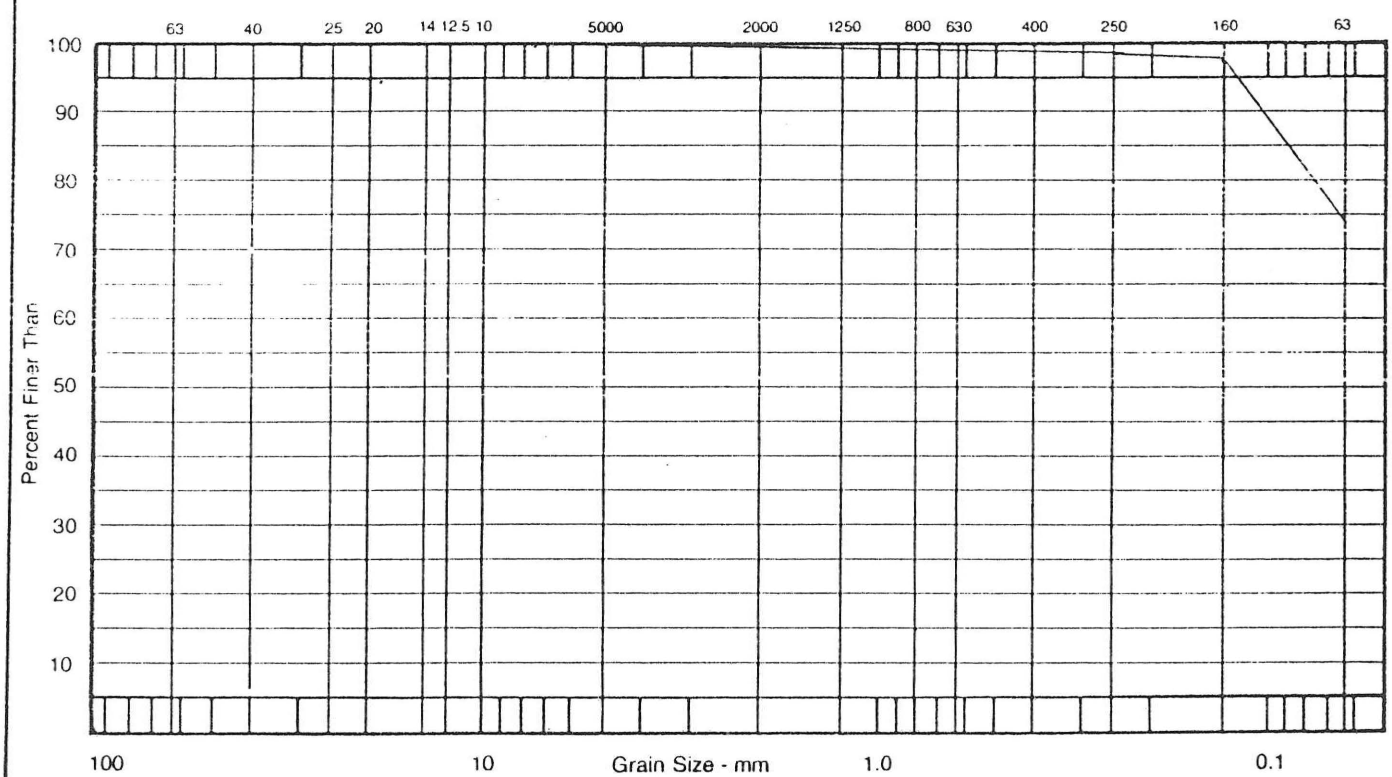
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0					
25000	25.0					
20000	20.0					
14000	14.0					
12500	12.5					
10000	10.0					
5000	5.0					100.0
2000	2.0					99.9
1250	1.250					99.7
800	0.800					99.5
630	0.630					99.3
400	0.400					99.1
250	0.250					98.7
160	0.160					97.6
63	0.063					74.3

Description of Sample: Fine Sandy Silt
Organics

Time of Sieving 15 Min.

Method of Preparation .... Dry .... Washed X

Remarks M.C. = 47.8%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff
Sample: DD3 S #1 Depth: 1.0 Project: Dawson Dyke
Location: DD3 Made by: LK & BK Job. No. 8001
Ck'd by: [signature] Date: 1986.09.04

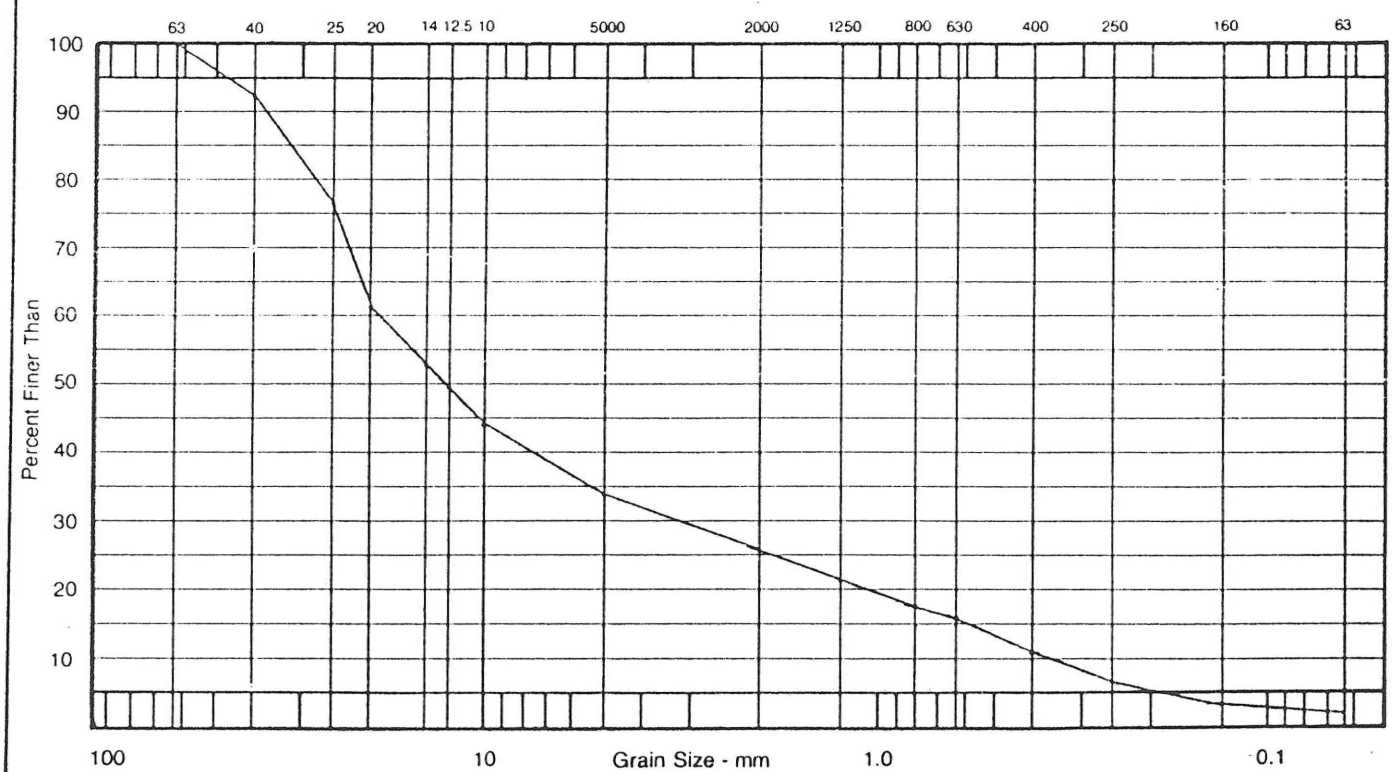
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
						100.0
40000	40.0					92.4
25000	25.0					76.8
20000	20.0					61.9
14000	14.0					53.1
12500	12.5					49.9
10000	10.0					44.1
5000	5.0					34.0
2000	2.0					25.2
1250	1.250					21.2
800	0.800					17.6
630	0.630					15.5
400	0.400					10.2
250	0.250					5.8
160	0.160					3.3
63	0.063					1.5

Description of Sample: Sandy Gravel

Method of Preparation: Dry ____ Washed X

Remarks:

Time of Sieving: 15 Min.



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: DD4A S #1 Depth: 1.5 Project: Dawson Dyke

Location: DD4A Made by: LK & BK Job. No. 8001

Ck'd by: [signature] Date: 1986.09.04

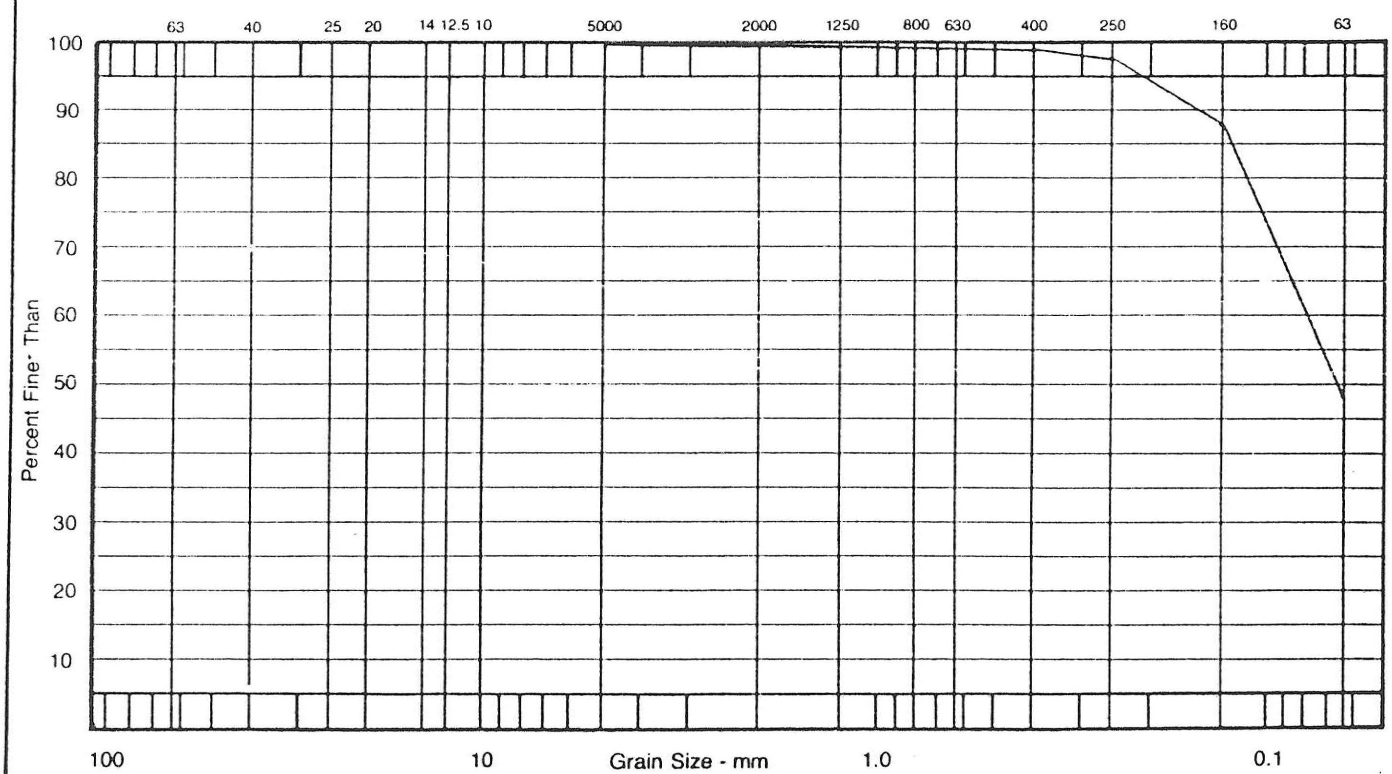
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0					
25000	25.0					
20000	20.0					
14000	14.0					
12500	12.5					
10000	10.0					
5000	5.0					100.0
2000	2.0					99.9
1250	1.250					99.8
800	0.800					99.7
630	0.630					99.6
400	0.400					99.4
250	0.250					97.6
160	0.160					88.3
63	0.063					48.4

Description of Sample: Silty Sand Organics

Time of Sieving: 15 Min.

Method of Preparation: Dry ..... Washed X

Remarks: M.C. = 23.9%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff
Sample: DD4A S #2 Depth: 2.8 Project: Dawson Dyke
Location: DD4A Made by: LK & BK Job. No. 8001
Ck'd by: [signature] Date: 1986.09.04

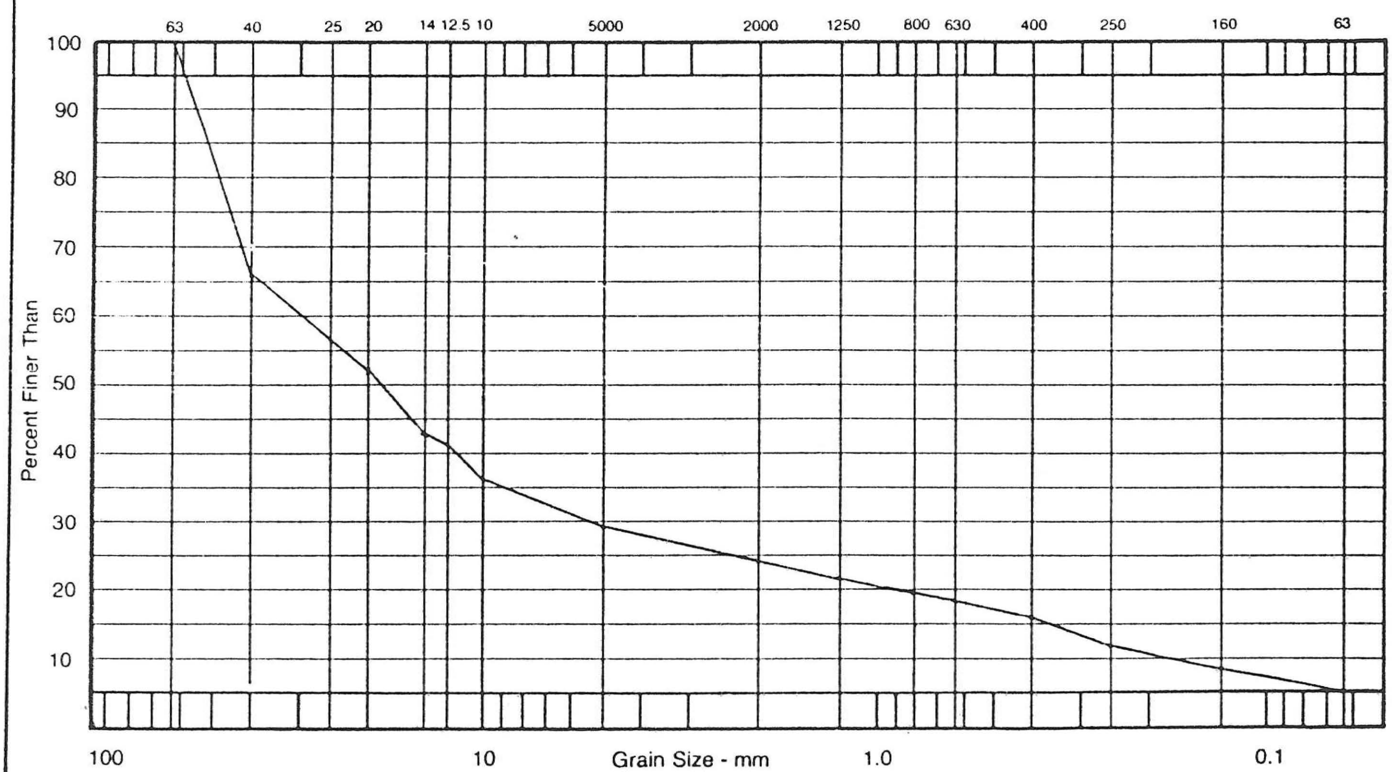
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						100.0
40000	40.0					65.6
25000	25.0					56.5
20000	20.0					52.3
14000	14.0					43.4
12500	12.5					41.8
10000	10.0					35.9
5000	5.0					29.3
2000	2.0					24.1
1250	1.250					21.8
800	0.800					19.9
630	0.630					18.7
400	0.400					15.7
250	0.250					11.5
160	0.160					8.7
63	0.063					5.0

Description of Sample: Sandy Gravel, Trace Silt

Time of Sieving 15 Min.

Method of Preparation ...... Dry ...... Washed X

Remarks



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: DD7 S #1 Depth: 1.5 Project: Dawson Dyke

Location: DD7 Made by: BK & LK Job. No. 8001

Ck'd by: [signature] Date: 1986.09.04

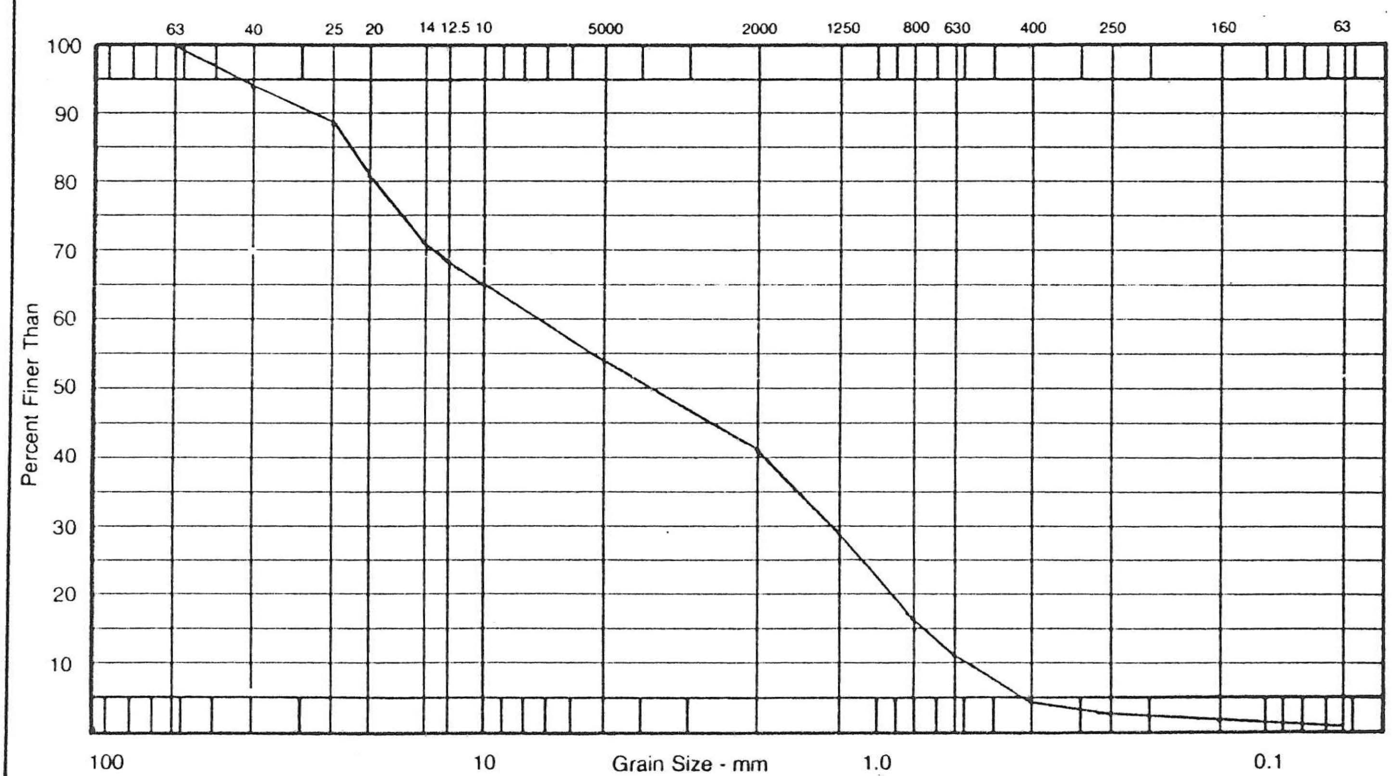
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						100.0
40000	40.0					94.1
25000	25.0					88.7
20000	20.0					80.5
14000	14.0					70.6
12500	12.5					68.9
10000	10.0					65.0
5000	5.0					54.7
2000	2.0					40.9
1250	1.250					29.4
800	0.800					16.8
630	0.630					10.8
400	0.400					4.8
250	0.250					2.2
160	0.160					1.2
63	0.063					0.7

Description of Sample: Sandy Gravel

Time of Sieving: 15 Min.

Method of Preparation: Dry ...... Washed X

Remarks:



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: DD10 S #1 Depth: 2.0 Project: Dawson Dyke

Location: Made by: LK & BK Job. No. 8001

Ck'd by: [signature] Date: 1986.09.04

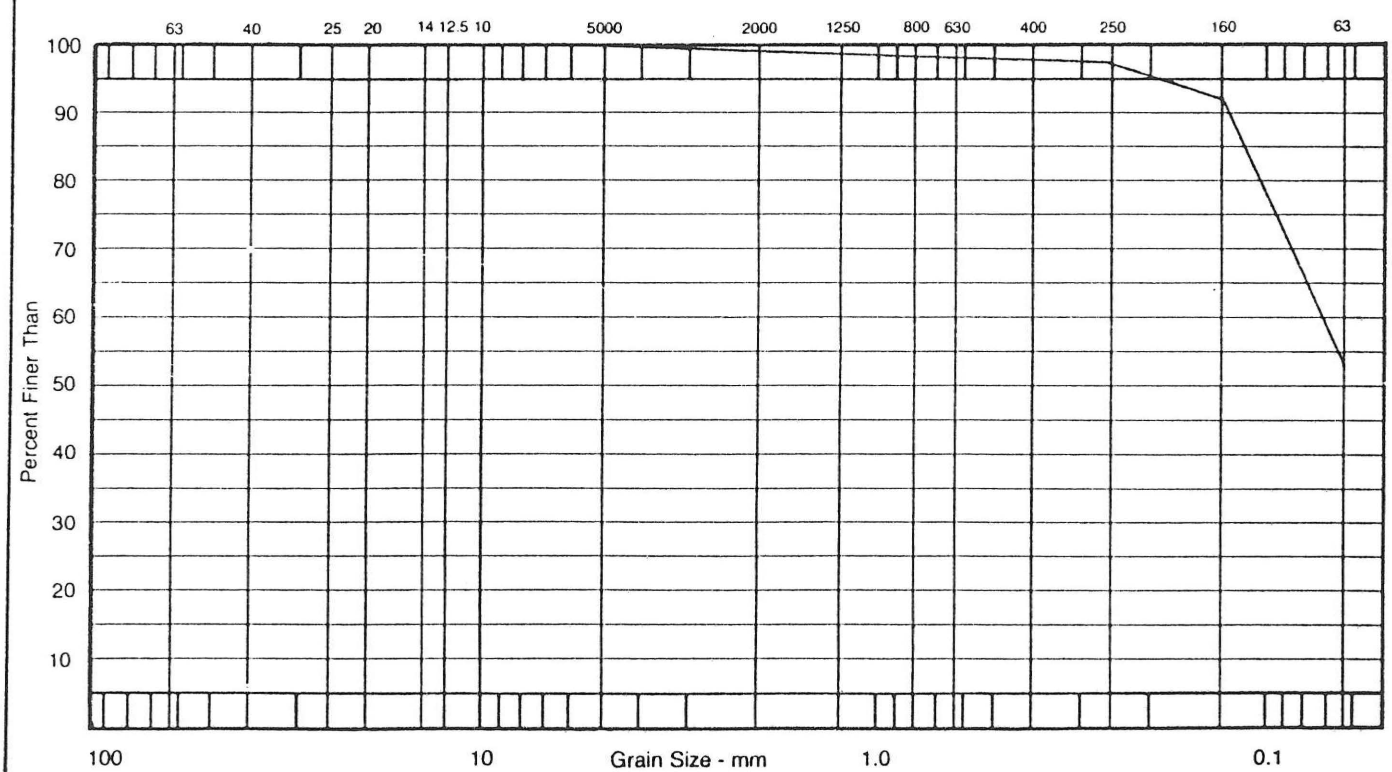
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0					
25000	25.0					
20000	20.0					
14000	14.0					
12500	12.5					
10000	10.0					
5000	5.0					100.0
2000	2.0					99.9
1250	1.250					99.7
800	0.800					99.5
630	0.630					99.3
400	0.400					98.9
250	0.250					97.7
160	0.160					92.0
63	0.063					53.5

Description of Sample: Fine Sandy Silt Organics

Method of Preparation: Dry ...... Washed X

Remarks: M.C. = 44.39 %

Time of Sieving: 15 Min.



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: DD11 S #1 Depth: 3.5 Project: Dawson Dyke

Location: DD11 Made by: LK & BK Job. No. 8001

Ck'd by: [signature] Date: 1986.09.04

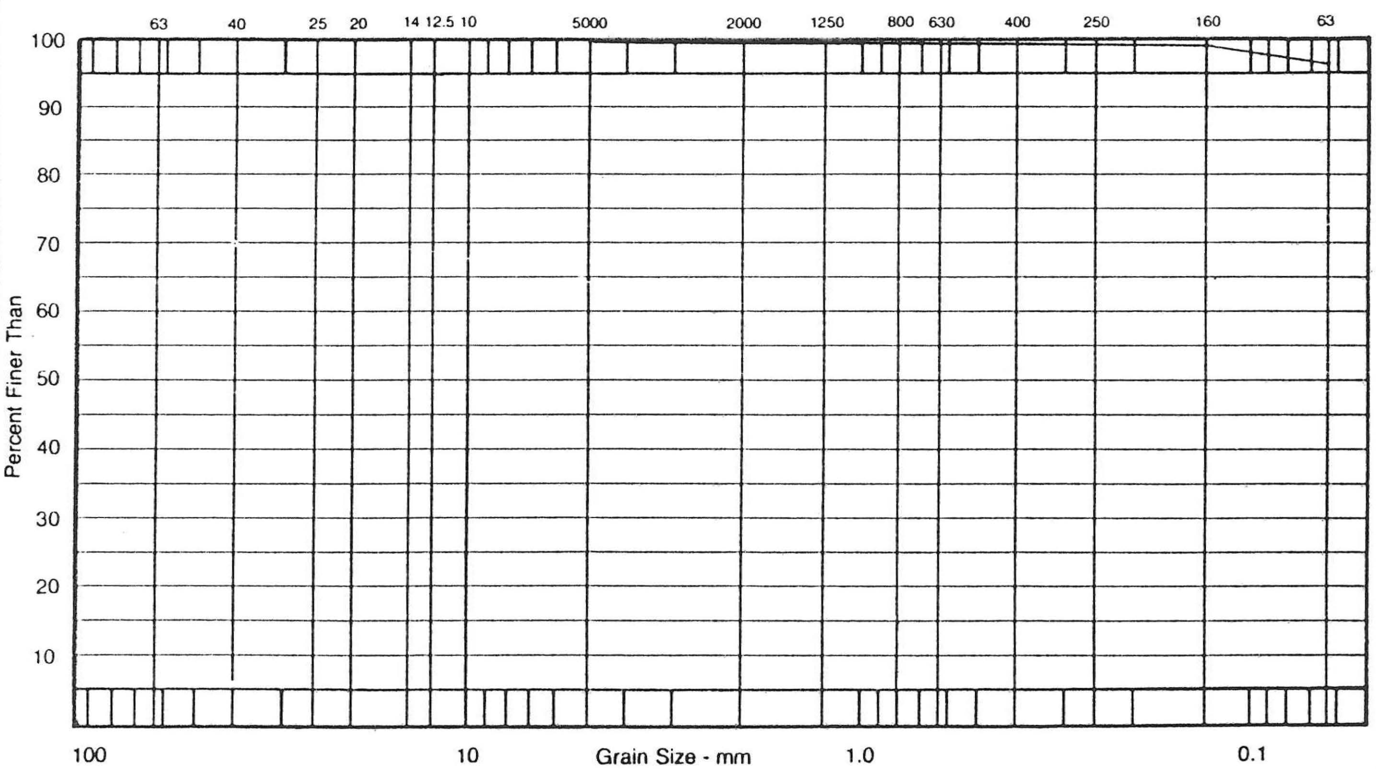
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0					
25000	25.0					
20000	20.0					
14000	14.0					
12500	12.5					
10000	10.0					
5000	5.0					
2000	2.0					99.9
1250	1.250					99.9
800	0.800					99.9
630	0.630					99.8
400	0.400					99.8
250	0.250					99.7
160	0.160					99.5
63	0.063					96.5

Description of Sample: Silt, Trace Sand, Organics

Time of Sieving: 15 Min.

Method of Preparation: Dry ..... Washed X

Remarks: M.C. = 31.3%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: Depth: 1.2m Project: Dawson Dyke

Location: DD 12 B Made by: LK Job. No. 8051

Ck'd by: Date: 1986.09.12

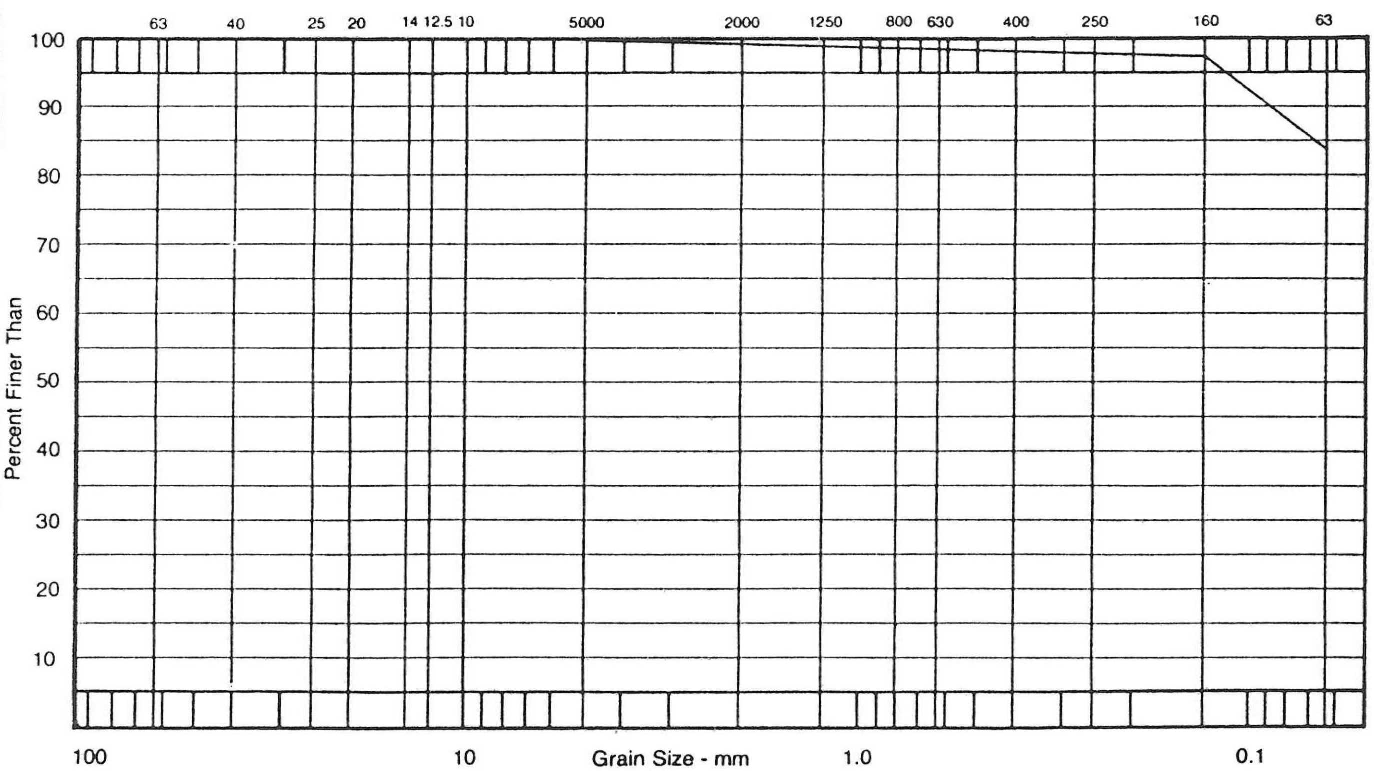
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
40000	40.0					
25000	25.0					
20000	20.0					
14000	14.0					
12500	12.5					
10000	10.0					
5000	5.0					100.0
2000	2.0					99.9
1250	1.250					99.6
800	0.800					99.4
630	0.630					99.1
400	0.400					98.9
250	0.250					98.5
160	0.160					97.7
63	0.063					84.0

Description of Sample: Sandy Silt
Organics Present

Time of Sieving: 15 Min.

Method of Preparation: Dry Washed X

Remarks: Moisture Content - 38.1%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: .... Depth: 2m .... Project: Dawson Dyke

Location: TP 12 B .... Made by: LK .... Job. No. 8051

Ck'd by: [illegible] .... Date: 1986.09.12

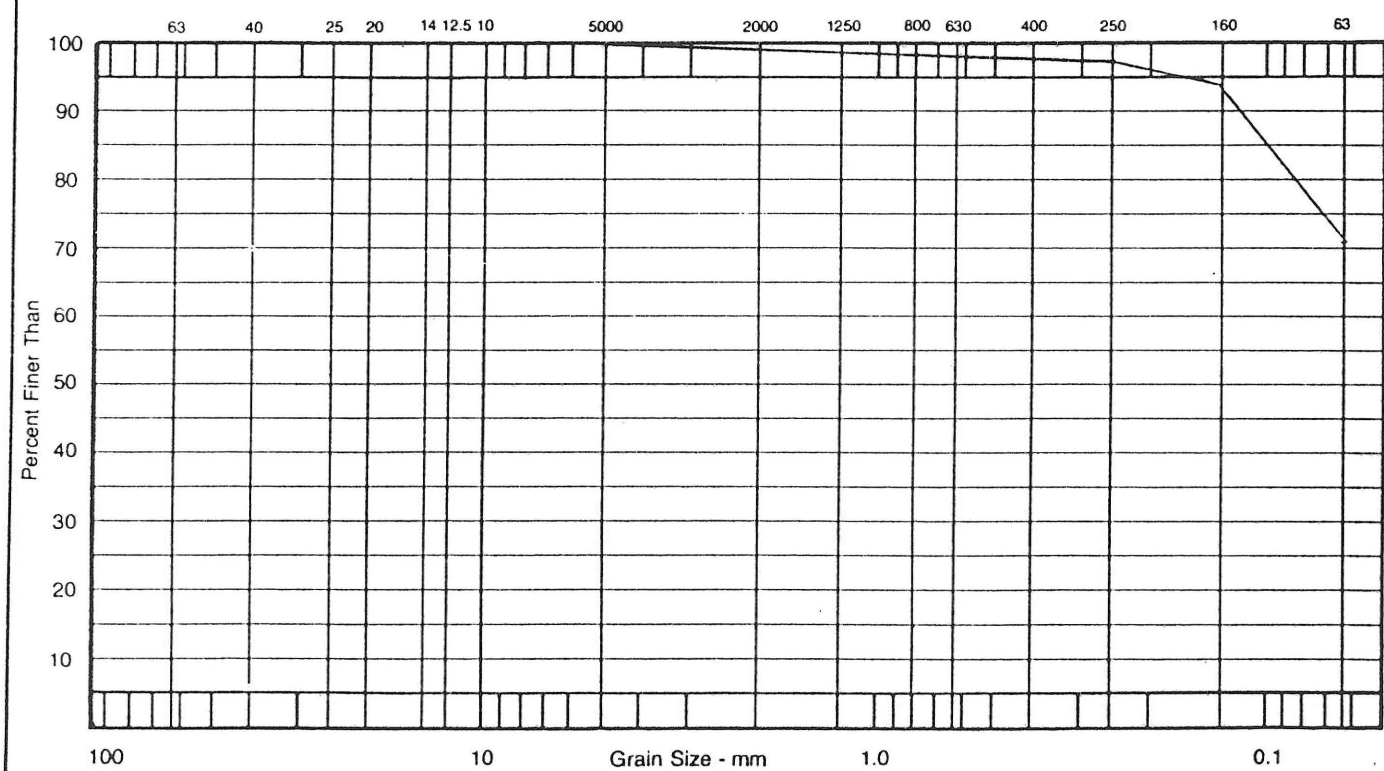
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
40000	40.0					
25000	25.0					
20000	20.0					
14000	14.0					
12500	12.5					
10000	10.0					
5000	5.0					100.0
2000	2.0					99.9
1250	1.250					99.7
800	0.800					99.3
630	0.630					99.1
400	0.400					98.7
250	0.250					97.9
160	0.160					94.7
63	0.063					70.6

Description of Sample: Sandy Silt, Organics Present

Time of Sieving: 15 Min.

Method of Preparation: .... Dry .... Washed X

Remarks: Moisture Content - 48.2%



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: YTG/ Municipal Engineering

Sample: #3 Depth:

Project: Dawson City Dike Improvements

Location: Lovet Gulch Bonanza Creek

Made by: bk Job No. 8002

Ck'd by: Date: 86.04.07

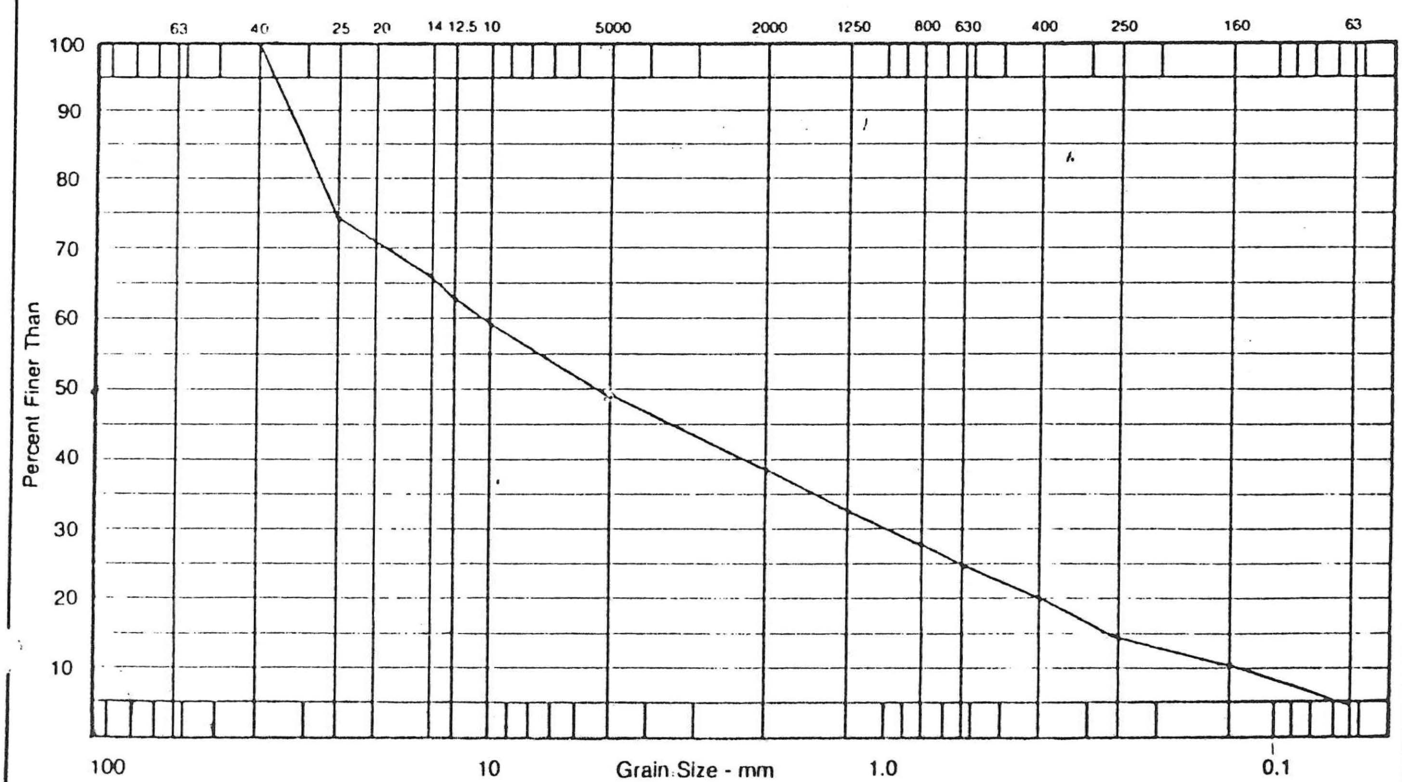
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig Sample
40000	40.0					100.0
25000	25.0					74.8
20000	20.0					71.2
14000	14.0					65.9
12500	12.5					63.0
10000	10.0					59.6
5000	5.0					49.3
2000	2.0					38.7
1250	1.250					32.5
800	0.800					27.5
630	0.630					25.0
400	0.400					20.1
250	0.250					14.8
160	0.160					10.2
63	0.063					4.7

Description of Sample:
85 mm Maximum Size
Sandy Gravel
Non-plastic Fines

Time of Sieving: Min.

Method of Preparation: Dry Washed X

Remarks:
3.5% Natural Moisture
Standard Proctor completed.

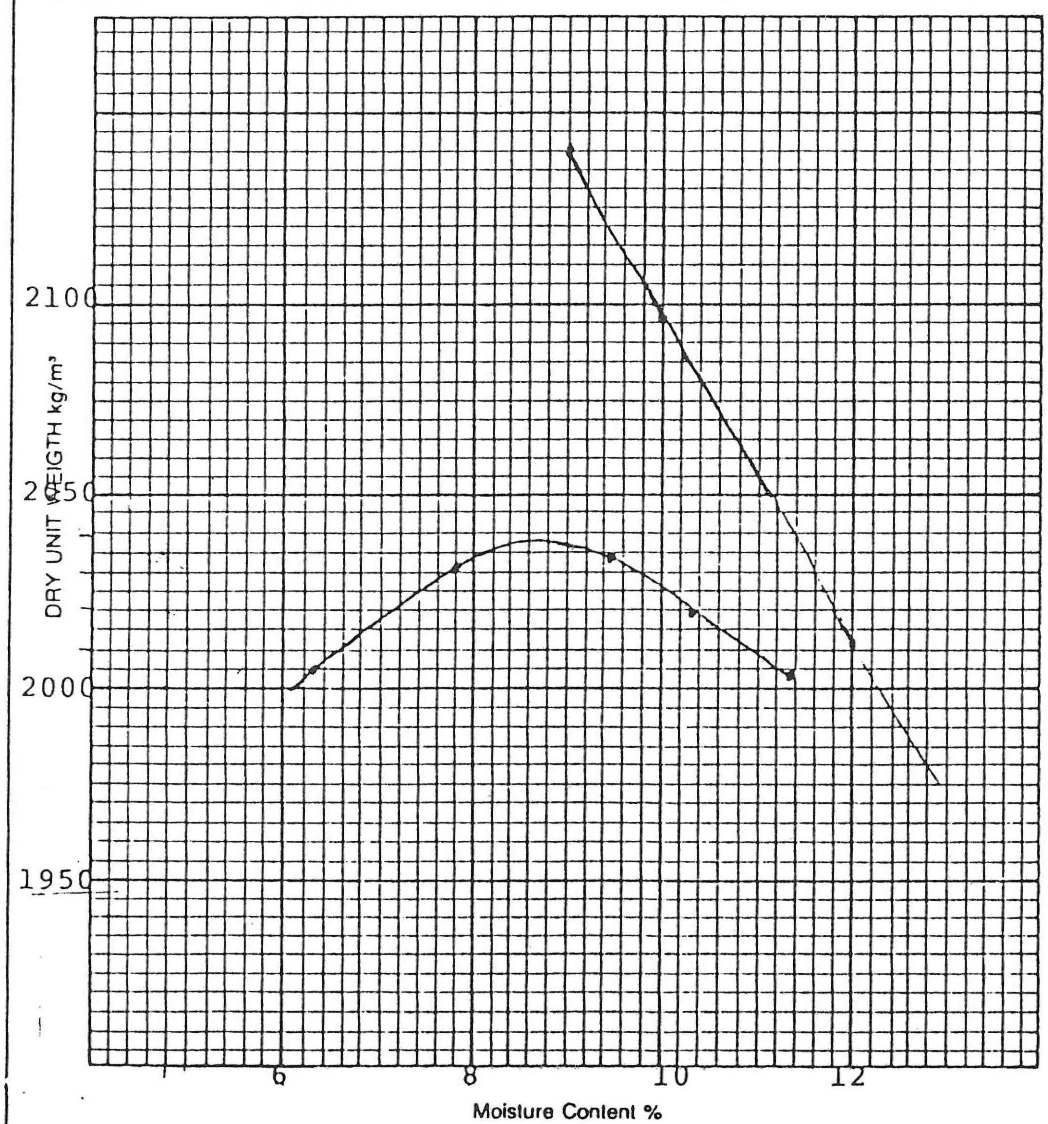


J. R. Paine & Associates Ltd.
CONSULTING AND TESTING ENGINEERS
EDMONTON - GRANDE PRAIRIE - WHITEHORSE

COMPACTION TEST

Project: Dawson City Dike Improvements Client: YTG/ Municipal Engineering
Sample: #3 Depth: ____ Made By: bk Job No.: 8002
Location: Lovet Gulch Ck'd By: ____ Date: 86.04.07

TRIAL NUMBER								
UNIT WEIGHT DETERMINATION	Mold No.							
	Wt. Sample Wet + Mold							
	Wt. Mold							
	Wt. Sample Wet							
	Volume Mold							
	Wet Unit Weight kg/m³							
	Dry Unit Weight kg/m³	6.3	7.8	9.5	10.3	11.4		
MOISTURE CONTENT DETERMINATION	Container No.							
	Wt. Sample Wet + Tare							
	Wt. Sample Dry + Tare							
	Wt. Water							
	Tare Container							
	Wt. Dry Soil							
	Moisture Content	2005	2030	2035	2019	2004		



MAXIMUN UNIT WEIGHT kg/m³
= 2038

OPTIMUM MOIST. CONTENT = 8.9 %

METHOD OF COMPACTION
STANDARD (x)
MODIFIED ( )

SAMPLE DESCRIPTION
Sandy Gravel (19.0mm Max. Size)

REMARKS:
Rock Correction for +19.0mm Aggregate
2134 kg/m³

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: YTG/ Municipal Engineering

Sample: #4 Depth:

Project: Dawson City Dike Improvements

Location: Lovet Gulch

Made by: bk Job. No. 8002

Bonanza Creek

Ck'd by: Date: 86.04.07

Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0					100.0
25000	25.0					87.4
20000	20.0					74.5
14000	14.0					62.3
12500	12.5					59.2
10000	10.0					52.9
5000	5.0					42.0
2000	2.0					31.2
1250	1.250					25.5
800	0.800					21.2
630	0.630					19.0
400	0.400					14.9
250	0.250					10.6
160	0.160					7.0
63	0.063					3.1

Description of Sample

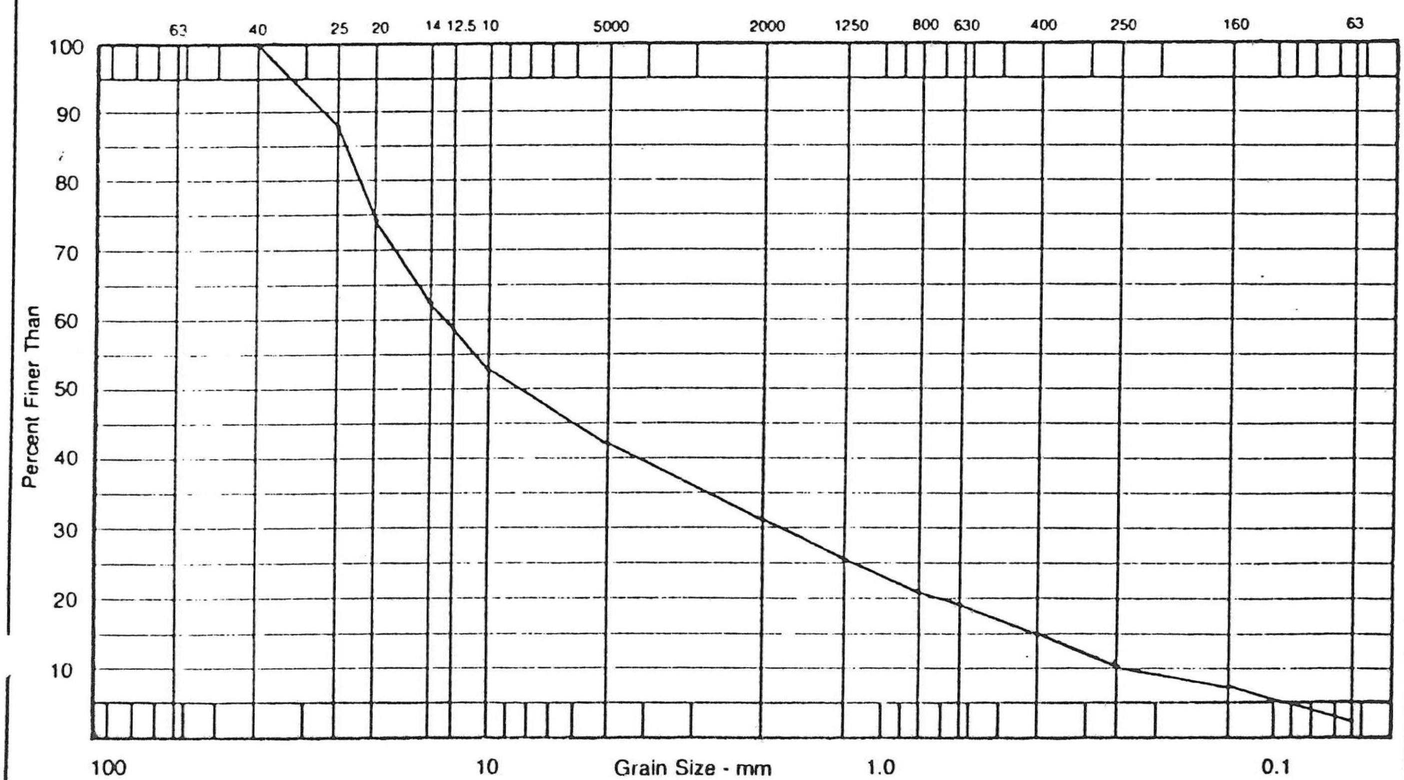
100 mm Maximum Size
Sandy Gravel
Non-plastic Fines

Time of Sieving 15 Min.

Method of Preparation Dry Washed X

Remarks

4.5 % Natural Moisture
Petrographic Analysis completed



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: .... Depth: .... Project: Dawson Dyke

Location: Lovett Gulch White Channel Made by: LK Job. No. 8051

Ck'd by: [illegible] Date: 1986.09.12

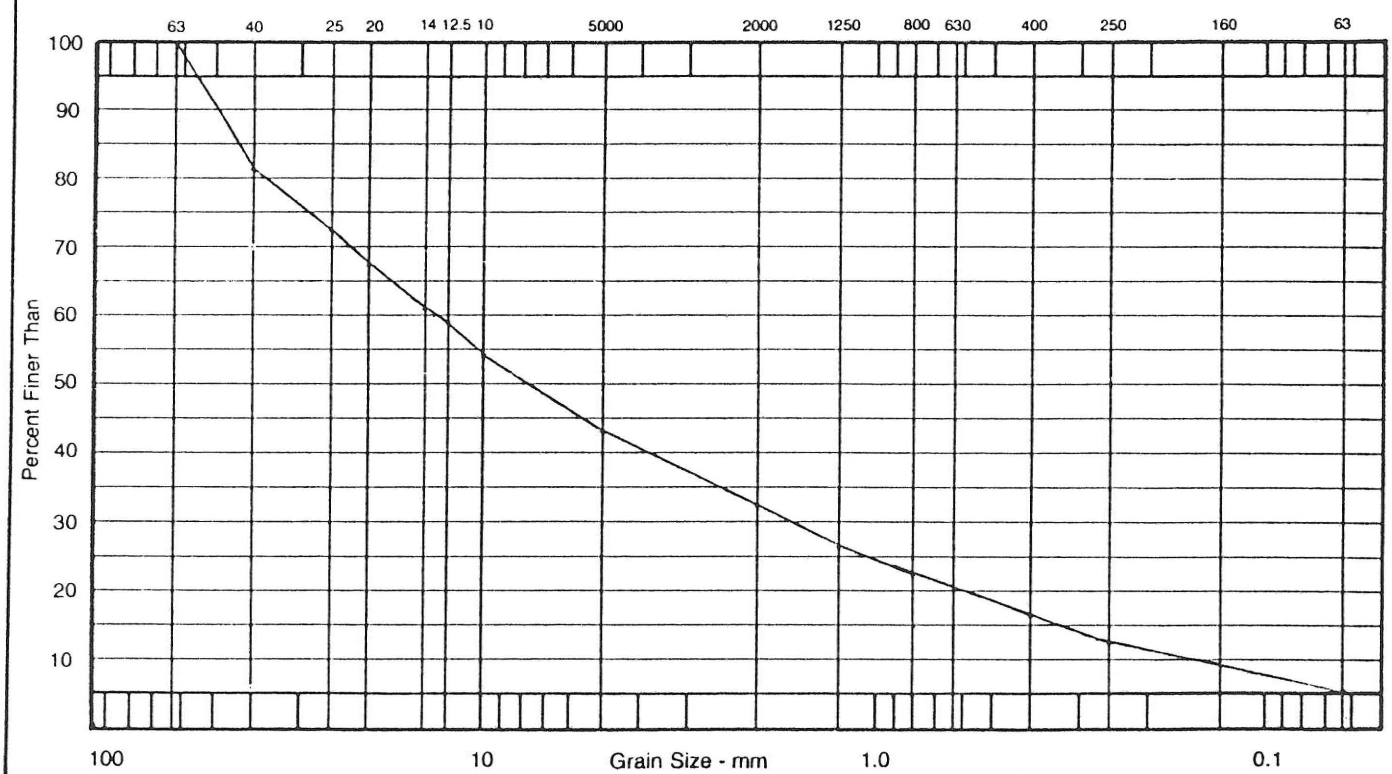
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						100.0
40000	40.0					81.0
25000	25.0					72.4
20000	20.0					67.6
14000	14.0					60.7
12500	12.5					59.0
10000	10.0					54.5
5000	5.0					43.1
2000	2.0					32.3
1250	1.250					26.6
800	0.800					22.5
630	0.630					20.2
400	0.400					16.4
250	0.250					12.7
160	0.160					9.6
63	0.063					5.0

Description of Sample: Sandy Gravel Pit Run

Time of Sieving 15 Min.

Method of Preparation .... Dry .... Washed X

Remarks: Combined Samples #1 and #2



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: #1 Depth:

Project: Dawson Dyke

Location: White Channel

Lovett Gulch

Made by: LK Job. No. 8051

Ck'd by: [signature] Date: 1986.10.03

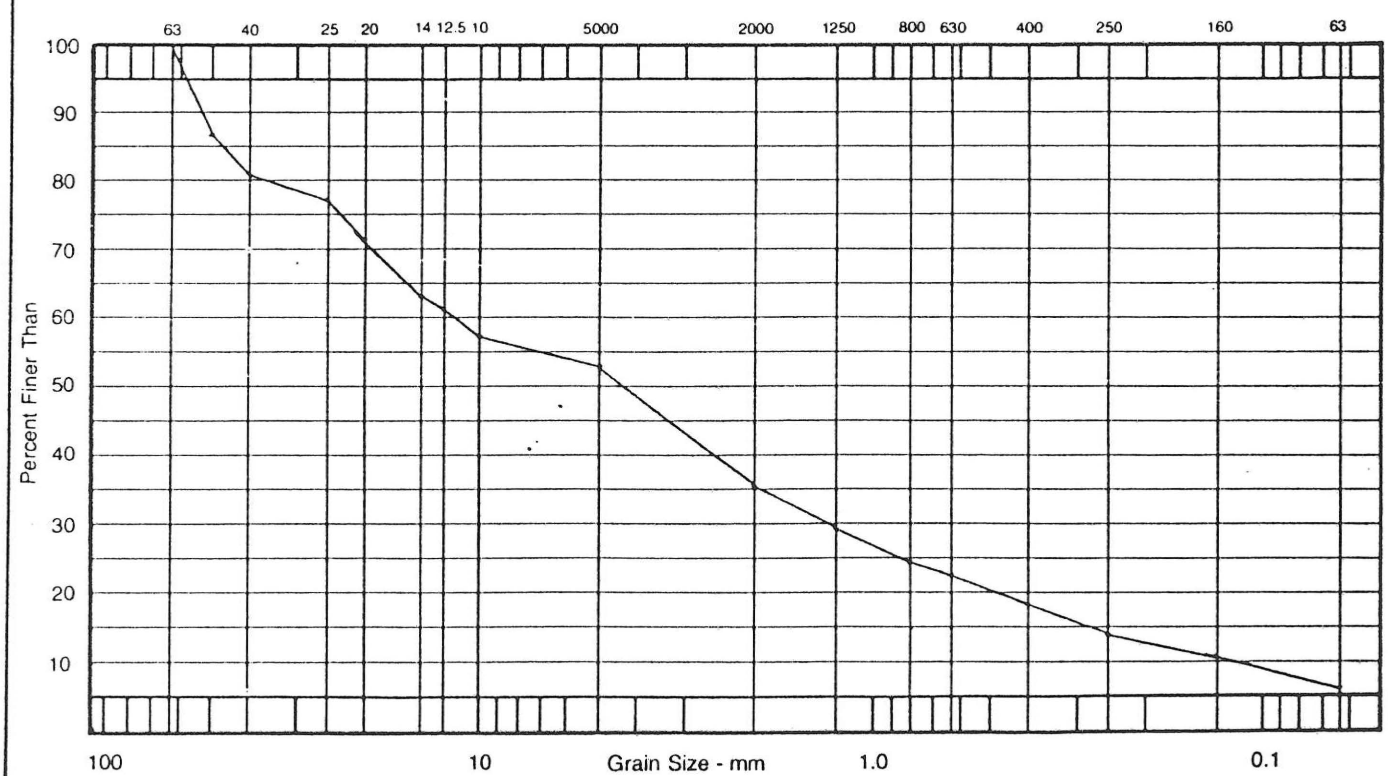
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						86.6
40000	40.0					80.9
25000	25.0					77.1
20000	20.0					71.4
14000	14.0					63.7
12500	12.5					61.9
10000	10.0					57.4
5000	5.0					53.5
2000	2.0					35.4
1250	1.250					29.4
800	0.800					24.8
630	0.630					22.5
400	0.400					18.3
250	0.250					14.1
160	0.160					10.5
63	0.063					5.3

Description of Sample: Sandy Gravel, Trace of Silt

Time of Sieving: Min. 15

Method of Preparation: Dry ...... Washed X

Remarks: Moisture Content 2.5%
100% Passing the 63.0mm Screen
Lovett Gulch Moisture Content 4.4%
Sandy Gravel Trace Silt

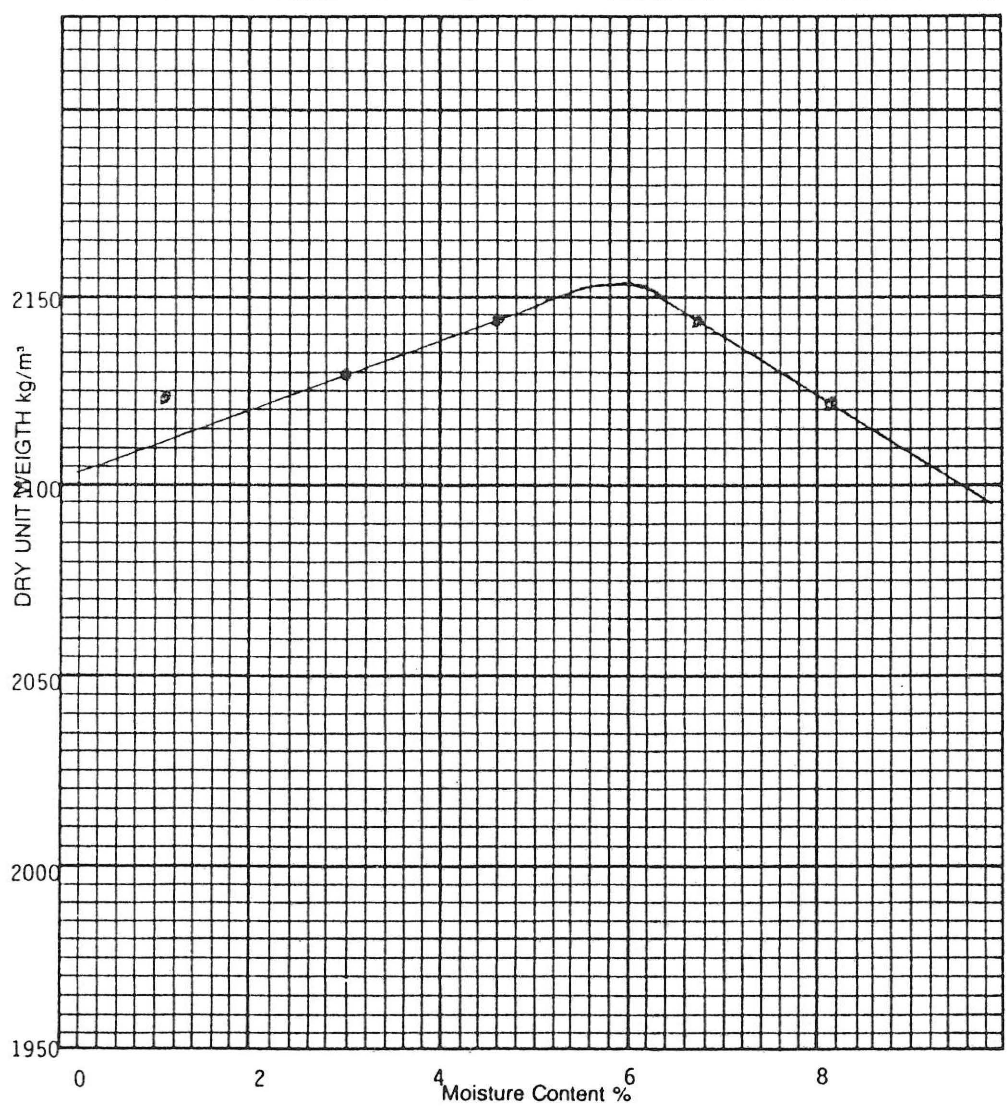


J. R. Paine & Associates Ltd.
CONSULTING AND TESTING ENGINEERS
EDMONTON - GRANDE PRAIRIE - WHITEHORSE

COMPACTION TEST

Project: Dawson Dyke — Client: Klohn Leonoff
Sample: #1 — Depth: — Made By: LK — Job No.: 8051
Location: White Channel Lovett Gulch — Ck'd By: — Date: 1986.10.06

TRIAL NUMBER		1	2	3	4	5		
UNIT WEIGHT DETERMINATION	Mold No.							
	Wt. Sample Wet + Mold							
	Wt. Mold							
	Wt. Sample Wet							
	Volume Mold							
	Wet Unit Weight kg/m³							
	Dry Unit Weight kg/m³	2124	2128	2143	2143	2121		
MOISTURE CONTENT DETERMINATION	Container No.							
	Wt. Sample Wet + Tare							
	Wt. Sample Dry + Tare							
	Wt. Water							
	Tare Container							
	Wt. Dry Soil							
	Moisture Content	1.1	3.0	4.6	6.7	8.1		



MAXIMUN UNIT WEIGHT kg/m³ = 2153

OPTIMUM MOIST. CONTENT = 5.9 %

METHOD OF COMPACTION
STANDARD ( )
MODIFIED (x)

SAMPLE DESCRIPTION
Sandy Gravel, Trace Silt

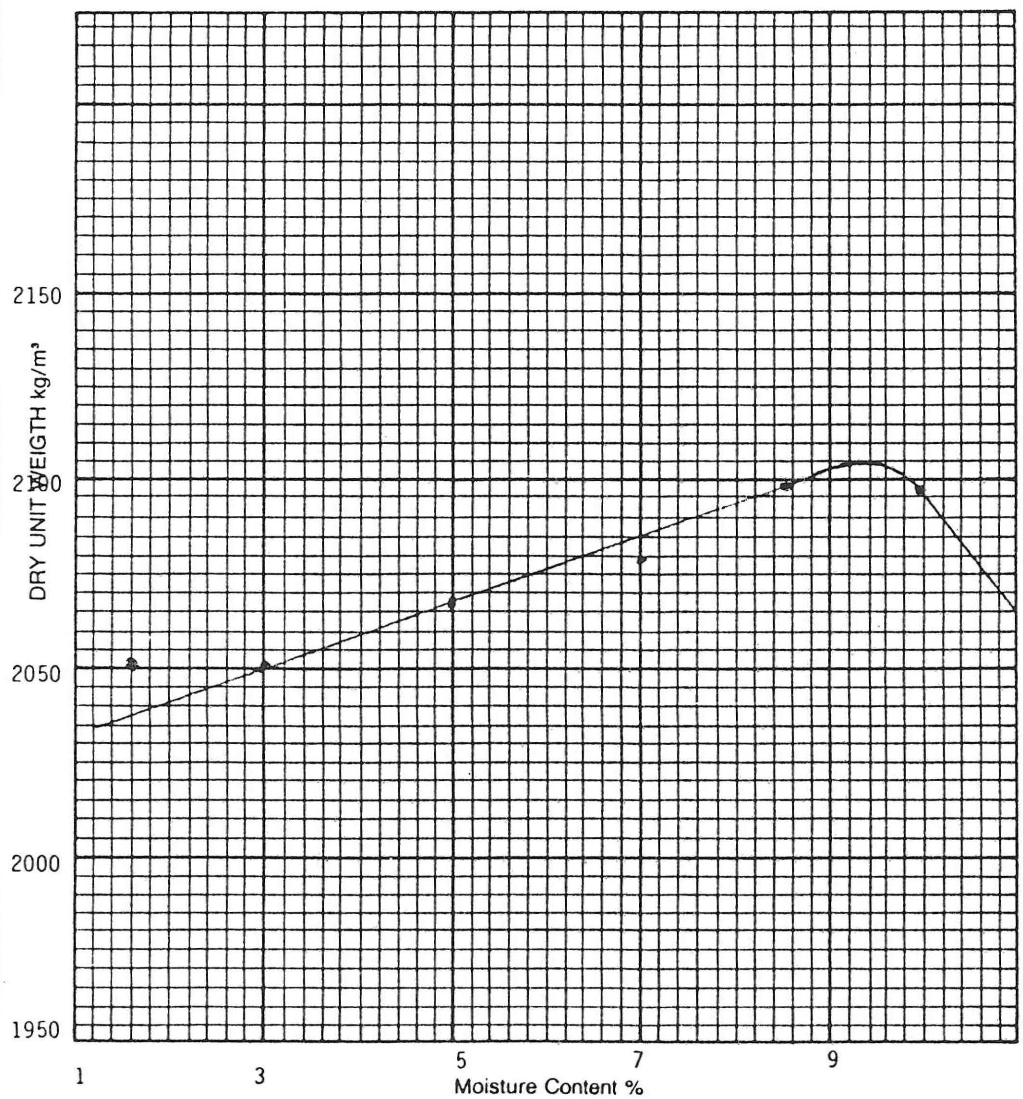
REMARKS:
Sample Rock Corrected for -50mm and +20mm
Free Water
Sample #5

J. R. Paine & Associates Ltd.
CONSULTING AND TESTING ENGINEERS
EDMONTON - GRANDE PRAIRIE - WHITEHORSE

COMPACTION TEST

Project: Dawson Dyke Client: Klohn Leonoff
Sample: #2 Depth: Made By: LK Job No.: 8051
Location: White Channel Lovett Butch Ck'd By: Date: 1986.10.07

	TRIAL NUMBER	1	2	3	4	5	6	
UNIT WEIGHT DETERMINATION	Mold No.							
	Wt. Sample Wet + Mold							
	Wt. Mold							
	Wt. Sample Wet							
	Volume Mold							
	Wet Unit Weight kg/m³							
	Dry Unit Weight kg/m³	2051	2052	2067	2080	2098	2099	
MOISTURE CONTENT DETERMINATION	Container No.							
	Wt. Sample Wet + Tare							
	Wt. Sample Dry + Tare							
	Wt. Water							
	Tare Container							
	Wt. Dry Soil							
	Moisture Content	1.1	3.0	4.9	7.0	8.5	9.9	



MAXIMUN UNIT WEIGHT kg/m³ = 2104

OPTIMUM MOIST. CONTENT = 9.4 %

METHOD OF COMPACTION
STANDARD (x)
MODIFIED ( )

SAMPLE DESCRIPTION
Sandy Gravel, Trace Silt

REMARKS:
Rock Corrected for Aggregate between -50mm and +20mm

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn-Leonoff

Sample: 1 of 1 Depth:

Project: Dawson City Dyke

Location: TP #2 White Channel Jackson Hill Borrow Pit

Made by: LK Job. No. 8051

Ck'd by: Date: 1987.02.02

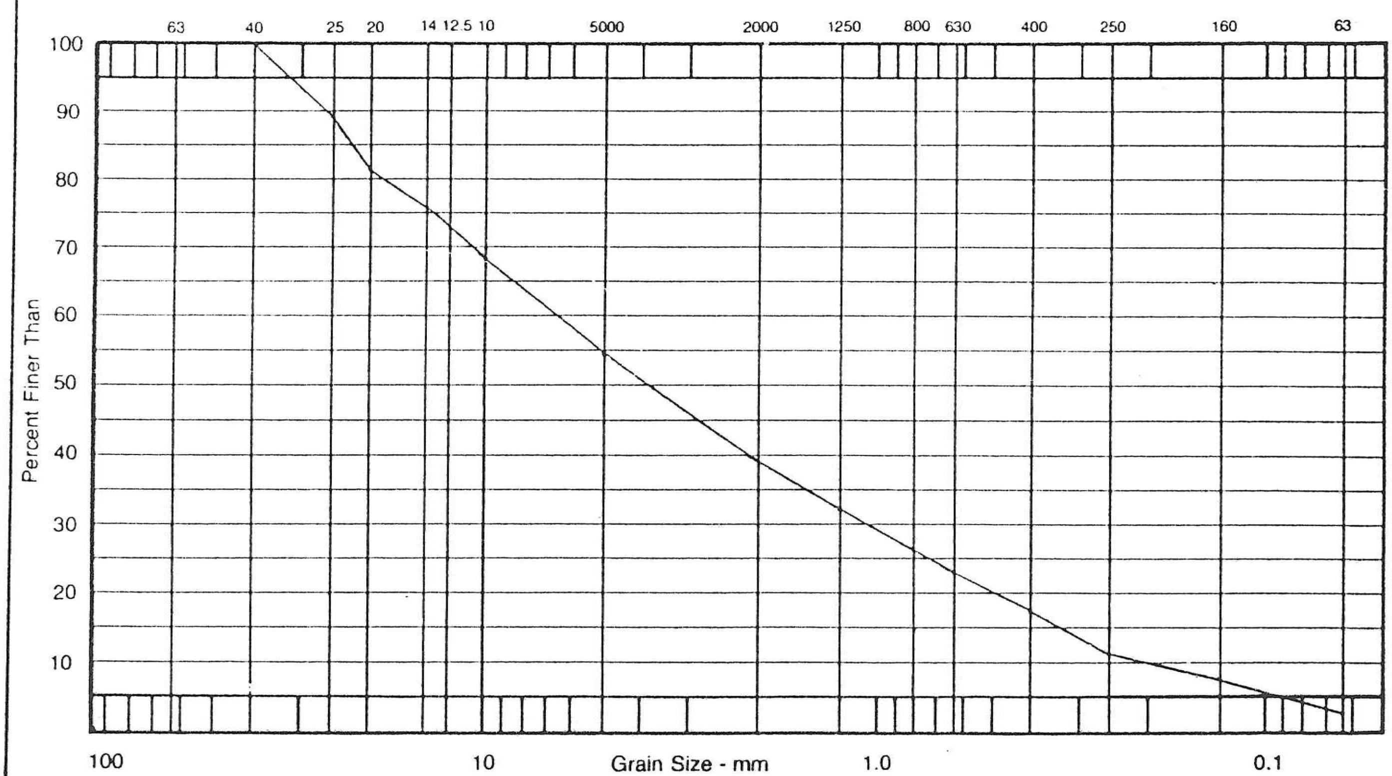
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						100.0
40000	40.0					95.2
25000	25.0					89.7
20000	20.0					81.5
14000	14.0					75.7
12500	12.5					73.7
10000	10.0					68.6
5000	5.0					54.9
2000	2.0					39.6
1250	1.250					32.0
800	0.800					26.2
630	0.630					23.2
400	0.400					17.5
250	0.250					11.8
160	0.160					7.4
63	0.063					2.9

Description of Sample Gravelly Sand

Time of Sieving Min. 15

Method of Preparation Dry Washed X

Remarks Moisture Content 2.7%



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CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn-Leonoff
Sample: 1,2,3 Depth: Project: Dawson City Dyke
Location: TP #1 Made by: LK Job. No. 8051
Jackson Hill Borrow Pit Ck'd by: [illegible] Date: 1987.02.02

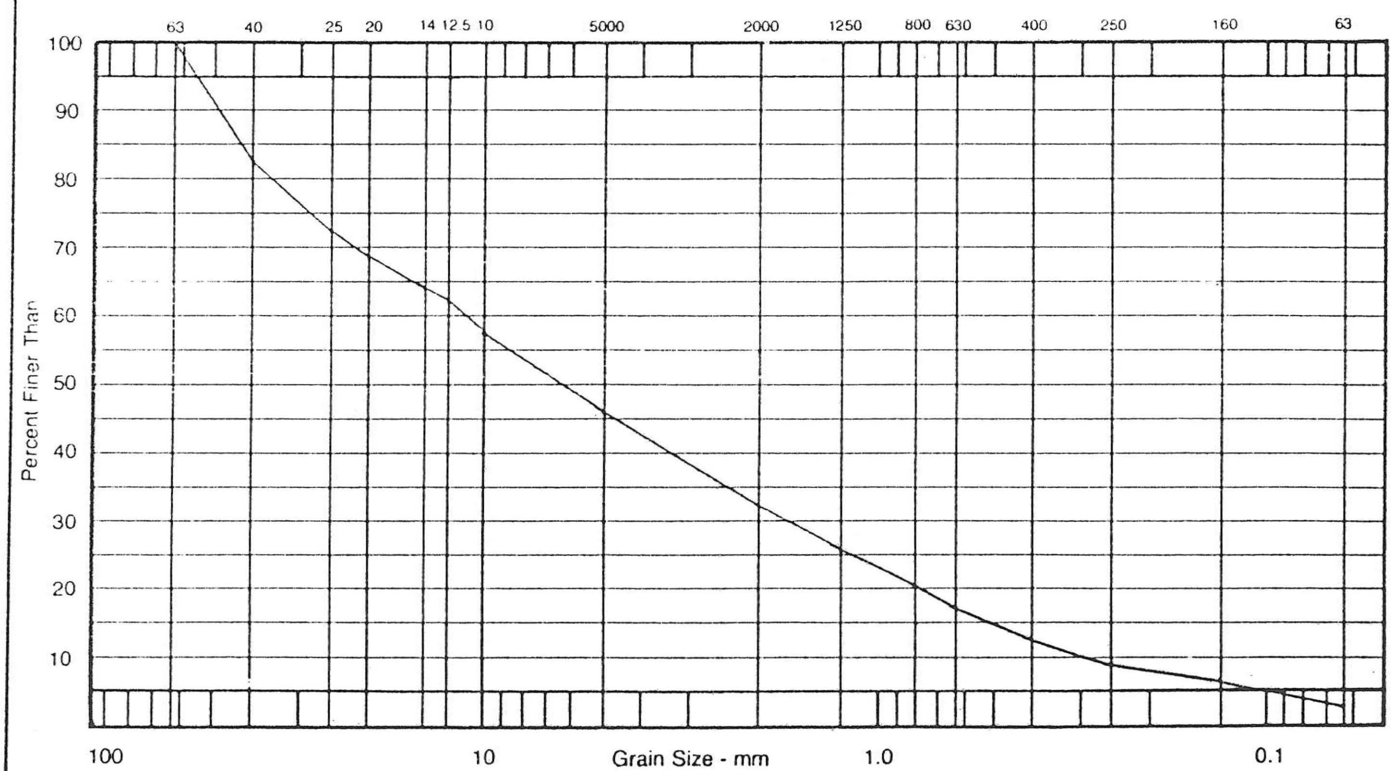
Sieve No	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
						100.0
40000	40.0					82.3
25000	25.0					72.7
20000	20.0					68.8
14000	14.0					64.4
12500	12.5					62.2
10000	10.0					57.7
5000	5.0					45.3
2000	2.0					32.0
1250	1.250					25.2
800	0.800					20.1
630	0.630					17.7
400	0.400					13.5
250	0.250					9.5
160	0.160					6.3
63	0.063					2.6

Description of Sample: Sandy Gravel

Time of Sieving: Min. 15

Method of Preparation: Dry Washed X

Remarks: TP #1 Samples 1,2,3 Combined
Moisture Content Sample #1 2.0%
Moisture Content Sample #2 2.7%
Moisture Content Sample #3 2.5%



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CONSULTING AND TESTING ENGINEERS

EDMONTON · GRANDE PRAIRIE · WHITEHORSE

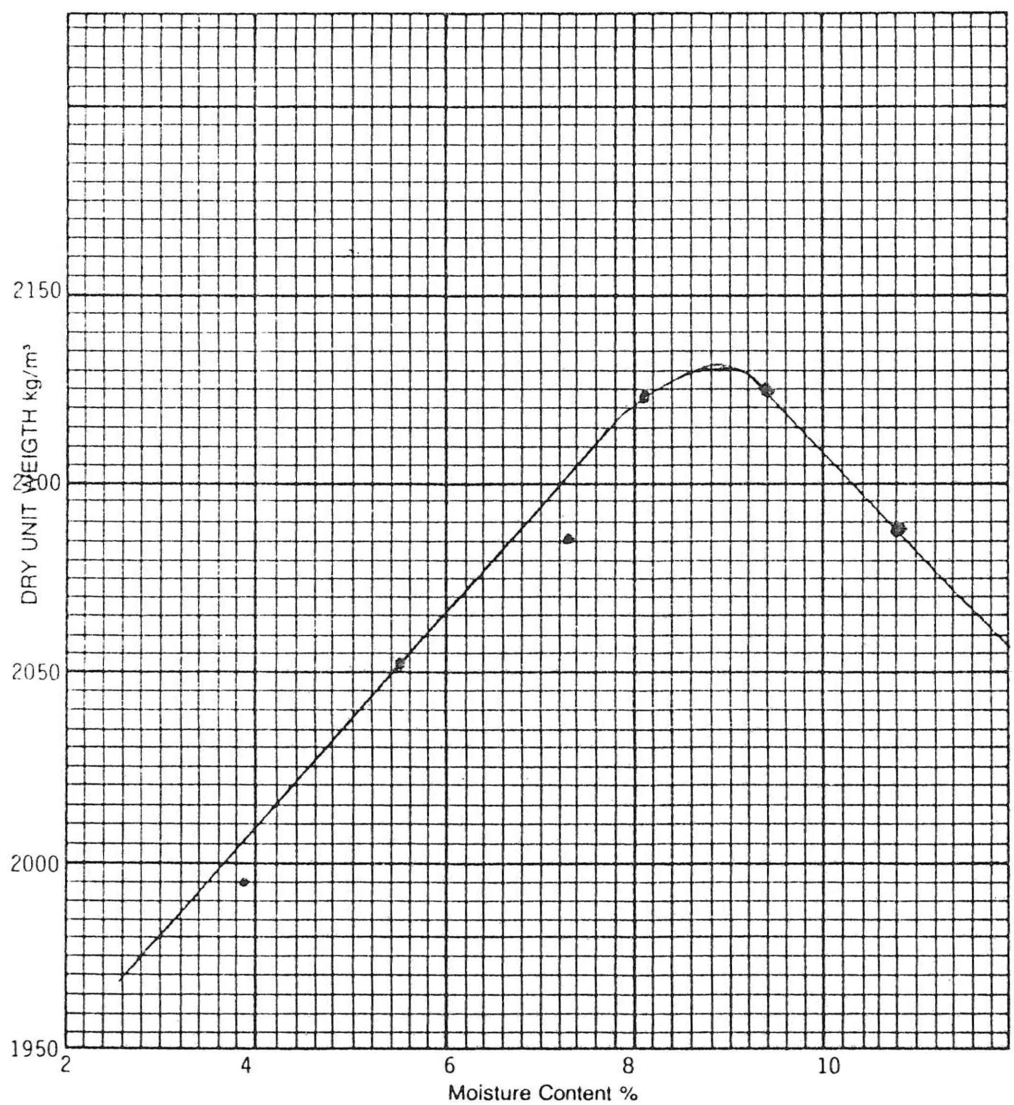
COMPACTION TEST

Project: Dawson City Dyke — Client: Klohn-Leonoff

Sample: TP#1, Sam. 1,2,3 — Depth: — Made By: LK — Job No.: 8051

Location: White Channel Jackson Hill — Ck'd By: — Date: 1987.02.03

	TRIAL NUMBER	1	2	3	4	5	6	
UNIT WEIGHT DETERMINATION	Mold No.							
	Wt. Sample Wet + Mold							
	Wt. Mold							
	Wt. Sample Wet							
	Volume Mold							
	Wet Unit Weight kg/m³							
	Dry Unit Weight kg/m³	1995	2052	2086	2123	2125	2089	
MOISTURE CONTENT DETERMINATION	Container No.							
	Wt. Sample Wet + Tare							
	Wt. Sample Dry + Tare							
	Wt. Water							
	Tare Container							
	Wt. Dry Soil							
	Moisture Content	3.9	5.5	7.3	8.1	9.4	10.8	



MAXIMUN UNIT WEIGHT kg/m³ = 2132

OPTIMUM MOIST. CONTENT = 8.9 %

METHOD OF COMPACTION

STANDARD (X)

MODIFIED ( )

SAMPLE DESCRIPTION

Sandy Gravel

REMARKS:

Rock Corrected for +20mm material

Free Water in Samples 5 and 6

J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: A Depth:

Project: Dawson Dykes

Location: Klondike River Bars

Made by: LK Job. No. 8001

Ck'd by: [signature] Date: 1987.01.21

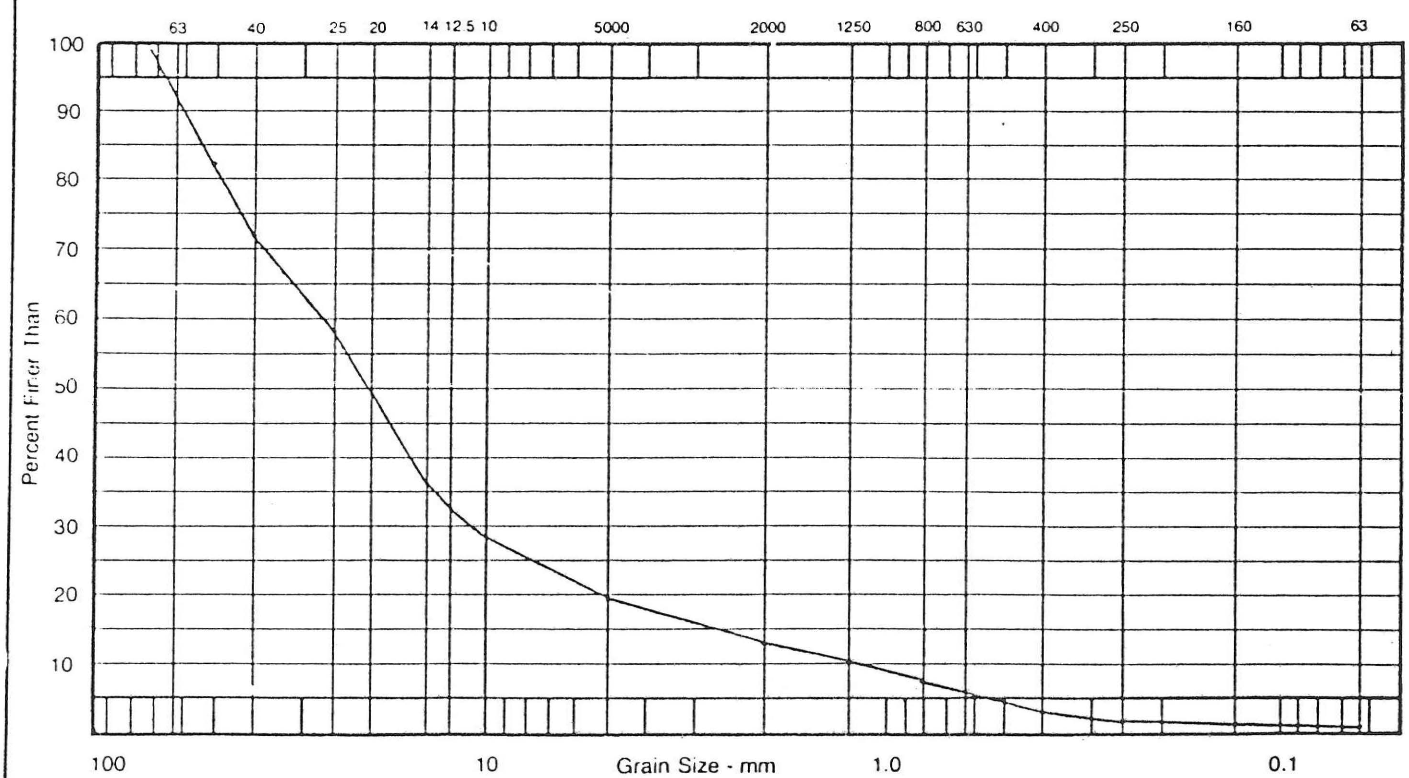
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
						82.7
40000	40.0					72.0
25000	25.0					58.5
20000	20.0					49.9
14000	14.0					36.9
12500	12.5					33.6
10000	10.0					28.9
5000	5.0					19.8
2000	2.0					13.0
1250	1.250					10.1
800	0.800					7.5
630	0.630					5.9
400	0.400					3.1
250	0.250					1.4
160	0.160					0.9
63	0.063					0.5

Description of Sample: Coarse Sandy Gravel

Time of Sieving: Min. 15

Method of Preparation: Dry Washed X

Remarks: 100% Passing 75mm



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: B Depth: Project: Dawson Dyke

Location: Klondike River Bars Made by: LK Job. No. 8001

Ck'd by: Date: 1987.01.21

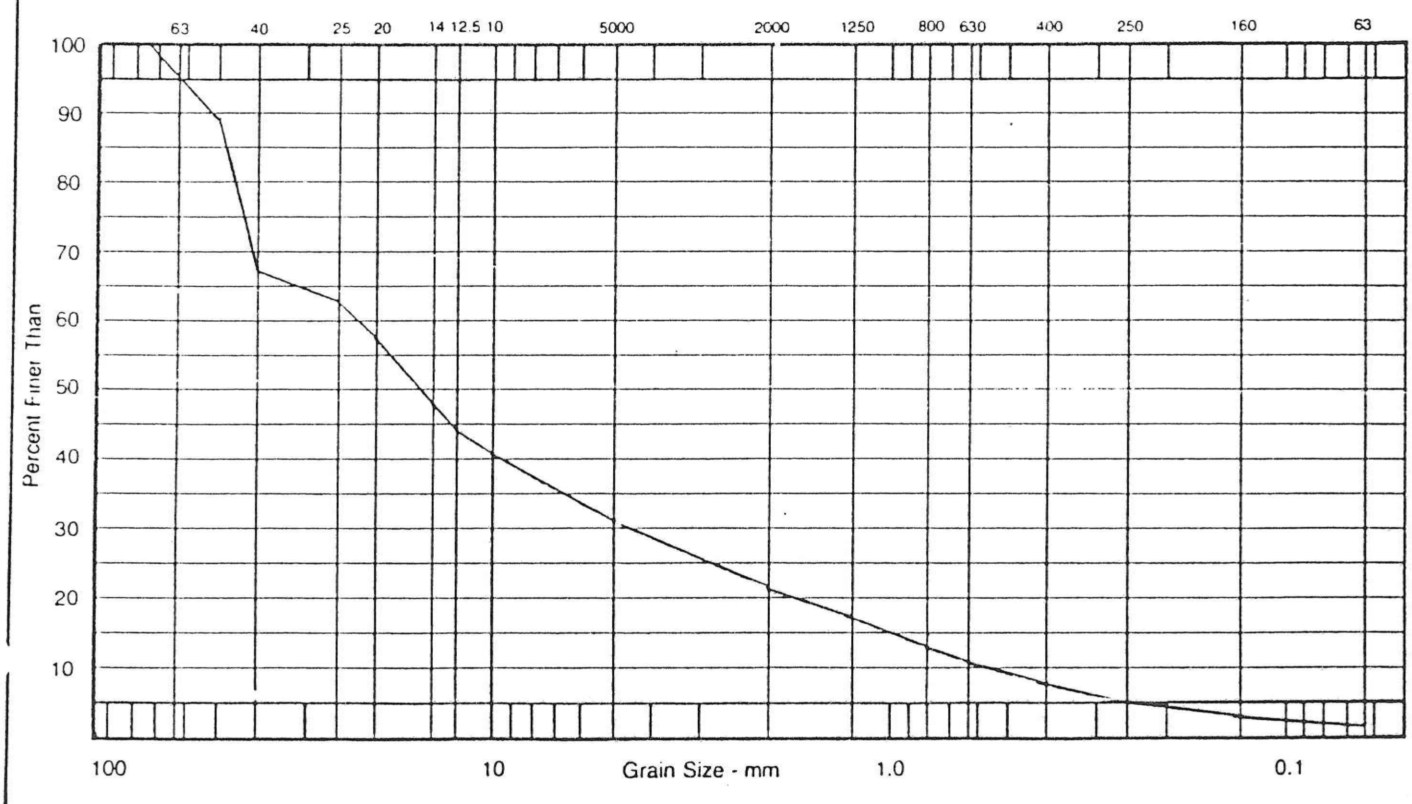
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
						89.4
40000	40.0					67.6
25000	25.0					63.0
20000	20.0					57.4
14000	14.0					47.3
12500	12.5					44.4
10000	10.0					40.3
5000	5.0					30.8
2000	2.0					21.6
1250	1.250					17.2
800	0.800					13.3
630	0.630					11.1
400	0.400					7.4
250	0.250					5.0
160	0.160					3.5
63	0.063					1.8

Description of Sample Sandy Gravel

Method of Preparation Dry Washed X

Remarks 100% Passing 75mm

Time of Sieving Min. 15



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: C Depth:

Project: Dawson Dyke

Location: Klondike River Bars

Made by: LK Job. No. 8001

Ck'd by: [signature] Date: 1987.01.21

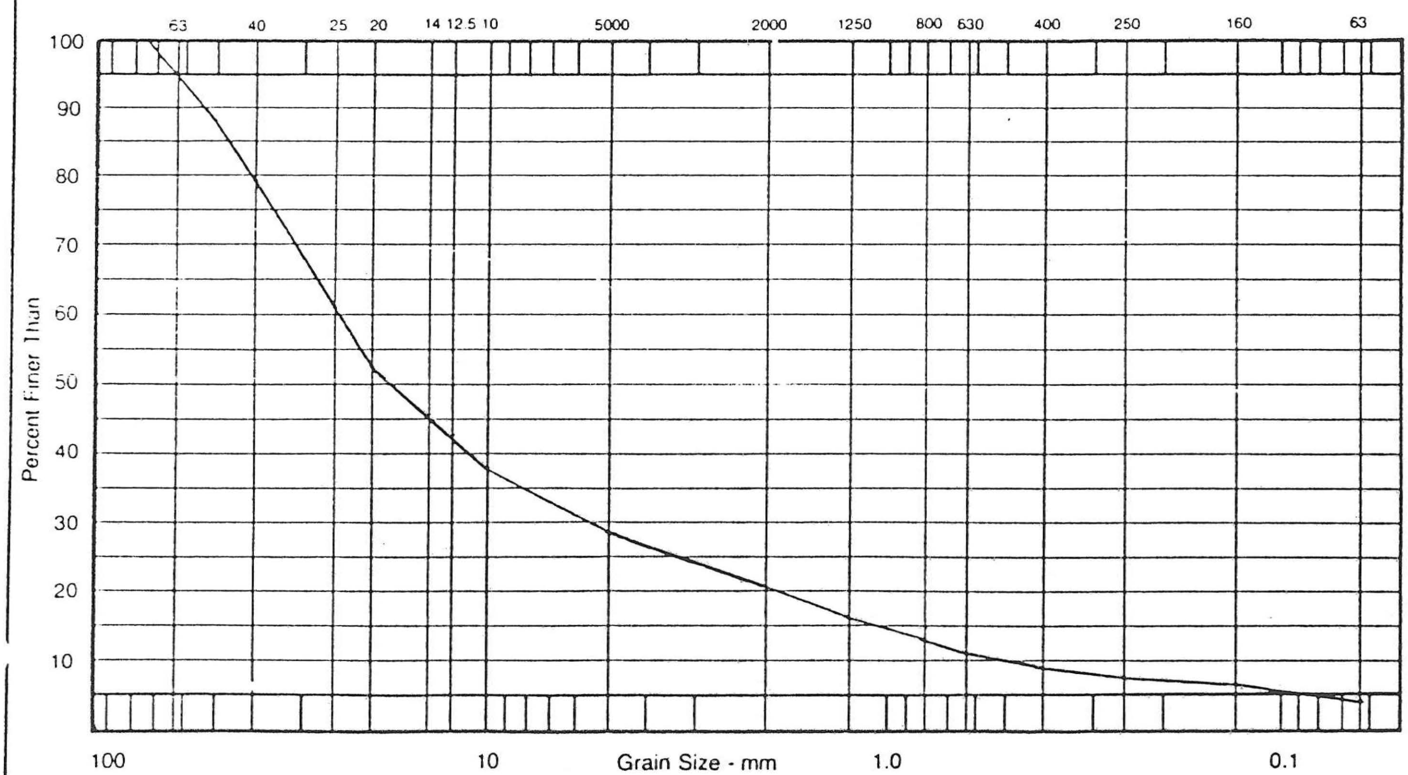
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
						88.0
40000	40.0					79.4
25000	25.0					60.8
20000	20.0					52.1
14000	14.0					45.2
12500	12.5					42.5
10000	10.0					38.7
5000	5.0					28.3
2000	2.0					20.1
1250	1.250					16.6
800	0.800					13.5
630	0.630					11.7
400	0.400					9.0
250	0.250					7.3
160	0.160					6.1
63	0.063					4.4

Description of Sample: Sandy Gravel

Method of Preparation: Dry Washed X

Remarks: 100% Passing 75mm

Time of Sieving Min. 15



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Yukon

GEOTECHNICAL SERVICES

HIGHWAYS & TRANSPORTATION

CONTRACT NO.	PROJECT LOCATION OR PIT NO.	SAMPLED FROM	DATE
	RIVER GRAVEL	TEST #1	NOV 9/86

CONTRACTOR	AGGREGATE TYPE	TIME	LAB NO.
26488	100% Gravel Surface Base Course		

6" 4646 21842 ~~4646~~ 82.5%

SIEVE	WT. RETAINED	~~% RETAINED~~	% PASSING
80.0 mm	3351	18491	69.8%
50.0 mm			
25.0 mm			
20.0 mm	7385	11106	41.9%
12.5 mm	2227	8879	33.5
10.0 mm			
5.0 mm	3175	5704	21.5
2.5 mm	1345	4359	16.5
1.25 mm	940	3419	12.9
.630 mm		~~341~~	
.315 mm	1915	1504	5.7
.160 mm			
.080 mm	976	528	2.0
PAN	528		

WT. WET AGGREGATE + TARE

WT. DRY AGGREGATE + TARE

TARE WT.

WT. DRY AGGREGATE

WT. MOISTURE

% MOISTURE

WT. FRACTURED PARTICLES

WT. RETAINED ON 5000

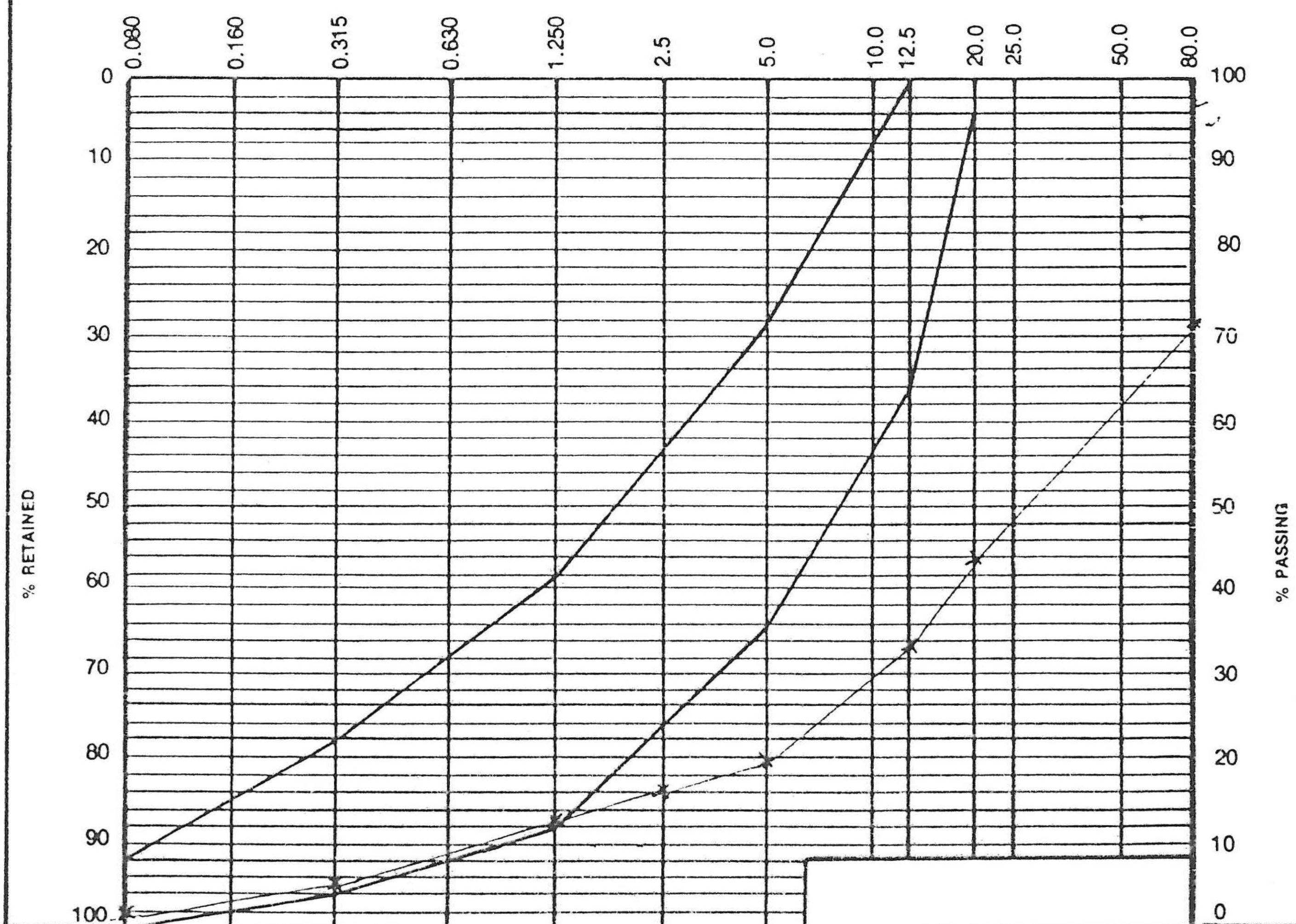
% FRACTURED FACES

LIQUID LIMIT

PLASTIC LIMIT

PLASTICITY INDEX

REMARKS SAMPLE FROM WHEAT TEST ON COARSE RIVER GRAVEL.



YG (2605) NC4

1st COPY WHITEHORSE OFFICE 3rd COPY LAB
2nd COPY RESIDENT 4th COPY CONTRACTOR

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GEOTECHNICAL SERVICES

HIGHWAYS & TRANSPORTATION

CONTRACT NO.	PROJECT LOCATION OR PIT NO.	SAMPLED FROM	DATE
	RIVER GRAVEL	TEST #2	NOV 9/86

CONTRACTOR	AGGREGATE TYPE	TIME	LAB NO.
	Gravel Surface Base Course		

SIEVE	WT. RETAINED	~~% RETAINED~~	% PASSING	
		10852	100.0	
80.0 mm	1314	9538	87.9	3"
50.0 mm	1338	8200	75.6	2"
25.0 mm				1"
20.0 mm	2731	5269	48.6	3/4"
12.5 mm	1049	4220	38.9	1/2"
10.0 mm				0.4" 3/8 #4
5.0 mm	1423	2797	25.8	0.2" #10
2.5 mm	588	2209	20.4	0.1" #10
1.25 mm	418	1791	16.5	
.630 mm				
.315 mm	1047	742	6.8	
.160 mm	~~502~~			
.080 mm	~~502 240~~ 240	240	2.2	

WT. WET AGGREGATE + TARE ______

WT. DRY AGGREGATE + TARE ______

TARE WT. ______

WT. DRY AGGREGATE ______

WT. MOISTURE ______

% MOISTURE ______

WT. FRACTURED PARTICLES ______

WT. RETAINED ON 5000 ______

% FRACTURED FACES ______

LIQUID LIMIT ______

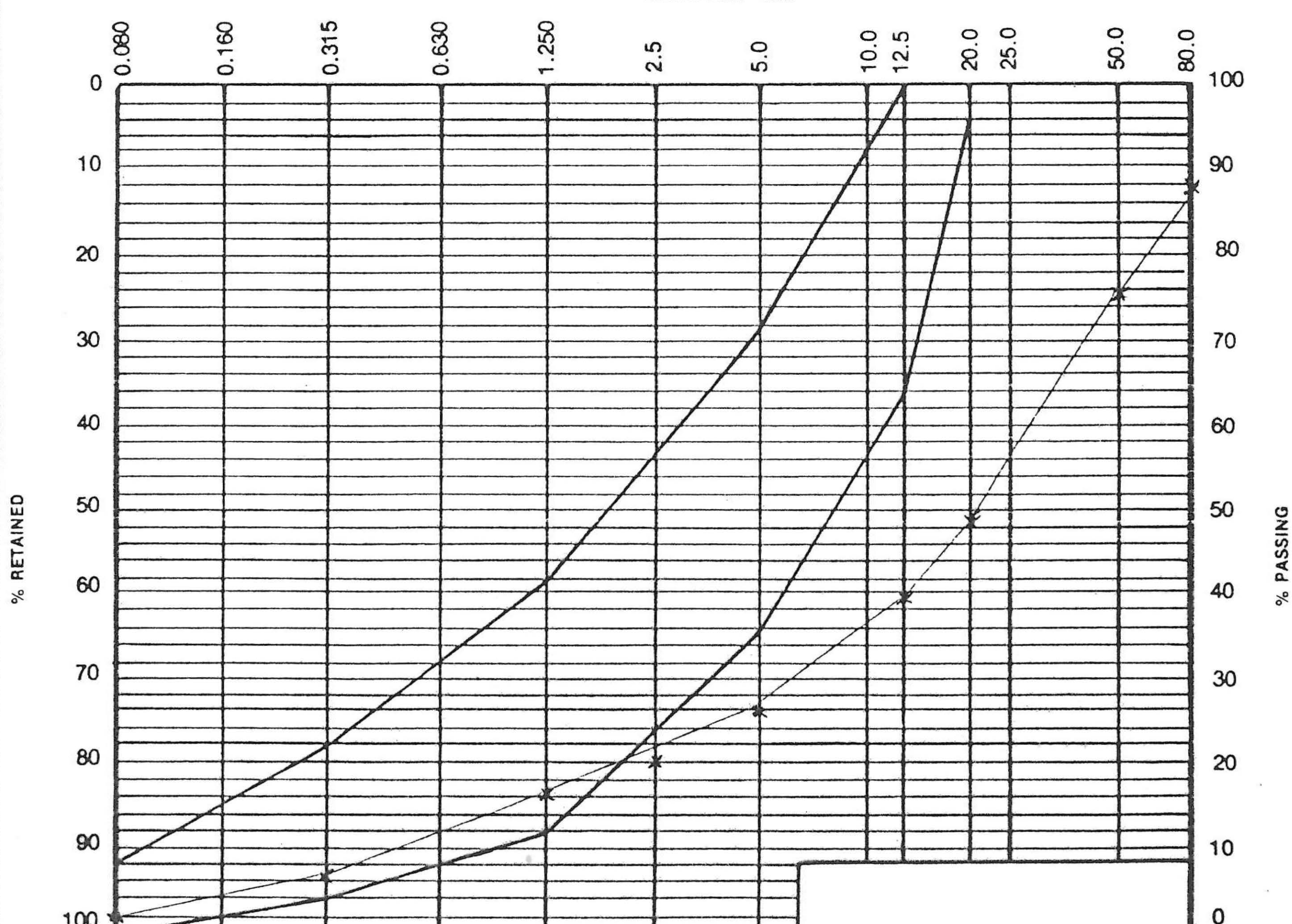
PLASTIC LIMIT ______

PLASTICITY INDEX ______

REMARKS SAMPLE FROM WHEAT

TEST ON COARSE RIVER

GRAVEL



YG [2605] NC4

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2nd COPY RESIDENT 4th COPY CONTRACTOR

Yukon

GEOTECHNICAL SERVICES

HIGHWAYS & TRANSPORTATION

CONTRACT NO.	PROJECT LOCATION OR PIT NO.	SAMPLED FROM	DATE
	RIVER GRAVELS 0+750	RIVER BAR	86-10-19

CONTRACTOR	AGGREGATE TYPE	TIME	LAB NO.
LOCAL EQUIPMENT.	Pit Run Base Course	1100	

SIEVE	WT. RETAINED	% RETAINED	% PASSING
80.0 mm			
50.0 mm			
25.0 mm			
20.0 mm			
12.5 mm	712	41.3	58.7
10.0 mm			
5.0 mm	1070	62.1	37.9
2.5 mm	1207	70.1	29.9
1.25 mm	1315	76.3	23.7
.630 mm			
.315 mm	1590	92.3	7.7
.160 mm			
.080 mm	1692	98.2	1.8

WT. WET AGGREGATE + TARE 2230

WT. DRY AGGREGATE + TARE 2180

TARE WT. N457

WT. DRY AGGREGATE 1723

WT. MOISTURE 50

% MOISTURE 2.8

WT. FRACTURED PARTICLES

WT. RETAINED ON 5000

% FRACTURED FACES

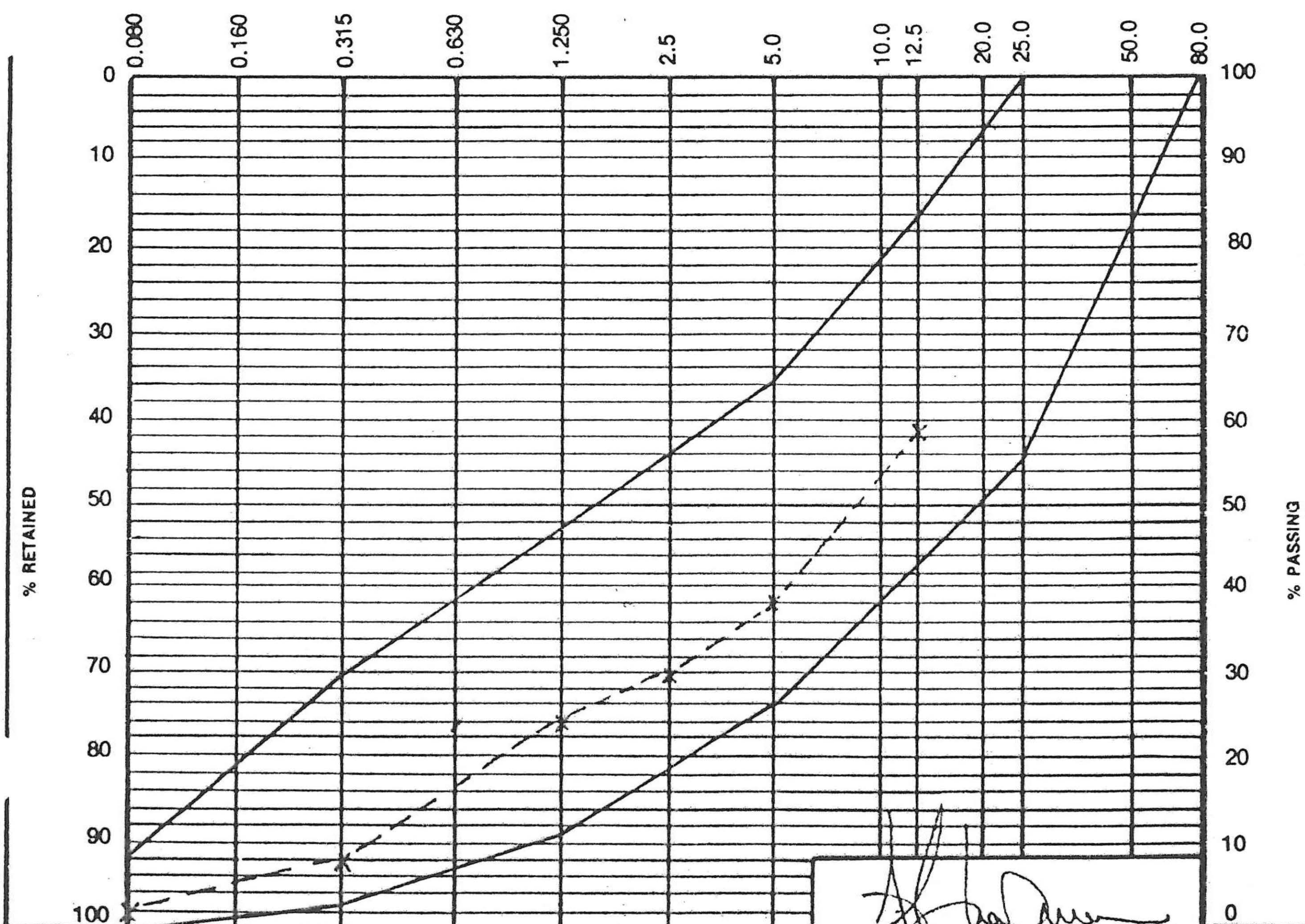
LIQUID LIMIT

PLASTIC LIMIT

PLASTICITY INDEX

REMARKS

SIEVE SIZE - mm



YG [2606] NC4

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J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: .... Depth: .... Project: Dawson Dyke

Location: West Dawson Dept. of Highway Pit Made by: LK Job. No. 8051

Ck'd by: [illegible] Date: 1986.09.12

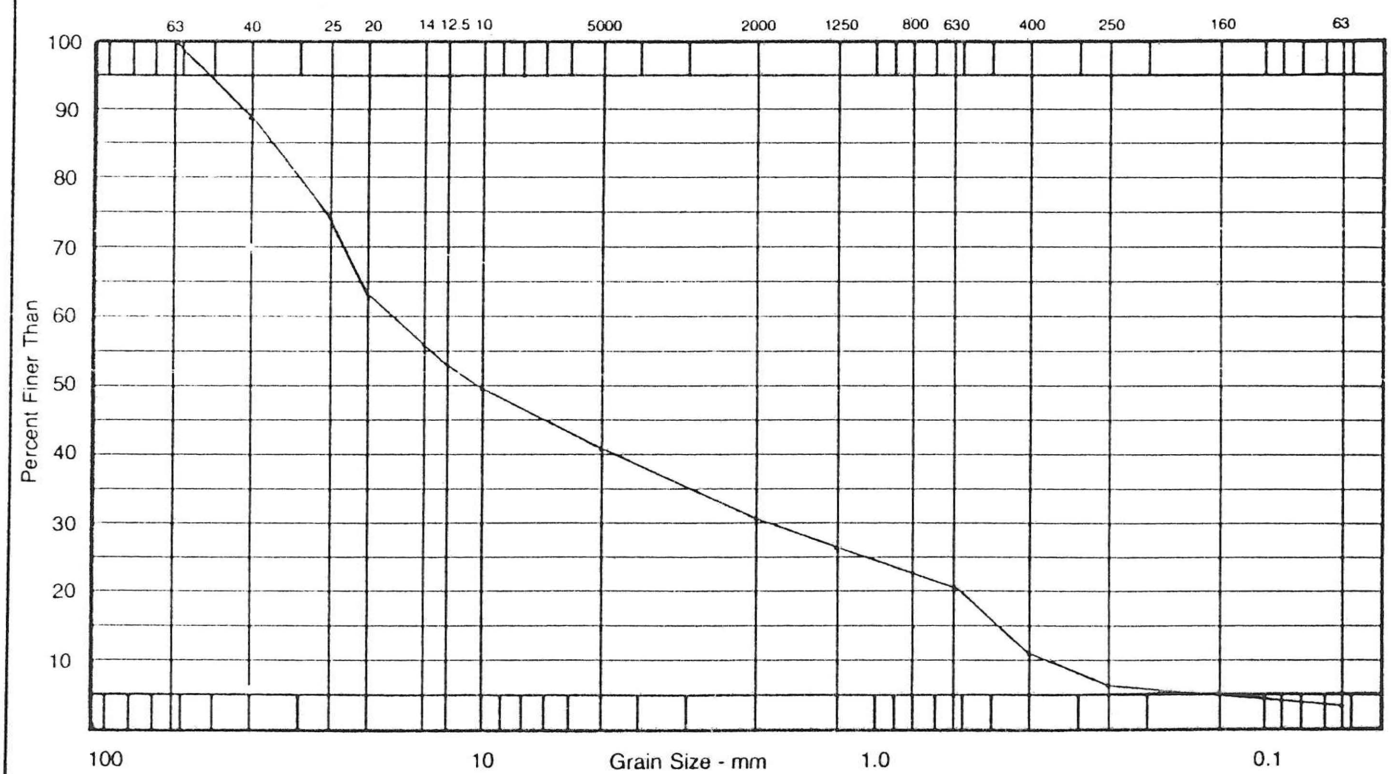
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						100.0
40000	40.0					89.0
25000	25.0					74.8
20000	20.0					63.7
14000	14.0					55.6
12500	12.5					53.3
10000	10.0					49.9
5000	5.0					40.3
2000	2.0					30.5
1250	1.250					26.4
800	0.800					23.6
630	0.630					20.5
400	0.400					10.8
250	0.250					6.6
160	0.160					5.0
63	0.063					3.0

Description of Sample: Sandy Gravel Pit Run

Time of Sieving: 15 Min.

Method of Preparation .... Dry .... Washed X

Remarks ....



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn Leonoff

Sample: .... Depth: .... Project: Dawson Dyke

Location: Dome Road Made by: LK Job. No. 8051

Ck'd by: [illegible] Date: 1986.09.12

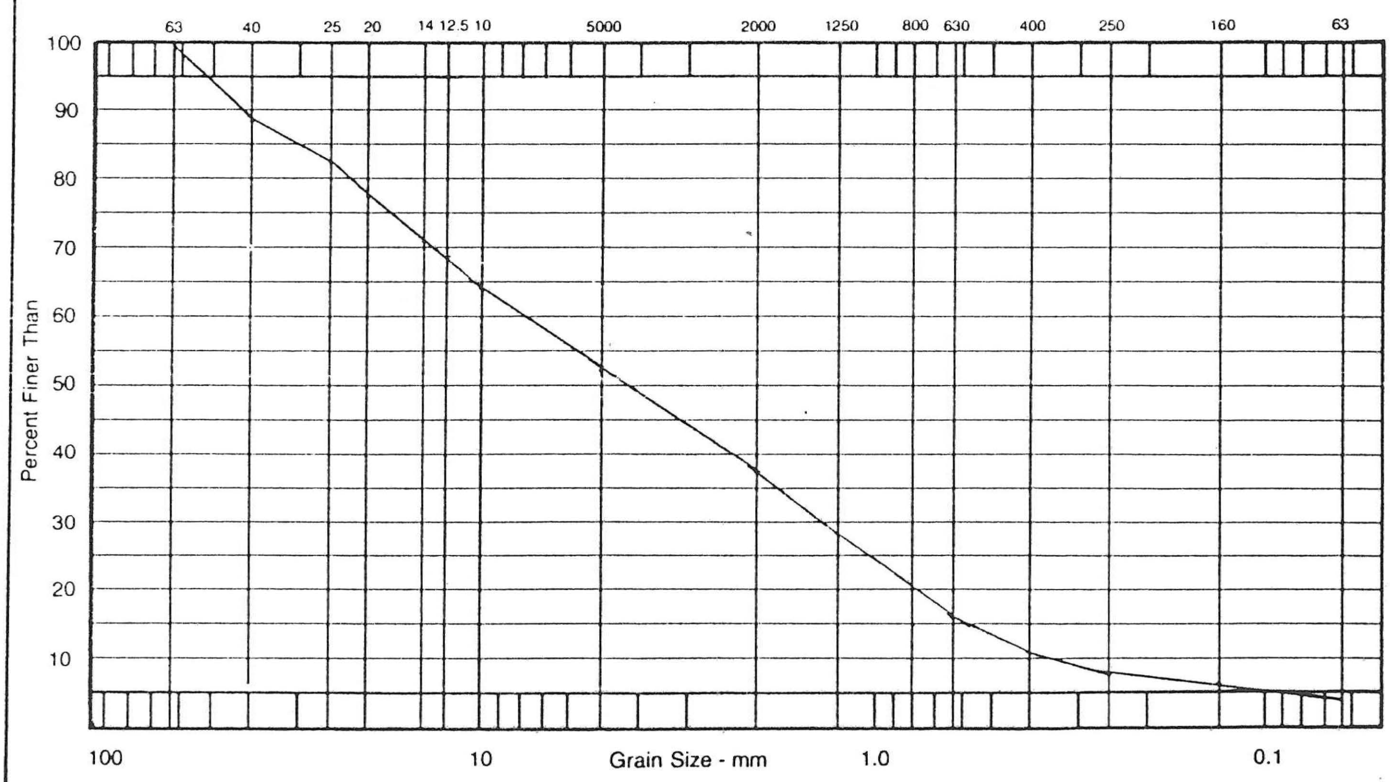
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig.Sample
						100.0
40000	40.0					88.1
25000	25.0					83.1
20000	20.0					77.4
14000	14.0					70.2
12500	12.5					68.2
10000	10.0					64.7
5000	5.0					52.4
2000	2.0					37.1
1250	1.250					28.5
800	0.800					20.4
630	0.630					15.9
400	0.400					10.3
250	0.250					7.3
160	0.160					5.7
63	0.063					4.0

Description of Sample: Sandy Gravel, Pit Run

Time of Sieving 15 Min.

Method of Preparation ...... Dry ...... Washed X

Remarks: Combined Samples 1 and 2



J. R. Paine & Associates Ltd.

CONSULTING AND TESTING ENGINEERS

SCREEN ANALYSIS

Client: Klohn-Leonoff

Sample: 1 of 1 Depth:

Project: Dawson City Dyke

Location: Klondyke Wash Coliston Pit

Made by: LK Job. No. 8051

Ck'd by: [illegible] Date: 1987.02.02

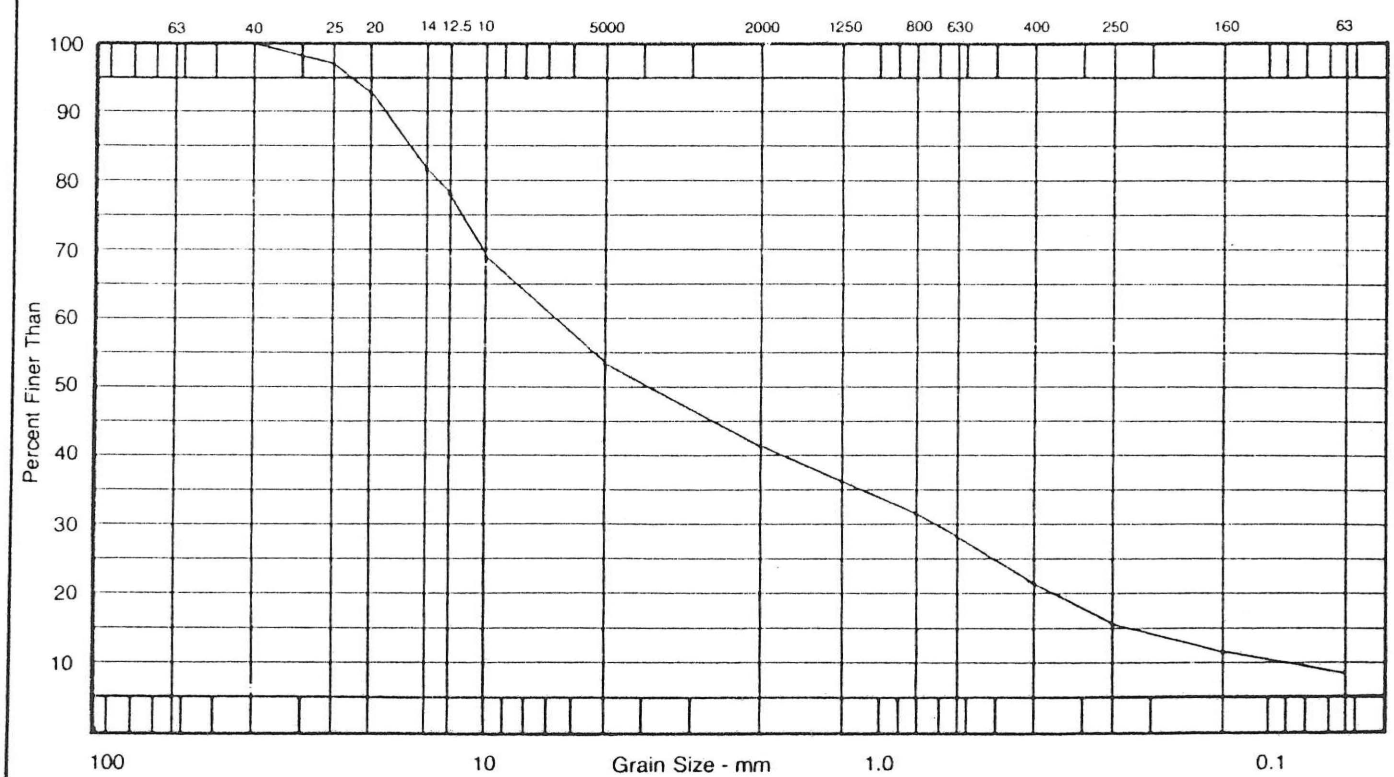
Sieve No.	Size of Opening MM		Weight Retained gms	Total Wt. Finer Than gms	Percent Finer Than	% Finer Than Basis Orig. Sample
40000	40.0					100.0
25000	25.0					97.2
20000	20.0					93.7
14000	14.0					81.4
12500	12.5					78.2
10000	10.0					69.4
5000	5.0					53.6
2000	2.0					41.5
1250	1.250					36.1
800	0.800					31.6
630	0.630					28.7
400	0.400					21.5
250	0.250					15.2
160	0.160					11.8
63	0.063					8.5

Description of Sample: Gravelly Sand

Time of Sieving: Min. 15

Method of Preparation: Dry Washed X

Remarks: Moisture Content 4.5%



APPENDIX III

APPENDIX III

REFERENCES

REFERENCES

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EBA Engineering Consultants Ltd., February 27, 1978, "Dawson City, Sieve Analysis of Potential Borrow".

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Klohn Leonoff Ltd., Dawson City Dyke Improvements, Report on Preliminary Design and Economic Analysis, April, 1986.

APPENDIX IV

APPENDIX IV

TEXT OF REPORT ON PRELIMINARY DESIGN
AND ECONOMIC ANALYSIS

REPORT ON PRELIMINARY DESIGN
AND ECONOMIC ANALYSIS

PROJECT: DAWSON CITY DYKE IMPROVEMENTS

LOCATION: DAWSON CITY, YUKON

CLIENT: YUKON DEPARTMENT OF COMMUNITY AND TRANSPORTATION SERVICES

OUR FILE: PB 3601 01 APRIL 17, 1986

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(continued)

APPENDICES

DRAWINGS

1. INTRODUCTION

1.1 BACKGROUND

Dawson City is located on a floodplain just below the confluence of the Klondike and Yukon Rivers and is subjected to repeated flooding. A protective dyke has been built around the City in stages over the last 20 years, but it does not have a uniform crest elevation and does not provide adequate protection. During the last 60 years, the City has been flooded many times, most recently in 1979, when a major overtopping of the dyke occurred at its lowest spot near Duke Street at the northern end of the City.

1.2 SCOPE OF WORK

On January 17, 1986, the Yukon Territorial Government (YTG), Department of Community and Transportation Services (DCTS), authorized Klohn Leonoff Ltd. to carry out consulting services required in connection with the Dawson City Dyke Improvement Project. Klohn Leonoff has retained the services of Thomson and Iles of Whitehorse, Yukon, Gary Bowden, Resource Economist, Vancouver, British Columbia and Dr. R. Gerard, Professor, Department of Civil Engineering, University of Alberta, Edmonton, Alberta to assist in the project.

The Request for Proposal defining the scope of work upon which this report is based is included in Appendix I. As proposed by the Consultant, the study was carried out in two phases: a conceptual design phase - Section 2, and a preliminary design phase - Section 3.

1.3 TEMPORARY REMEDIAL MEASURES

In order to improve the protection of the City to the general level provided by the dyke along most of its length before the next spring flood, the City and YTG decided to carry out temporary plugging of the low part of the dyke in April 1986. At the end of January 1986, Klohn Leonoff was authorized to prepare designs for the necessary temporary remedial works. The design work was carried out in February, and a report was submitted on March 7, 1986, together with the construction drawings and brief specifications.

The temporary work was to consist of additional fill placed to the required elevation and grade (El. 320.0 at Station 1+750; 0.04% gradient) either over the present roadway between Station 1+920 and Station 2+350, or on the riverside road shoulder, parking area or behind the buildings as appropriate between Station 1+520 and Station 1+920. Subsequently, it was decided to extend the roadway fill beyond Station 1+920 to approximately the York Street intersection at Station 1+810. Between York Street and the Bank of Commerce (Station 1+810 to Station 1+520) the temporary dyke will be located at the riverside shoulder of the road and will consist of a berm constructed with a 1 m wide crest to permit adequate compaction to the crest level.

As the temporary fill will be placed during April when the preparation of suitable foundation and general construction quality will be difficult to control, it is assumed that all of it will be removed before the placing of the permanent dyke fill is started. If it is decided later that some of the temporary work can be left in place, a small cost savings will be made.

1.4 PREVIOUS INVESTIGATIONS

The reports made available by DCTS at the start of the study are listed in the Request for Proposal (Appendix I). These reports were used throughout the study.

In addition, the cross-sections of the dyke obtained by DCTS were also utilized as explained under Section 2.2(a).

Many more reports, drawings, photographs and other records were made available to the Consultant during the course of the study by the members of the Steering Committee. Although these various documents are not all listed in this report, they contributed considerably to the results of the study. Particularly important reports are referenced in the text as appropriate and listed in Section 7.

2. PHASE I - STUDIES

2.1 GENERAL

Phase I studies consisted of the following:

- hydrologic, topographic, geotechnical and economic data collection and reviews;
- definition of design criteria and parameters; and
- conceptual design of options.

A key Steering Committee Meeting was held at the end of Phase I studies, where decisions were made as to which options were to be carried into Phase II.

2.2 DATA COLLECTION AND REVIEW

(a) Topography

In late January 1986, Northwest Survey Group of Edmonton was requested by the YTG to carry out the following photogrammetry work, based on 1984 aerial photographs:

i) longitudinal profile and 50 m interval cross-sections of the existing dyke;

ii) water surface spot elevations along the Yukon and Klondike Rivers; and

iii) 1:2000 scale, 1 m contours orthophoto map of the City, complete with spot elevations at road intersections.

Unfortunately, problems were encountered with the results of Northwest Survey's photogrammetry work and a considerable amount of ground surveying had to be done in order to permit the study to proceed:

i) Only the shapes of the Northwest Survey cross-sections were useable for calculation of dyke quantities. YTG ground survey data had to be used for elevations. Spot checking of the YTG elevations carried out by the Consultant confirmed their validity at all those locations checked.

   In those areas where additional fill was placed since the aerial photographs were taken, conventional survey was used to prepare new cross-sections.

ii) Northwest Survey's water surface spot elevations were not sufficiently accurate to resolve the discrepancy between the river gradients quoted in previous studies. A 0.04% gradient was conservatively selected as described in Section 2.3.

iii) Ground survey was carried out by the Consultant throughout the City and the extent of potential flooding established for the economic analysis.

b) Hydrology

A review of all hydrological reports made available to the Consultant by the YTG was carried out as required during the study. Based on this review, design criteria and parameters were accepted or formulated as described in Section 2.3.

(c) Geotechnical Studies

Geotechnical studies by others have been made for various structures in Dawson City, and copies of the reports provided by the YTG were reviewed to obtain an appraisal of the geotechnical conditions pertinent to the dyke improvement project. None of the previous reports specifically investigated the dyke. A visual appraisal was made of the existing dyke, but as the appraisal was made during February 1986 when a snow cover obliterated the details, little data was obtained. Apart from limited sampling of the White Channel gravels and rock exposures, no investigations were performed as part of the work.

Generally, Dawson City occupies a floodplain of the Yukon River and is underlain at depth by coarse gravel similar to that presently found in the riverbed. At the southern end of the City, the gravels are overlain by sand and are free of permafrost. The remainder of the City is underlain by either fill, peat or silt, which also overlie the alluvial gravels, and are in permafrost. The existing data does not extend to the riverside of the dyke, but it is believed that the softer silt and peat deposits are absent on the riverside, and the soils are predominantly river gravels.

The dyke has been built up over a number of stages since Dawson City was first settled. It is believed that the present dyke consists largely of material from the Moosehide Slide and White Channel gravels. However, drill holes by others(1) near the S.S. Keno indicate that fill could consist of a wide variety of materials including a mixture of silt, woodchips, peat, and gravels, usually in a loose condition.

The present dyke has a paved crest (Front Street). The riverside of the dyke appears to have been left near the natural angle of repose of the materials, and slopes are often approximately 1.5 horizontal to 1.0 vertical (1.5:1). It is understood that riprap has been installed in some areas, although the nature of the riprap is unknown. In general, the present riverside bank appears to be stable during spring flood conditions. One factor assisting the stability may be that the dyke soils are still frozen during the ice related flood period. Ice-jam related high water usually occurs during late April to May when soils have at best just begun to thaw at the surface.

Borrow sources for earthworks at Dawson City have been investigated by others, usually for specific purposes such as pipe bedding or building foundation support. For this project, the two borrow sources that would provide sufficient quantities of suitable material are the Moosehide Slide and the White Channel gravels. The Moosehide Slide material is a mixture of slide debris that probably varies in gradation from very large boulders to silt sizes. It is believed to be composed mostly of Serpentinite, which has been reported(2) to be a friable rock. Grain size analyses by others(3) on Moosehide Slide material samples indicate that the soil can be well graded to approximately 10% silt content on analyses done on minus 50 mm material. The investigator(3) indicated that samples provided for testing did not reflect the overall appearance of the slide debris, and that the silt content may be higher.

The White Channel gravels occur in the terraces and valley bottom of Bonanza and Hunker Creeks down to the Klondike River Valley. Analyses of samples(4) indicate that the material can be well-graded sand and gravel, containing less than 5% silt sizes. The analyses were performed on selected samples of material that were intended for specific projects, such as pipe bedding, and the overall characteristics may be somewhat different. It is believed that nearly all of the accessible sand and gravel deposits have been worked at least once by dredges or other means for placer mining, and the characteristics of the material could vary from area to area.

The suitability of the White Channel gravels for dyke construction was checked for this project. Laboratory tests performed in April 1986 by J.R. Paine & Associates on four samples obtained by the YTG confirm previous tests, and indicate that the material is a clean, sandy gravel, well graded from a top size of between 63 mm and 40 mm, with approximately 42% sand sizes, and approximately 3% silt sizes. Two samples were obtained near the Klondike Valley bottom at the Callison subdivision, and two samples were obtained at Lovette Gulch in the Bonanza Creek Valley. All four samples are nearly identical in gradation.

The natural moisture contents of the samples varied from 3.5% to 4.5%, which is considered to be typical of "air dry" moisture content. However, at the time of sampling, on April 4, 1986, the exposures were nearly vertical and were relatively difficult to sample with hand tools. This may indicate that excavations in this material when the ground is frozen could require ripping.

Petrographic analyses on the samples were also performed, and the results indicate somewhat different mineral composition in the two areas. The Callison material is predominantly quartz (60%) with quartz muscovite schist (30%), whereas the Lovette Gulch material is predominantly quartz muscovite schist (62%) with quartz (35%).

Previous riprap placed on the dyke was obtained from selective borrowing of suitable sizes from the Moosehide Slide. However, the quantities borrowed at any one time were probably small, and may have been obtained from a stockpile of oversizes that was developed over the years. For this project, use of the Moosehide

Slide only as a source of riprap may be uneconomical, and would include sorting of suitable sizes or breaking the larger sizes. Bedrock near Dawson City is essentially metamorphic, composed largely of quartzite, but with varying amounts of schist. Development of a quarry for riprap would be governed more by ease of access than by rock type. One potential quarry area is on the Dome Road at the "Cemetery Pit" where previous borrowing removed the overburden and exposed bedrock. It is understood that the Yukon Department of Highways plans to upgrade the Dome Road in the near future, and that rock excavations may be required. If excess rock could be stockpiled, this could be another source for some of the riprap.

(d) Existing Facilities

A review of all drawings and reports provided by the YTG to the Consultant indicated that a total of 26 drain pipes penetrated the dyke at some time. Their sizes and types vary from 150 mm diameter woodstave pipes to 600 mm diameter corrugated steel pipes. In discussions with the YTG and City officials a total of 14 of these drains were identified as being required for the existing drainage system. The locations of these 14 drains are shown on Drawing No. X-1001, together with elevations of their outlets (where known).

(e) Field Collection of Economic Data

A ground survey was undertaken to determine elevations for all streets and intersections in Dawson City. The level of the ground floor for each structure was established relative to the known street elevations, and the depth of flooding in each building was established for four flood elevations. The flood elevations were: 322.5 m, 321.7 m, 320.0 m (the level of protection which would be provided by a temporarily rehabilitated dyke) and 319.0 m (the protection currently provided by the existing dyke). Damage potential was estimated on the basis of five "zones" of flooding - water level below floor level, water level up to 0.3 m, 2.6 m, and 2.9 m above floor level, and exceeding 2.9 m.

It was found that there are 457 individual structures constructed at elevations such that they would be affected by flood elevation of 322.5 m. For each structure the type of construction, dimensions, current condition and use were noted. This provides the basis for estimating structure and contents value, and potential damages from each level of flood.

2.3 DESIGN CRITERIA AND PARAMETERS

(A) Flood Elevations

Based on previous investigations, flooding at Dawson City has been dominated at higher stages by ice related events. Ice-jams occur upstream and downstream of the City and result in very unsteady flow conditions.

For the purposes of this study, the preliminary flood elevations and frequencies were provided by Mr. R. Janowicz of Indian and Northern Affairs Canada (INAC) and Mr. N. Lyons of Inland Waters Directorate in conjunction with Dr. Gerard from the University of Alberta and are as follows:

Flood Elevation (m) at King Street (Station 1+750)	Preliminary Return Period (years)	
	Ice-Jam Related Flood	Open Water Flood
322.5	200	>>1000
321.7	100	>1000
321.0	50	1000
320.0	20	200
319.0	10	20

(B) River Profile

As mentioned in Section 2.2, water surface elevations from Northwest Survey could not be used to determine the Yukon River gradient in the vicinity of Dawson City.

Recognizing that surveys of water levels under the ice cover might also prove unreliable, a 0.04% gradient was conservatively selected for study purposes. This gradient is consistent with the overall slope of the Yukon River reported by others(5). Preliminary information on the results of Dr. Gerard's 1986 study for INAC indicates the river gradient might be between 0.03% and 0.035%, probably closer to the higher figure. This is so close to the gradient selected for this study that no design modifications are considered warranted at this late stage. Dr. Gerard recommends, however, that a conventional survey of the entire reach be undertaken during the 1986 period of high flows, probably in June or July as this may allow fine-tuning of the dyke design in the detailed design stage.

With the river gradient selected, water surface profiles for study purposes were developed assuming uniform flow conditions. This approach is considered acceptable, as a detailed study of the unsteady flow associated with surges caused by upstream ice-jam breakage such as recommended by others(6) would be required before any less conservative assumptions could be made with confidence.

In the absence of such a study, the 0.04% gradient corresponding to a uniform flow condition can be accepted as an "upper bound" on ice-jam related flood stages, for both downstream ice-jams and upstream ice-jams breakups. If sufficient quantity of ice is available, accumulation of ice upstream of an ice-jam can reach an equilibrium profile, which is parallel to the uniform flow gradient. If an upstream ice-jam breaks up, the peaks of the resulting dynamic surges passing the City can, depending on the degree of attenuation, reach the same uniform flow gradient elevations.

(C) Freeboard

Considering the conservative assumptions which had to be made for the water levels and river gradients related to ice-jam floods, no additional freeboard appeared justified on account of hydrological uncertainty. Furthermore, no additional freeboard was considered necessary for ice push-up because no historical evidence of ice push-up occurring was found. This absence of ice push-up appears to be the result of the orientation of the existing dyke relative to the river. The ice appears to concentrate along the western bank of the river throughout the City and does not strike the right bank until well downstream of the City.

As for freeboard provisions for the open water floods, it is to be noted that by designing the dyke crest for the 100-year and 200-year ice-jam related floods, a large freeboard of between 1.8 m and 2.5 m will exist for open water floods of equal probability of occurrence.

(D) Dyke Geotechnical Design

Design parameters considered for this project were strength of materials and foundation, permeability, erosion resistance, settlement and resistance to earthquake damage. Previous investigations did not specifically address any of these items, so the criteria were established indirectly. It has been assumed that the dyke fill materials will be well compacted granular materials that will have an effective friction angle in excess of 35°. Similarly, it is believed that the base of the new fill will be on river gravels which are also frictional, and relatively strong.

From estimates made on the basis of the grain size analyses, the permeability of well compacted materials from the White Channel deposits will be in the order of 2×10^{-3} cm/sec. In the event of an ice related flood, that permeability is sufficient to retard seepage through the dyke, and the dyke probably would not become fully saturated.

Erosion protection on the riverside of the proposed dyke is required against the action of the river current. It is estimated that during floods, the average velocity of the river at the dyke will be in the order of 1.8 to 2.0 m/sec. During high river stages, there could be natural or boat-induced waves superimposed on the current. Design of riprap is governed as much by wave size as current velocity. In this project, riprap that will resist 0.9 m waves will also be adequate for the estimated currents.

For portions of the dyke constructed on the riverside of the existing fill, settlement is not expected to be a problem, as the dyke and foundation materials are anticipated to be granular, and almost incompressible for the loadings considered. However, fill placed over the existing dyke (Front Street) may cause settlement in the existing dyke material. Since no data is available on the exact nature or distribution of existing dyke fill, no settlement allowance was made, but an observational procedure is recommended to correct any future settlement by placing additional fill as required.

Previous studies by others indicate that Dawson City is in earthquake Zone 2 as defined by the National Building Code. This represents a zone of moderate earthquake risk. A study performed by Indian and Northern Affairs[7] predicts a ground acceleration of 6% of gravity, for an earthquake having a 100-year recurrence interval. Neither the dyke material nor the foundation is considered to be susceptible to loss of strength from such a low intensity occurrence.

For the dyke portion that will be formed by raising Front Street, the design allowed for a pavement width of 7 m, shoulders of 2 m on each side, for a total width of 11 m. This is consistent with the current dimensions of Front Street.

2.4 CONCEPTUAL DESIGN OPTIONS

Providing flood protection for an ice-jam related flood with a return period of 200 years requires raising the existing dyke levels 2.5 m on average. It was immediately evident that simply raising Front Street by 2.5 m over its entire length would not be feasible because of the access problem to streets and buildings along its length, in particular in the few blocks near the S.S. Keno. However, at the southern end of the project, along the Klondike River, raising the road level is appropriate because the highway has to tie into the dyke and landside access is less difficult. Similarly at the north end of the project area, access towards the river, such as at the ferry terminus, is feasible only if the dyke raising is essentially directly over the present Front Street. Therefore, the concept for locating the new dyke was developed as follows:

up to Station 0+100:	Taper existing highway up to new dyke level.
at Station 0+150:	Full dyke height requires tie into hillside.
Station 0+100 to 0+200:	Front Street on crest of dyke over present dyke.
Station 0+200 to 0+300:	Taper Front Street from dyke crest to existing grade; new dyke on riverside.
Station 0+200 to 2+150:	Dyke raising is on riverside of all existing fill; Front Street as is.
Station 2+000 to 2+150:	Taper Front Street up to dyke level.
Station 2+150 to 2+350:	Front Street on crest of dyke over present location.

For the two areas where the dyke raising would be coincident with raising Front Street, earthfill construction was obvious. For the remainder of the dyke the only potential dyking method other than earthfill that appeared feasible was an earthfilled cribwall with suitable facing. The relatively high cost of cribwalls became apparent and several sub-alternatives were studied: limiting the cribwall either to the top portion of the dyke, or to a short full height section behind the more restricted area behind the S.S. Keno. For comparison, it may be noted that while the estimated cost of the 200-year protection for the earthfill dyke is $700/m, the full height cribwall would cost $1800/m in treated timber and $3500/m in concrete.

The options investigated were presented during a Steering Committee Meeting on February 14, 1986 and are listed below:

(a) Earthfill for full height and length.

(b) A 3 m high timber crib on an earthfill base for approximately 1300 m of the dyke; remainder of dyke to be constructed by raising roadway.

(c) Full height treated timber cribwall for either 150 m or 225 m length near S.S. Keno; all remaining dyke of earthfill.

(d) As above but using concrete members for cribwall.

Appendix II contains illustrations of the concepts presented above, and contains a comparative estimate of costs.

3. PHASE II - PRELIMINARY DESIGN OF RECOMMENDED SCHEME

3.1 RECOMMENDED SCHEME

The results of the conceptual design phase clearly indicated that an earthfill dyke for the entire project length was the most economical alternative. The cribwall alternatives have no cost advantage, and probably have greater negative visual impact than the earthfill. In addition, the high cribwall alternatives behind the S.S. Keno do not appear to significantly reduce encroachment onto the rivershore, and actually hinder waterfront access and appearance. Therefore, as discussed with the Steering Committee on February 14, 1986, the recommended scheme is an earthfill structure. The earthfill would include a roadway on its crest at the north and south extremities, and would be placed on the riverside of the existing fill elsewhere.

The Phase II work included comparison of flood protection for 200-year, 100-year, and 50-year events (all ice-jam related), staged as follows:

Stage 1: 50-year protection (El. 321.0), crest wide enough to permit raising to El. 322.5 without widening.

Stage 2: 100-year protection (El. 321.7).

Stage 3: 200-year protection (El. 322.5).

The results of the Phase II studies are reported in the following sections.

3.2 DESIGN DETAILS

3.2.1 Section

As previously mentioned, the recommended scheme would consist of a raised roadway at each end, and a dyke adjacent to the existing dyke elsewhere. Thus, there are two typical sections with the following features:

Roadway Section
- 7 m wide pavement
- 2 m wide shoulders each side
- 2:1 side slopes both sides
- riprap slope protection on riverside slope
- grassing on landside slope

Dyke Section
- 2.5 m wide crest to random fill section (minimum access width), for 200-year ice-related flood level; wider for lower stages
- 2:1 landside slope
- riverside slope 2:1 to 200-year open-water flood level, 1.5:1 slope above
- riprap slope protection on riverside slope
- grassing on landside slope

3.2.2 Foundation Preparation

River gravels are anticipated to be present over most of the base of the dyke. However, there are reaches where there may be silty pockets which should be removed, and portions of the existing riverside dyke slope may contain soft or objectionable material. In addition, a growth of shrub has developed over much of the site. Therefore, it has been assumed that foundation preparation would include stripping of soils to an average depth of 0.15 m over the base of the new fill, except where present development is obvious. In practice, the stripping would probably be occasional, and to a greater depth. Removal of the shrub growth directly under the proposed dyke is assumed to be part of the stripping operation.

In the areas where the new road surfacing would meet the existing pavement, some pavement removal or grinding may be required to produce a good bond and a smooth transition.

3.2.3 Embankment Materials

The main portion of the dyke would be constructed of pit run materials, consisting of well graded, strong, durable particles. Of the two potential material sources, Moosehide Slide and White Channel gravels, the White Channel gravels are preferred for the following reasons:

- relatively consistent material can be obtained for the quantities required;
- the gravels are probably easier to excavate and handle;
- they are composed of relatively strong materials;
- they would also be the source of road base course and paving aggregate.

The Moosehide Slide material by comparison is unproven in its consistency. If the present excavation bench is extended to obtain the required quantities for this project, an excavation in the order of 30 m deep would be required. This quantity of excavation in one construction season may affect the stability of the slide. Investigations and analyses would be required before proceeding with the excavation.

Furthermore, the more friable materials could result in a finer-grained compacted fill which could be weaker, and may require modifications to the present design.

At the present time, the YTG has closed the Moosehide Slide pit due to the potential health hazard from the asbestos fibres contained in the slide material.

The riverside slope protection will be blasted rock riprap. A potential source of this material has not been positively identified, but the exposure at the cemetery pit indicates that development of this source may be feasible and that additional material may be availabe from the proposed Dome Road reconstruction. The material should be graded from a maximum particle size of 450 mm, with a mean size of 300 mm, and should grade down to no more than 5% finer than 75 mm. If such a gradation is produced by the quarrying operations, and if the White Channel gravels are well graded as anticipated, then no transition zone is required between the riprap and the random fill zone.

With the use of the White Channel gravels for the main dyke fill, the need for slope protection on the landside of the dyke is more for visual impact than for structural integrity. Therefore, landside slope protection is assumed to be a 300 mm layer of a material suitable for growing grasses. This layer may be fine to medium sand, with topsoil or other organic material cover. A source for these materials has not been identified.

The sections of the dyke which include a full roadway section on the crest would also be constructed of pit run material for the main zone. A 300 mm thickness of base course would underlie the paving and form the shoulders. The base course and gravel for use in the paving would be obtained from crushing White Channel gravel.

3.2.4 Existing Drains and River Access

An allowance for locating, strengthening and extending 14 existing drains has been included in the cost estimate.

As requested by the Steering Committee during the study, river access ramps were provided in the design as follows:

- vehicular access ramp to the Government ferry near Edward Street;
- vehicular access ramp for smaller commercial vehicles near Duke Street;
- pedestrian access ramp near the S.S. Keno; and
- pedestrian access ramp near Church Street.

As for the winter haulout for the Government ferry, the Department of Highways expressed their preference for the existing location near Duke Street. Alternatively, provisions for a new winter haulout could be incorporated into the design of the summer access ramp near Edward Street.

All these ramps are shown on Drawing No. X-1001.

3.2.5 Seepage

The ice-jam related river levels are known to reach their peak and recede to their normal level in a relatively short time. Records and observations indicate that usually the river level will rise to a peak flood level and recede to the pre-flood level in less than 24 hours. In addition, the peak is usually instantaneous, as the water level rises only to a point where the ice-jam breaks, and then recedes. Estimates of the possible saturation of the proposed dyke during these conditions indicated that the dyke will not become fully saturated, even with the assumption that the dyke material is unfrozen and has the same permeability as in its unfrozen state. Therefore, no seepage is anticipated through the dyke for ice-related flood events.

The open water flood levels are coincident with or lower than the existing dyke crest level for the same probabilities of recurrence. Therefore, no additional seepage will result from open water floods.

One area where seepage may increase, from riverside to landside, due to the proposed increased height of dyke, is at the southern end of the City near the Klondike River, where unfrozen sand and gravel form the foundation materials. In that area, foundation seepage could be in the order of 1500 l/min, and which would probably emerge in a reasonably broad zone on the landside of the dyke. This magnitude of seepage does not warrant installation of permanent seepage pumping facilities, and could probably be handled with construction pumps when and if the need arises. Therefore, no allowance has been made in the cost estimate for pumping of seepage water.

3.3 CONSTRUCTION SCHEDULING

Based on the staged construction concept, it is estimated that the construction period for the 50-year dyke (El. 321.0) would be in the order of 65 working days, assuming that the work would be performed continuously and efficiently.

The Department of Fisheries and Oceans requires all in-stream construction work to be carried out before mid-June, with an additional period available on the Klondike River after the river level has dropped in September and/or October.

Assuming that the construction starts in late March, it would appear that the dyke can be built to El. 321.0 without conflicting with the Fisheries and Oceans' requirements. Depending on the weather and the severity of the ice-jam flooding in the year of construction, it should be possible to substantially complete the dyke before the tourist season starts in late June. If necessary, some selected items of work may be delayed until after the tourist season (September or October). Two such items are placing the landside slope protection and seeding.

With the construction starting in late March, the soils will be frozen, making the foundation preparation very difficult. For this reason it might be prudent to carry out some limited foundation preparation in the fall prior to construction.

An additional 20 working days are estimated to be required to raise the dyke to the 100-year level (El. 321.7), and a further 20 days to raise it the 200-year level (El. 322.5).

3.4 ESTIMATE OF COSTS

For the designs described and presented on the drawings, the costs of dyke construction are summarized on Table 1. The earthfill costs were obtained from a best estimate of current costs in the Dawson City area, assuming the use of White Channel gravels as the predominant borrow source. However, it is believed that the indicated cost estimates would cover the cost of the Moosehide Slide material, if required. No allowance has been made for royalties.

A contingency of 15% has been added to cover any unusual conditions, or slight design modifications. The main areas where modifications could be required are at the ferry haulout, and street intersections.

TABLE 1

COST SUMMARY

Item	Incremental Costs		
	50-year(1)	100-year	200-year
A. Capital Costs			
1. Mobilization	380,000	110,000	140,000
2. Foundation Preparation	30,000	-	-
3. Pit Run Fill	972,000	76,000	61,000
4. Riprap	264,000	36,000	33,000
5. Landside Slope Protection	60,000	30,000	25,000
6. Base Course	50,000	55,000	83,000
7. Paving	58,000	76,000	110,000
8. Extend Existing Pipes	70,000	-	-
9. Winter Ferry Haulout	10,000	15,000	15,000
10. Highway Guard Rails	13,000	18,000	20,000
Sub Totals	1,907,000	418,000	487,000
Contingency (15%)	287,000	62,000	73,000
Design and Supervision	246,000	60,000	60,000
Totals	2,440,000	540,000	620,000
B. Operation and Maintenance Costs			
Year 1 - Dyke Construction	0	0	0
Year 2	34,000	5,000	4,000
Year 3	34,000	5,000	4,000
Year 4 Onwards	26,000	1,000	1,000

NOTES: (1) Costs include extra width to permit future extension to 100-year protection.

4. PRELIMINARY ECONOMIC ANALYSIS

Estimates of the economic benefits from flood protection at Dawson City are presented in Appendix III. Benefits from flood protection consist of damages prevented, hence the essence of the analysis in Appendix III is to estimate damages which can be expected over time, in the absence of flood protection.

4.1 DAMAGE CATEGORIES

Following conventional methodology in analyses of flood damages, potential damages fall into several categories: primary direct, primary indirect and intangible.

Primary direct damages include damages to structures and contents, and vehicles and equipment. The estimates of primary direct damages for Dawson City are complete, with one notable exception. The historic buildings in Dawson City are repositories for important artifacts and archival material. Neither the value of such objects, nor the extent to which they would be damaged by floods could be satisfactorily established within the scope of the present study. There is, therefore, an omission with respect to these resources in the estimate of primary direct damages.

Primary indirect damages represent permanent income losses to firms located in the floodplain, as a result of flooding. These are estimated for business income losses in the tourist sector of the Dawson City economy.

Intangible damages are flood effects which cannot be measured in monetary terms. They include possible loss of life, suffering, anxiety, inconvenience and disruption. By definition such effects are not quantified and as a result have to be omitted from subsequent direct comparisons of dyking costs and benefits. However, they should not be neglected in the final decisions regarding the feasibility of dyke construction. When dealing with ice-related floods which can occur with very little warning, as is the case at Dawson City, the threat to human life - which remains as an intangible - may merit particular emphasis.

4.2 DAMAGE ESTIMATES

Flood damages have been estimated in terms of the damages that would occur as a result of floods at specific elevations. These are then translated into average annual damages for floods between certain elevations. Finally, the average annual values for these ranges are discounted to present value equivalents so that they can be compared with dyke construction and maintenance costs.

4.2.1 Damage Estimates for Specific Floods

Damages were estimated for floods at the following elevations and expected frequency of occurrence: elevation 319.0 m, 10-year return period; elevation 320.0 m, 20-year return period; elevation 321.0 m, 50-year return period; elevation 321.7 m, 100-year return period; elevation 322.5 m, 200-year return period.

The results are summarized in Table 2.

TABLE 2

PRIMARY DAMAGE ESTIMATES FOR SPECIFIC FLOOD ELEVATIONS

Elevation	Primary Damages		Total Primary Damages
	Direct	Indirect	
319.0 m	$ 542,000	$ 0	$ 542,000
320.0 m	4,165,000	240,000	4,405,000
321.0 m	9,055,000	640,000	9,695,000
321.7 m	12,479,000	920,000	13,399,000
322.5 m	21,005,000	1,995,000	23,000,000

4.2.2 Average Annual Damages

Estimating damages for the specific floods provides a basis for computing the average annual value of damages, as set out in Section 4 of Appendix III. In order that these estimates can be compared with the cost of building dykes to various elevations, they are expressed as damages associated with floods between given elevations. The findings are summarized in Table 3.

TABLE 3

ESTIMATE OF AVERAGE ANNUAL FLOOD DAMAGES

Flood Elevations	Average Annual Damages (Primary, Direct and Indirect)
319.0 m to 320.0 m	$ 124,000
320.0 m to 321.0 m	211,500
321.0 m to 321.7 m	115,500
321.7 m to 322.5 m	91,000

4.2.3 Present Value Equivalents

Three factors are provided for in converting the estimated annual values to present value equivalents so that they can be directly compared with the costs of dyke construction. These are the discount rate, project life, and expected rate of growth in annual damages. A range of values has been used for these factors. Discount rates of 6%, 8%, 10% and 12% were used in the calculations. Two assumptions regarding project life - 50 years and 35 years - were used. The rate at which damages were expected to grow was set at 1%, 2% and 3%. The resulting wide array of estimates is presented in Tables 8 through 11 of Appendix III.

A base case, with the results drawn from what were felt to be acceptable values for the discount rate (10%), project life (50 years) and annual rate of growth (2%) is summarized in Table 4.

TABLE 4

PRESENT VALUE, POTENTIAL FLOOD DAMAGES

Flood Elevations	Present Discounted Value of Damages
319.0 m to 320.0 m	$ 1,545,000
320.0 m to 321.0 m	2,635,000
321.0 m to 321.7 m	1,439,000
321.7 m to 322.5 m	1,134,000

The calculations of present values are sensitive to the discount rate selected, as well as to the values adopted for future growth, and the project life. The comparisons in Table 5 indicate how the results are affected by the choice of discount rate.

TABLE 5

PRESENT VALUE OF FLOOD DAMAGES, ALTERNATE DISCOUNT RATES

($1,000)

Flood Elevations	Present Discounted Value of Damages* With Discount Rates of			
	6%	8%	10%	12%
319.0 m to 320.0 m	2,700	1,990	1,550	1,250
320.0 m to 321.0 m	4,600	3,390	2,640	2,140
321.0 m to 321.7 m	2,520	1,850	1,440	1,170
321.7 m to 322.5 m	1,980	1,460	1,130	920

* 50-year project life, 2% annual rate of growth

The influence of the assumptions regarding the rate of growth of future damages, and the project life, can be determined from Tables III-8 through III-11 in Appendix III. The direction of the effects is that present values are larger the higher the assumed rate of growth (3% versus 1%) and the longer the project life (50 years versus 35 years). These tables indicate the sensitivity of the ultimate results to the values adopted for these parameters. While the estimates presented above in Table 4 are felt to be acceptable for the present study, this sensitivity should not be overlooked in assessing overall project feasibility.

5. BENEFIT/COST ANALYSIS

The results of the preliminary benefit/cost analysis are summarized in Table 6:

TABLE 6

COMPARISON OF PRELIMINARY BENEFITS AND COSTS

Elevation of Dyke Crest (m)	320.0	321.0	321.7	322.5
Estimated degree of protection against ice-related flooding (preliminary)	20-year	50-year	100-year	200-year
Estimated incremental capital and O&M costs (preliminary) - $1,000 (1)	200	2,510	560	640
Estimated incremental benefits (preliminary) - $1,000 (1)	1,550	2,640	1,440	1,130
Benefit/Cost Ratios (preliminary)	7.7	1.05	2.6	1.8

(1) Present value of costs and benefits calculated on the basis of a 50-year project life and a 10% discount rate.

As would be expected, the benefit/cost ratios generally reduce with increased protection. The variation at El. 321.0 can be explained by the requirement for staged construction. The dyke at El. 321.0 is wide enough for raising to El. 322.5 and therefore it is disproportionally expensive.

As can be seen from Table 6, all benefit/cost ratios within the investigated range (50-year, 100-year and 200-year ice-jam related flood protection) are larger than one and each of those levels of protection can therefore be justified.

6. CONCLUSIONS AND RECOMMENDATIONS

a) Based on the preliminary design and economic study, the benefit/cost ratios for the 50-year ice-related flood protection (El. 321.0), 100-year protection (El. 321.7), and 200-year protection (El. 322.5) are all larger than one and their implementation can therefore be justified.

b) An earthfill dyke for the entire project length is the most economical alternative. It should be built on the riverside of the existing dyke/Front Street, except at the south and north extremities where it should be placed on the existing roadway.

c) The available topographical surveys of the dyke are inadequate for final design and construction. The dyke should be re-surveyed with cross-sections at approximately 25 m intervals and with detailed topographic plans at access ramps and intersections.

e) The proposed conservative flood levels and river gradients cannot be refined with the available hydrological information. An additional study of dynamic surges caused by upstream ice-jam breakage is recommended, as is a conventional survey of the river gradient during periods of high flow.

e) Of the two potential construction material sources for the main portion of the dyke, Moosehide Slide and White Channel gravels, the latter is preferred and its suitability should be confirmed during final design. If the Moosehide Slide is considered as a borrow source, an investigation and analyses of the effect on the stability of the slide is recommended.

f) A 450 mm thick layer of blasted rock riprap with a mean size of 300 mm is the recommended protection of the riverside slope. The availability of suitable rock in the cemetery pit on Dome Road should be confirmed during final design.

g) No serious problems are expected to occur with respect to seepage through the dyke during floods. Even at the southern end of the City where increased underseepage may occur through the foundation gravel, no permanent seepage pumping facilities are considered warranted.

h) Fourteen existing drains through the dyke were identified as needed in the future. Strengthening, modifications and extensions of these drains should be provided for during final design.

i) Two vehicular and two pedestrian access ramps to the river were identified and should be incorporated in final design. A government ferry winter haulout should be incorporated during final design in either of the two vehicular ramps.

7. REFERENCES

(1) J.R. Paine and Associates Ltd., November, 1984, "Foundation Report, S.S. Keno Paddlewheel Steamship, Dawson City, Yukon".

(2) Archer, Cathro Associates (1981) Limited, November 15, 1985, "Report on the Distribution of Asbestos in Bedrock, Dawson, Y.T.".

(3) EBA Engineering Consultants Ltd., February 27, 1978, "Dawson City, Sieve Analysis of Potential Borrow".

(4) EBA Engineering Consultants Ltd., March 17, 1978, "Lovette Gulch Borrow Pit".

(5) Underwood McLellan Ltd., October, 1983, "Yukon River Basin Flood Risk Study".

(6) IWD, Environment Canada, June, 1984. "Yukon River Freeze-up and Break-up Study".

(7) Indian and Northern Affairs, September, 1978, "Earthquake Risk, Dawson City, Yukon Territory".

KLOHN LEONOFF LTD.

Josef Lampa, P.Eng.
Project Manager

Walter Shukin, P.Eng.
Project Engineer

Gary K. Bowden
Resource Economist

APPENDIX V

APPENDIX V

FIGURES

LIST OF FIGURES

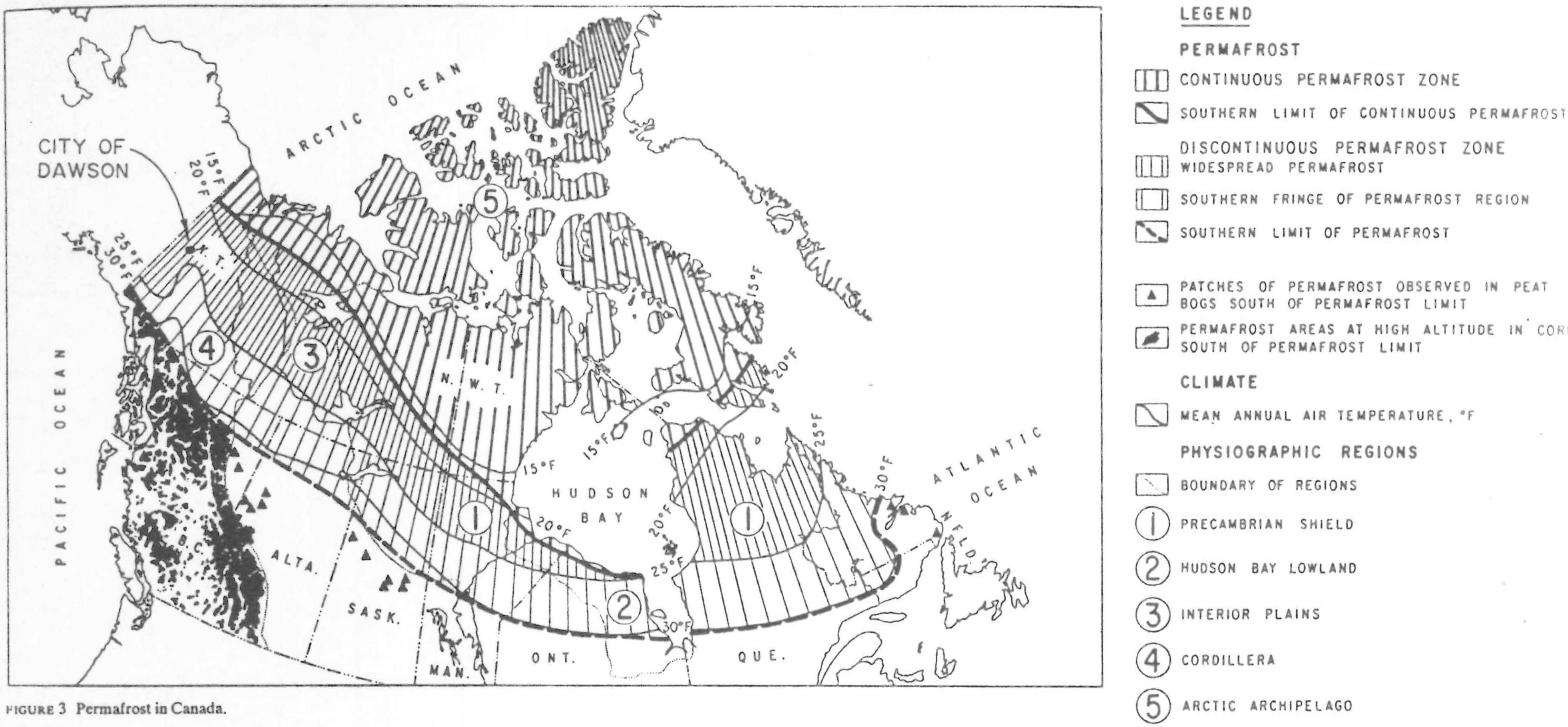
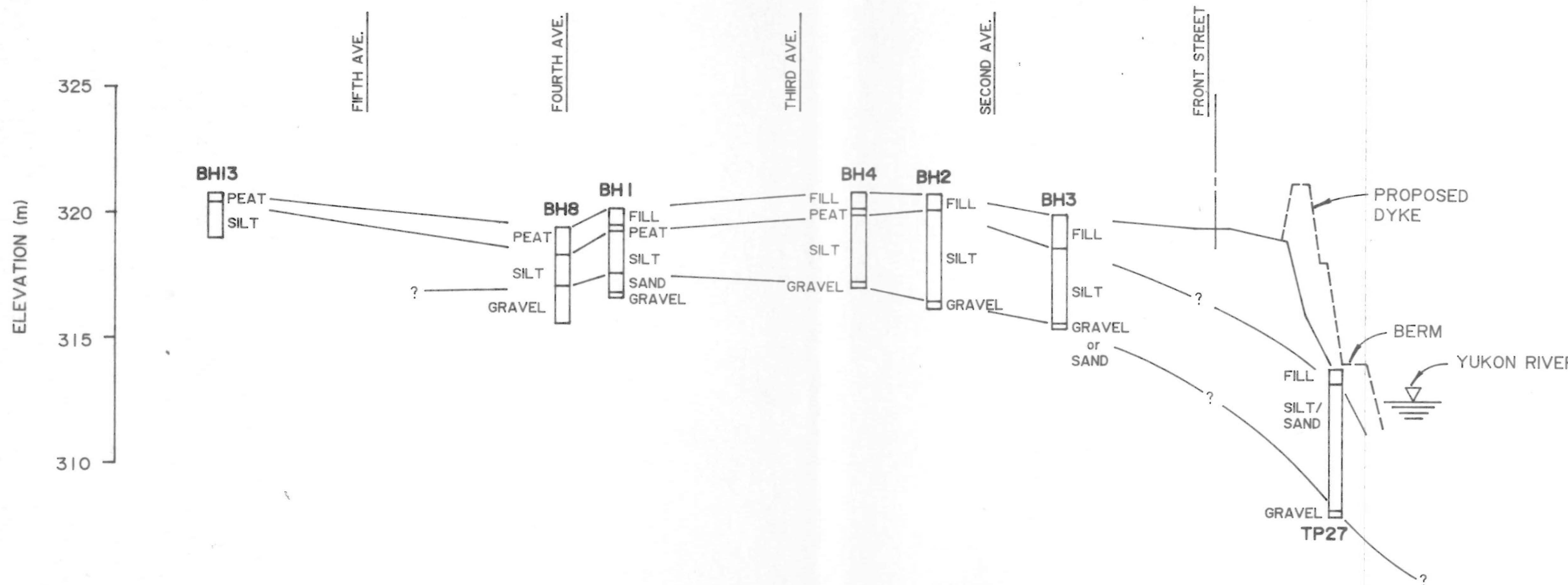


FIGURE 3 Permafrost in Canada.

(Ref. Permafrost in Canada Roger J. E. Brown University of Toronto Press)

Figure 1



SECTION ALONG KING STREET

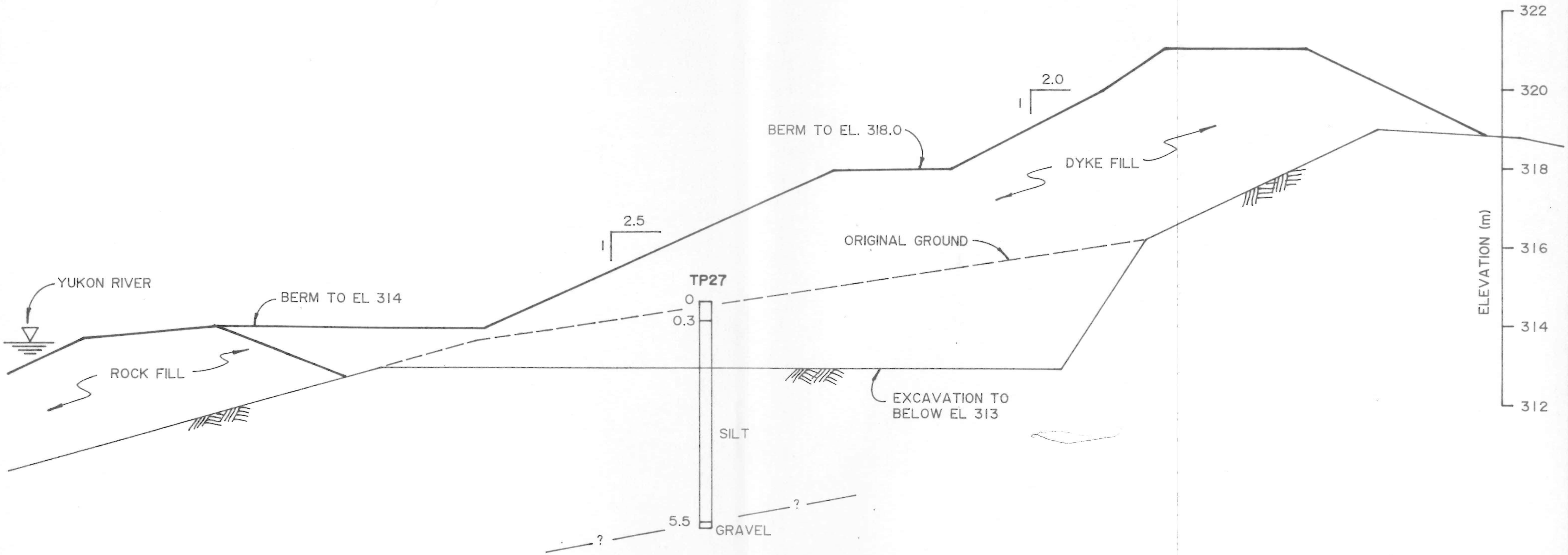
(Approx. STA 1+750)

SCALE: HORIZ. 1 : 2000
VERT. 1 : 200

B.H. - Boreholes by E.W. Brooker & Associates Ltd.
Reference Preliminary Report on Subsurface Conditions, Dawson, Yukon.

Figure 2

KLOHN LEONOFF YUKON LTD.



STATION 1+750

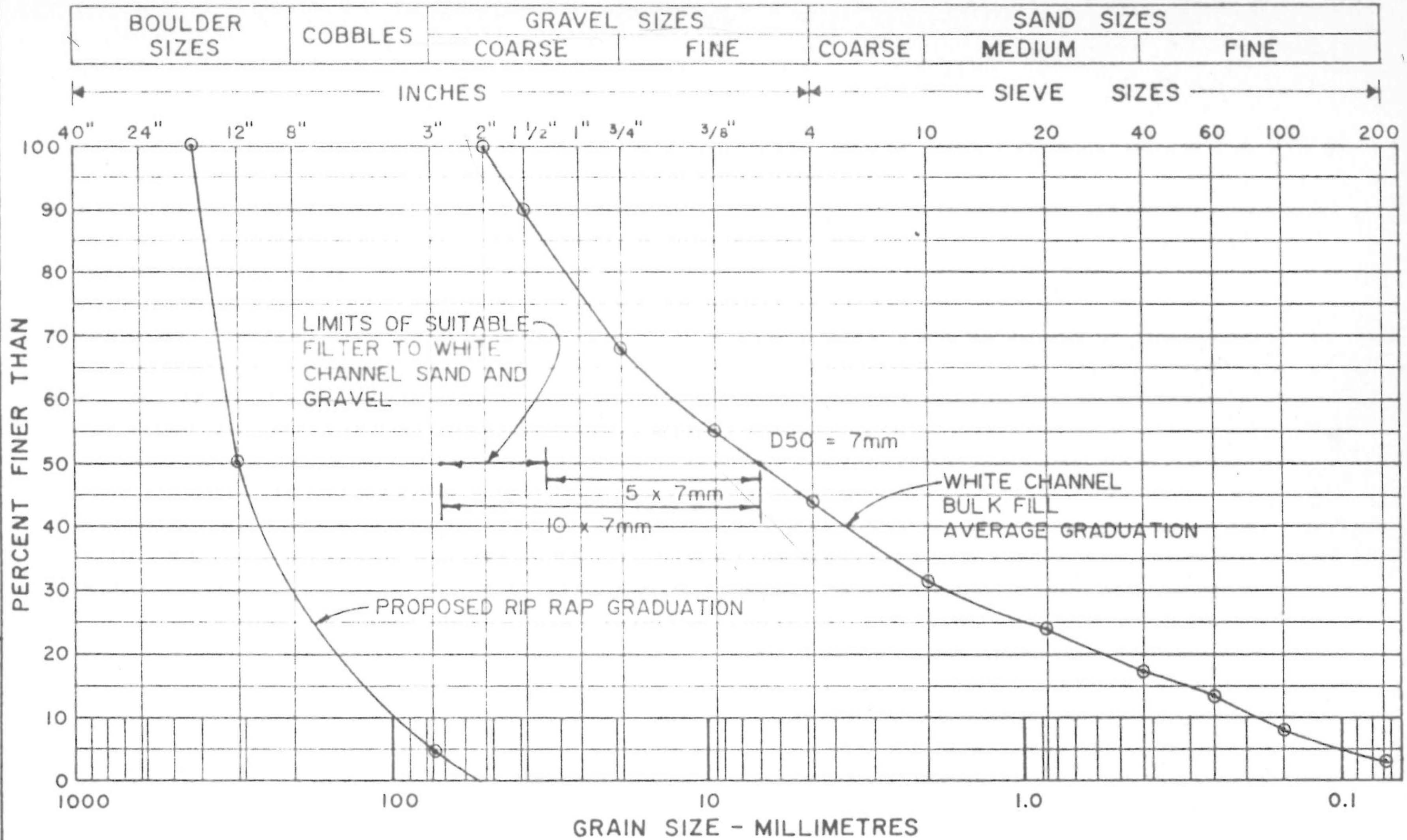
SCALE: 1 : 100

Figure 3

KLOHN LEONOFF YUKON LTD.

KLOHN LEONOFF
CONSULTING ENGINEERS

GRAIN SIZE CURVE
GRANULAR SOILS



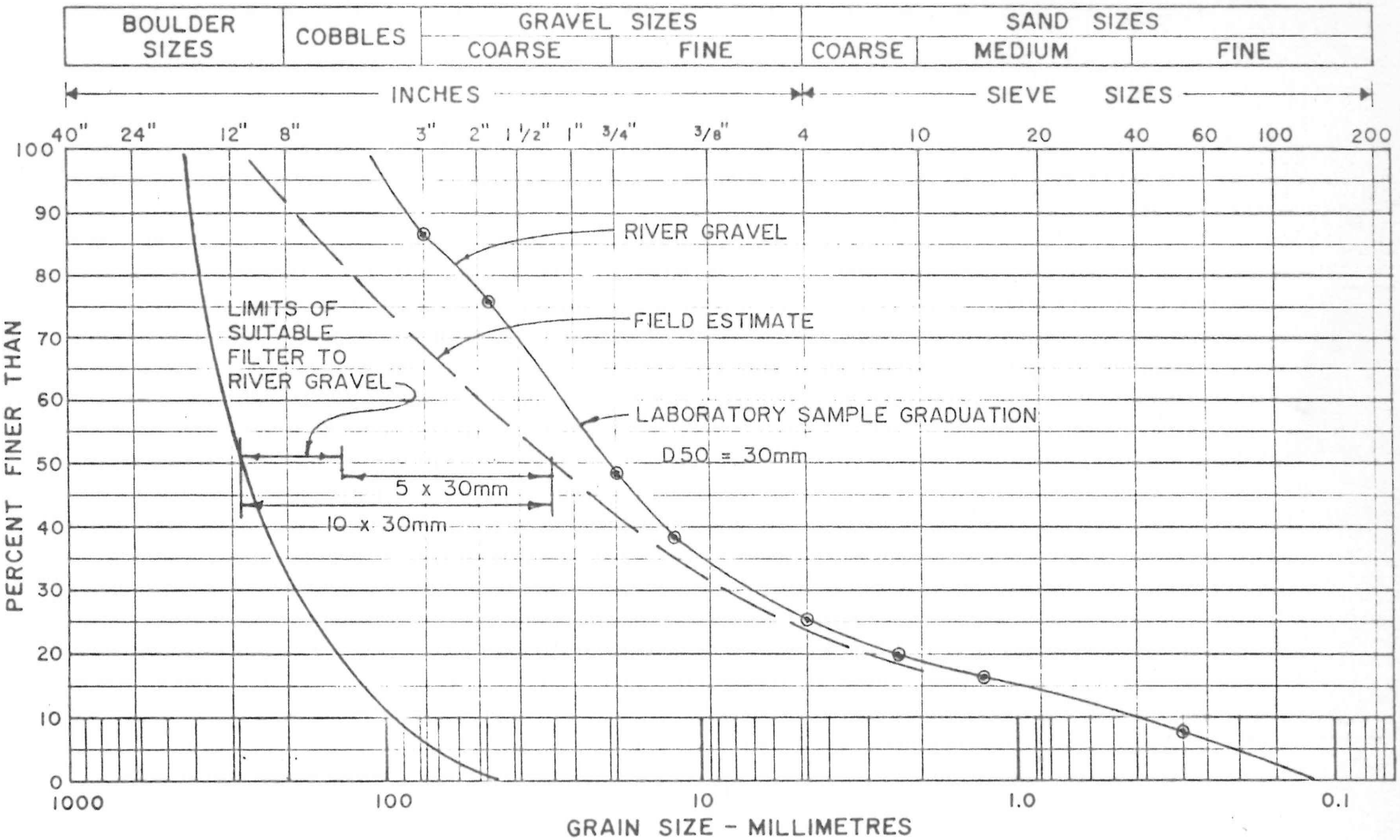
REMARKS: ILLUSTRATION OF FILTER CRITERIA REQUIRED
FOR WHITE CHANNEL SAND AND GRAVEL.
RIP RAP DOES NOT MEET FILTER REQUIREMENTS
FOR WHITE CHANNEL MATERIAL.

JOB No.
PROJECT DAWSON DYKE
LOCATION
HOLE No. DEPTH
DATE

Figure 4

KLOHN LEONOFF
CONSULTING ENGINEERS

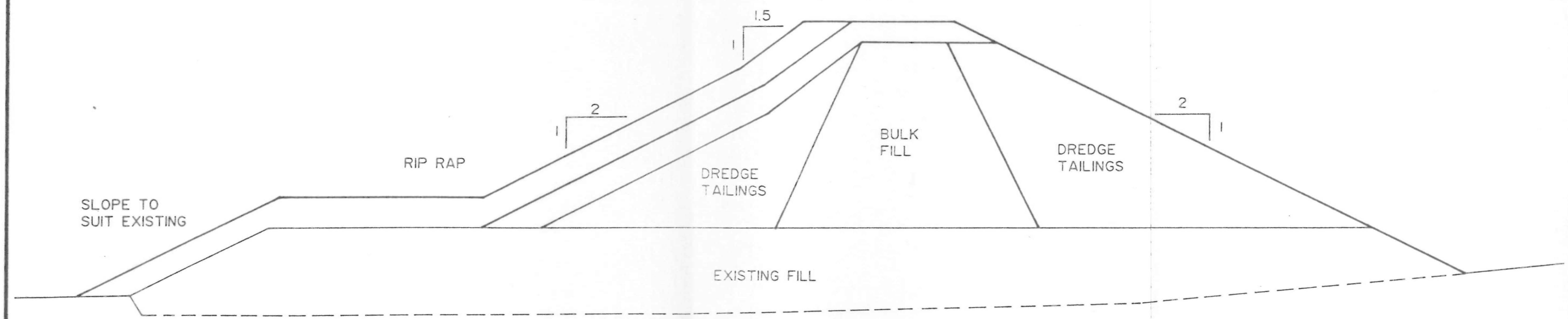
GRAIN SIZE CURVE
GRANULAR SOILS



REMARKS: ILLUSTRATION OF FILTER CRITERIA REQUIRED FOR RIVER GRAVEL MATERIAL. RIP RAP MEETS THESE FILTER REQUIREMENTS.

JOB No.
PROJECT DAWSON DYKE
LOCATION
HOLE No. DEPTH
DATE

Figure 5



Yukon
Community and Transportation Services

KLOHN LEONOFF YUKON LTD.
CONSULTING ENGINEERS

PROJECT: DAWSON DYKE RECONSTRUCTION - PHASE I

TITLE: ALTERNATIVE ZONING

DESIGN:	DRAWN BY:	DATE:	SCALE:
	INTEGRAPHICS	MAR. 1, 1987	1: 100

PROJECT No.	DRAWING No.
PB 3601 - 02 - 13	Figure 6


YUKON RIVER
KLONDIKE RIVER
APPROX. LOCATION OF DYKE CENTRELINE
Dwg. 03005
Dwg. 03006
Dwg. 03007
Dwg. 03008
Dwg. 03009
Dwg. 03010
Dwg. 03004
STA 0+875
STA 1+200
STA 1+425
STA 1+850
STA 2+175
STA 2+400
STA 0+225
LIMIT OF CONTRACT
LEGEND:
Test pits shown thus
6A
Yukon
KLOHN LEONOFF YUKON LTD.
DAWSON DYKE RECONSTRUCTION
KEY PLAN &
TEST PIT LOCATIONS
NO.
REVISION
BY
APPR
DATE
JAN 22/87
PB 3601-02
X3012

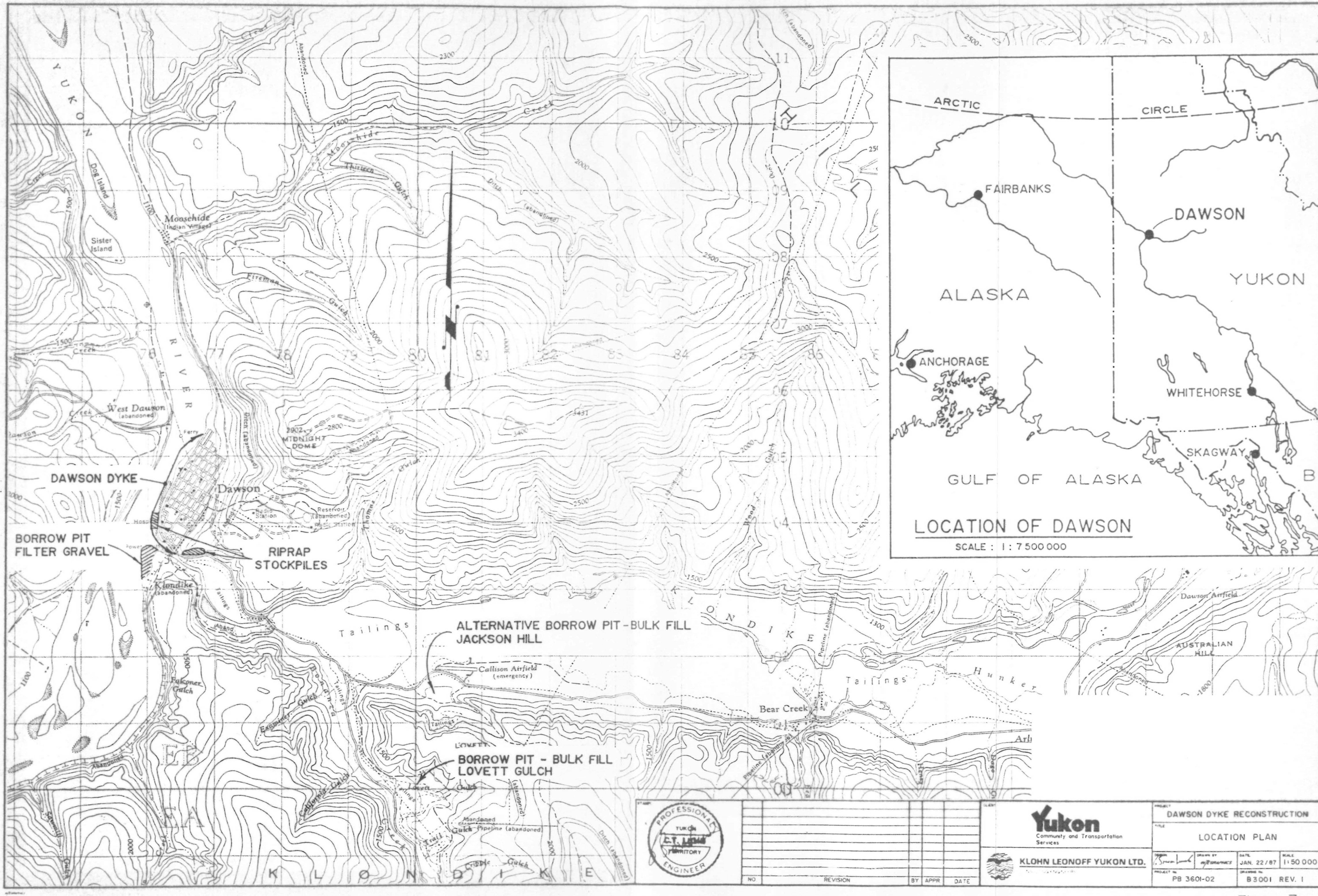
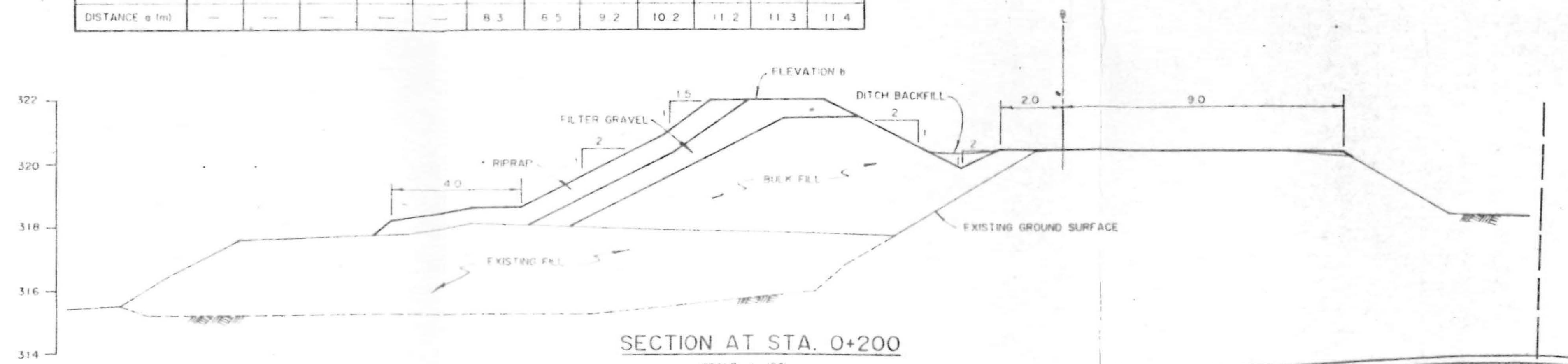

DAWSON DYKE
BORROW PIT
FILTER GRAVEL
RIPRAP
STOCKPILES
ALTERNATIVE BORROW PIT - BULK FILL
JACKSON HILL
BORROW PIT - BULK FILL
LOVETT GULCH
YUKON RIVER
KLONDIKE
Dawson
Moosehide
(Indian Village)
Sister Island
Dog Island
West Dawson
(abandoned)
MIDNIGHT DOME
Klondike
(abandoned)
Tailings
Callison Airfield
(emergency)
Bear Creek
Dawson Airfield
AUSTRALIAN HILL
Hunker
ARCTIC CIRCLE
FAIRBANKS
DAWSON
ALASKA
YUKON
ANCHORAGE
WHITEHORSE
SKAGWAY
GULF OF ALASKA
LOCATION OF DAWSON
SCALE : 1 : 7 500 000
PROFESSIONAL ENGINEER
YUKON TERRITORY
C.T. LIGHT
NO
REVISION
BY
APPR
DATE
Yukon
Community and Transportation Services
KLOHN LEONOFF YUKON LTD.
DAWSON DYKE RECONSTRUCTION
LOCATION PLAN
JAN. 22/87
1:50 000
PB 3601-02
B3001 REV. 1

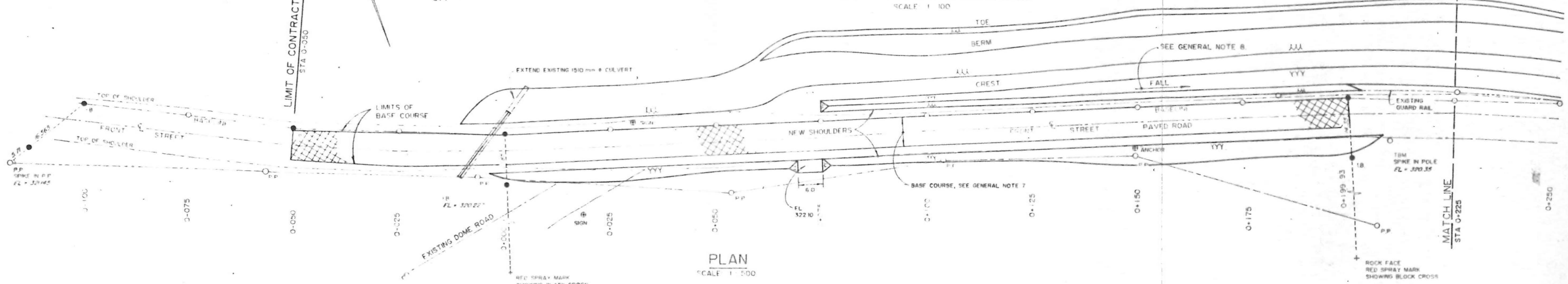
Figure 7

HIGHWAY RECONSTRUCTION	
SETTING OUT DETAILS	
STA	ELEVATION c
0-050	EXISTING
0-025	321 00
0+000	321 30
0+025	321 74
0+050	322 04
0+075	322 10
0+100	321 97
0+125	321 60
0+150	321 00
0+175	320 55
0+200	EXISTING

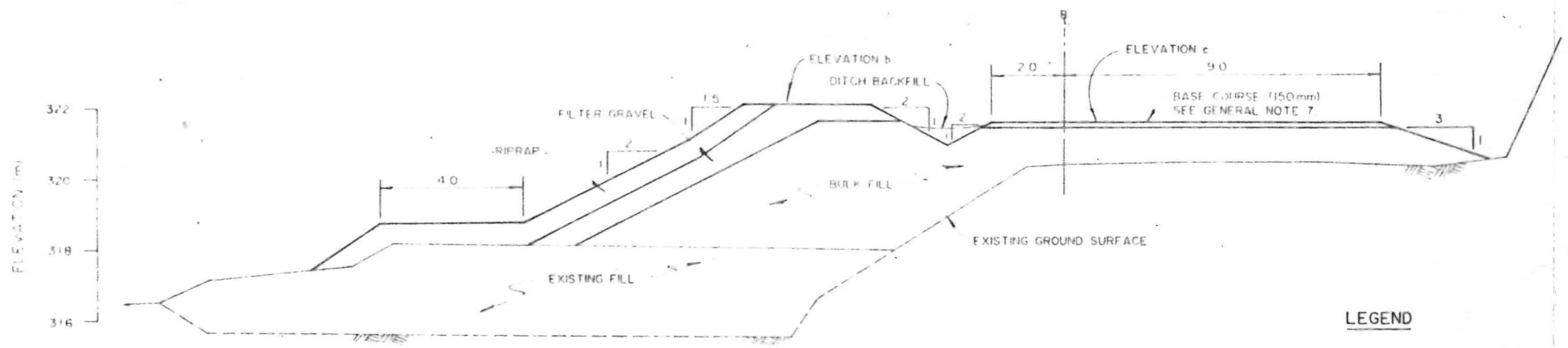
DYKE SCHEDULE												
STATION	0-050	0-025	0+000	0+025	0+050	0+075	0+100	0+125	0+150	0+175	0+200	0+225
ELEVATION b	—	—	—	—	—	322 10	322 09	322 08	322 06	322 05	322 03	322 02
DISTANCE e (m)	—	—	—	—	—	8 3	6 5	9 2	10 2	11 2	11 3	11 4



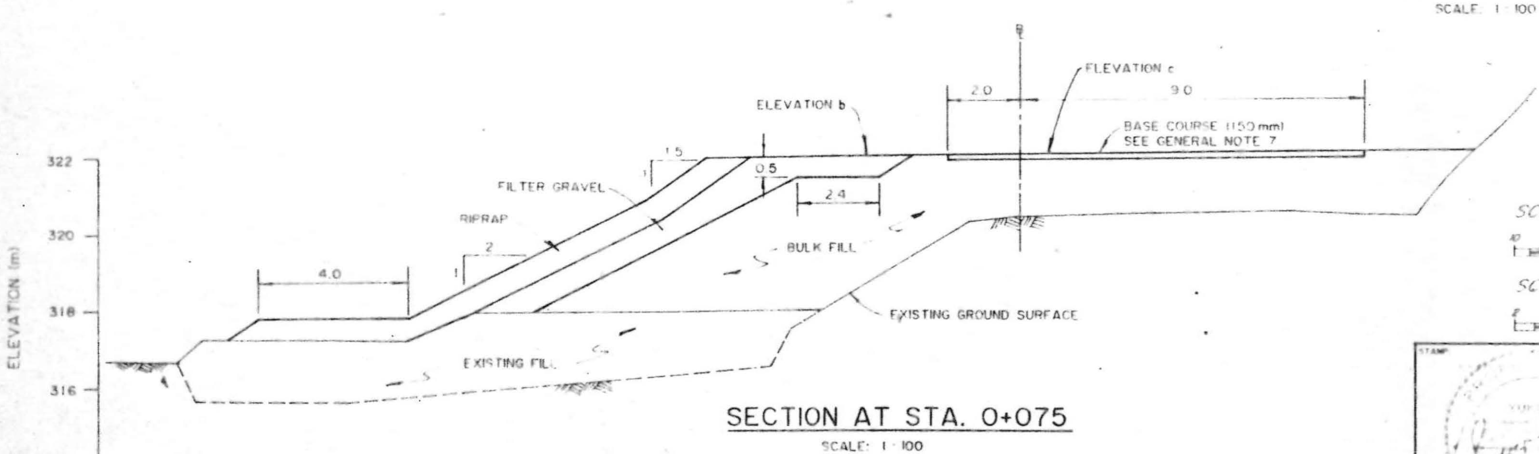
SECTION AT STA. 0+200
SCALE 1:100



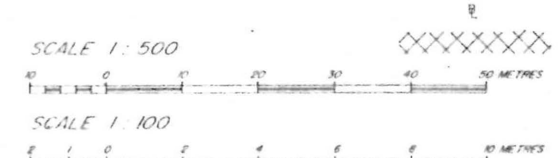
PLAN
SCALE 1:500



SECTION AT STA. 0+125
SCALE 1:100



SECTION AT STA. 0+075
SCALE 1:100

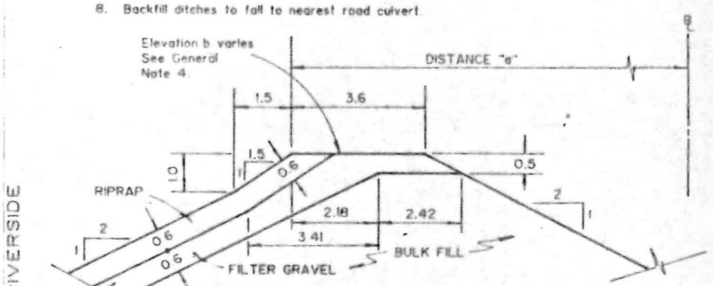


LEGEND

- Base Line Stations
- Base Line P.I
- Existing Structure
- Existing Drain Pipe
- Proposed Drain Pipe
- Power Pole
- Base Line (Section)
- Base Course

GENERAL NOTES

1. Dimensions and Elevations are in metres Elevations are to Geodetic Datum
2. Dyke Stations are measured along Baseline established by the Engineer
3. Cross sections and setting out dimensions given on Dyke Schedule are shown normal to the Baseline
4. Crest Elevations to be uniform grades at 0.06%, + ve upstream and 0.03% - ve downstream, of elevation 321.10 at Sta 1+750
5. Dyke crest and berms to be constructed to give uniform and neat horizontal curves between stations at which setting out dimensions are given.
6. Where setting out dimensions result in less than 1.0m horizontal width of Bulk Fill Material, this width to be increased to 1.0m by local cut as determined by the Engineer in the Field.
7. Location of new road centreline to be same as that of existing road centreline. Crossfall to be 2.5%
8. Backfill ditches to fall to nearest road culvert



SETTING OUT DETAIL (TYPICAL)

NO	REVISION	BY	APPR.	DATE
2	[illegible]			[illegible] MAR 87
1	LANDSIDE SIDE SLOPE CHANGED ON ROAD EMBANKMENT	CTL		4 FEB 87

Yukon Community and Transportation Services

KLOHN LEONOFF YUKON LTD.

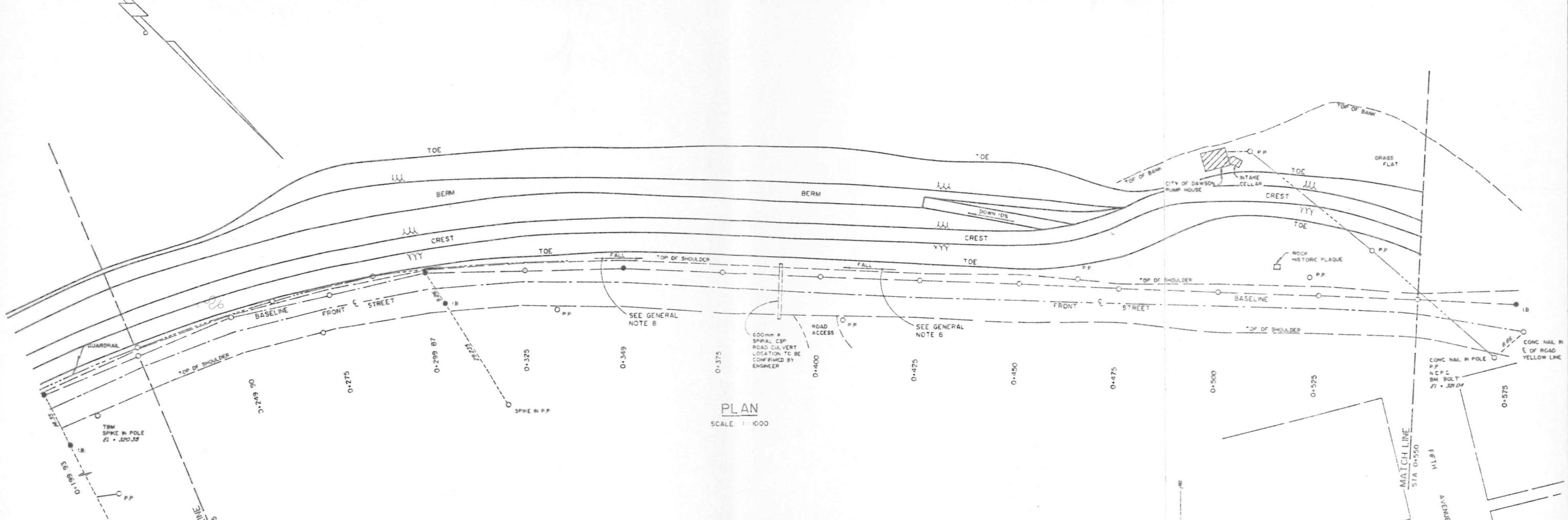
PROJECT: DAWSON DYKE RECONSTRUCTION

TITLE: PLAN AND SECTIONS STA 0-050 TO 0+225

DATE: JAN. 22/87 | SCALE: AS SHOWN

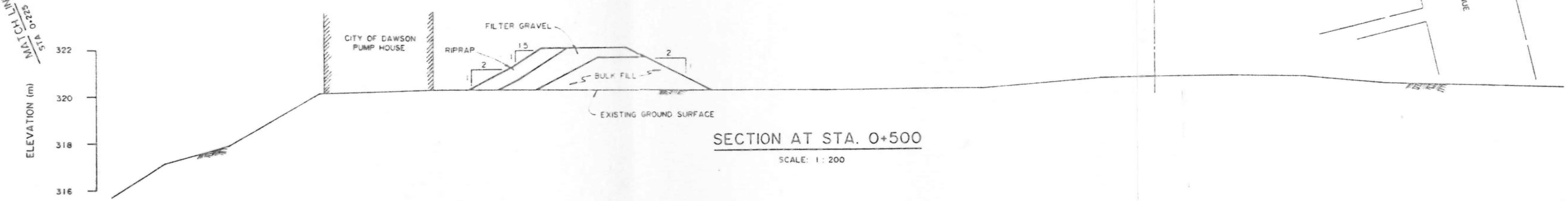
PROJECT No: PB 3601-02 | DRAWING No: D3003 REV 2

DYKE SCHEDULE														
STATION	0+225	0+250	0+275	0+300	0+325	0+350	0+375	0+400	0+425	0+450	0+475	0+500	0+525	0+550
ELEVATION b	322 02	322 00	321 99	321 97	321 96	321 94	321 93	321 91	321 90	321 88	321 87	321 85	321 84	321 82
DISTANCE a (m)	11 4	10 2	10 8	9 6	12 4	12 8	13 15	13 3	13.0	13 1	20 0	26 3	25 9	26 0



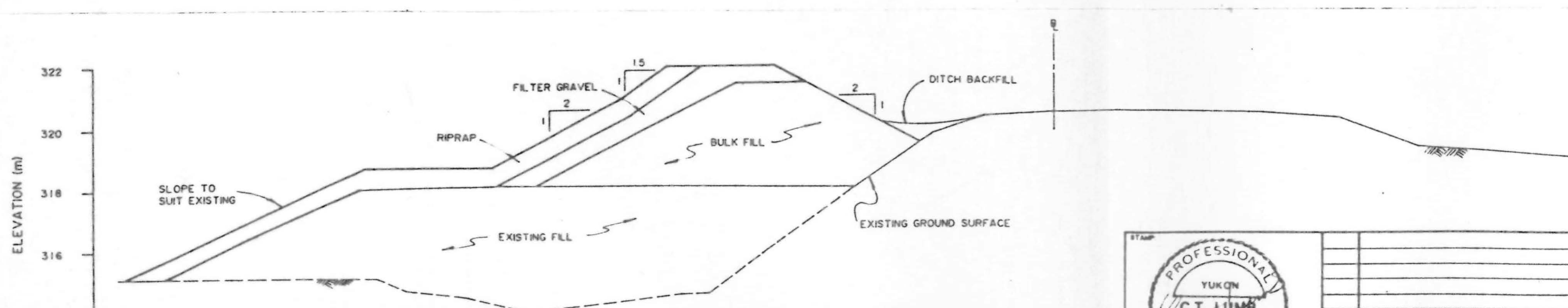
PLAN

SCALE 1:1000



SECTION AT STA. 0+500

SCALE: 1:200



SECTION AT STA. 0+350

SCALE: 1:200

SCALE 1:1000

SCALE 1:200

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NO	REVISION	BY	APPR	DATE

Yukon Community and Transportation Services

KLOHN LEONOFF YUKON LTD.

PROJECT: DAWSON DYKE RECONSTRUCTION

TITLE: PLAN AND SECTIONS STA 0+225 TO 0+550

DATE: JAN. 22/87 — SCALE: AS SHOWN

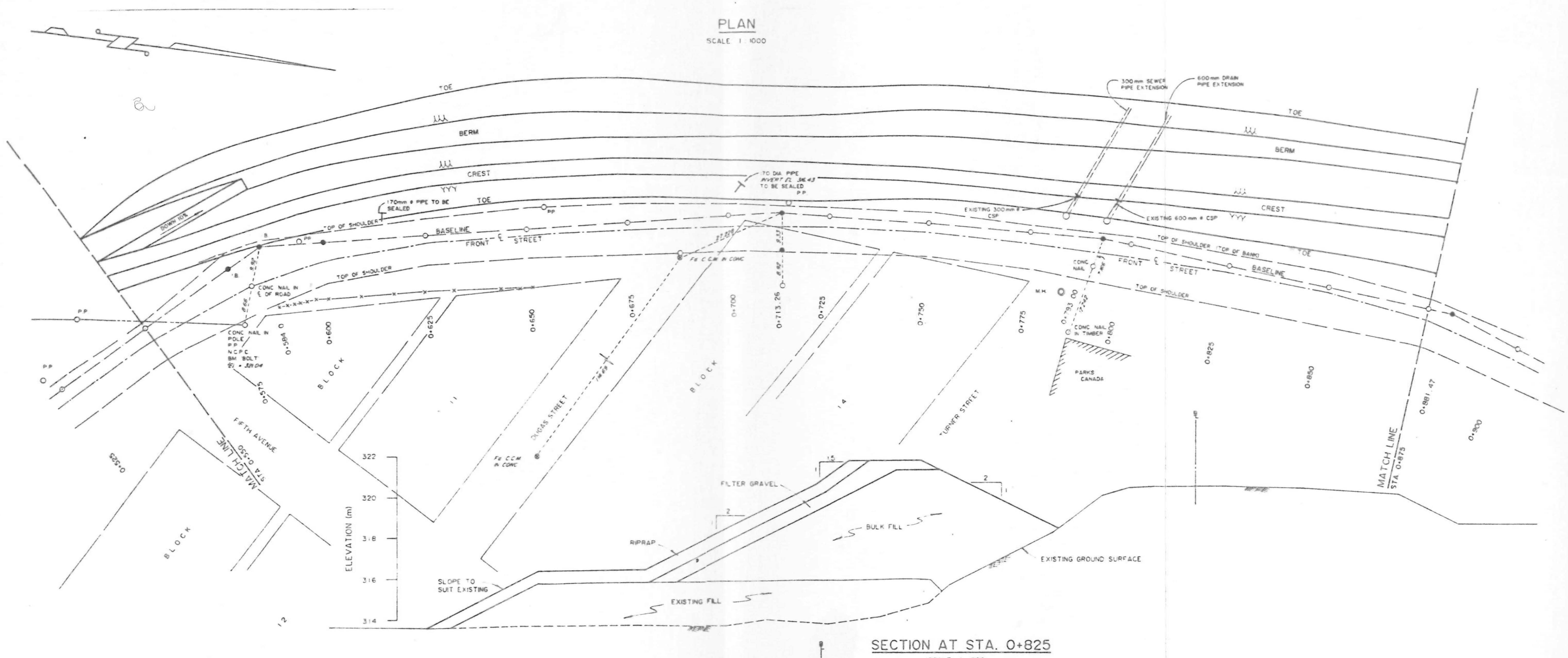
PROJECT No: PB 3601-02 — DRAWING No: D3004

Figure 10

DYKE SCHEDULE														
STATION	0+550	0+575	0+600	0+625	0+650	0+675	0+700	0+725	0+750	0+775	0+800	0+825	0+850	0+875
ELEVATION b	321.82	321.81	321.79	321.78	321.76	321.75	321.73	321.72	321.70	321.69	321.67	321.66	321.64	321.63
DISTANCE a (m)	20.0	11.7	12.3	15.3	16.0	15.3	14.0	13.1	13.4	13.2	14.0	17.1	20.0	22.7

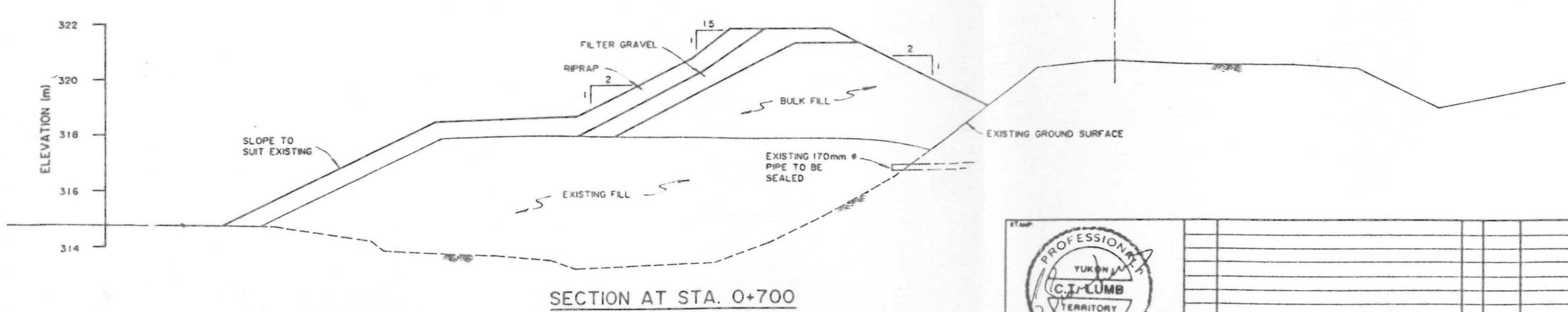
PLAN

SCALE 1:1000



SECTION AT STA. 0+825

SCALE: 1:200



SECTION AT STA. 0+700

SCALE: 1:200

SCALE 1:1000

10 0 10 20 30 40 50 METRES

SCALE 1:200

2 1 0 2 4 6 8 10 METRES

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STAMP: PROFESSIONAL ENGINEER — YUKON TERRITORY — C.T. LUMB

CLIENT: Yukon Community and Transportation Services

KLOHN LEONOFF YUKON LTD.

PROJECT: DAWSON DYKE RECONSTRUCTION

TITLE: PLAN AND SECTIONS STA 0+550 TO 0+875

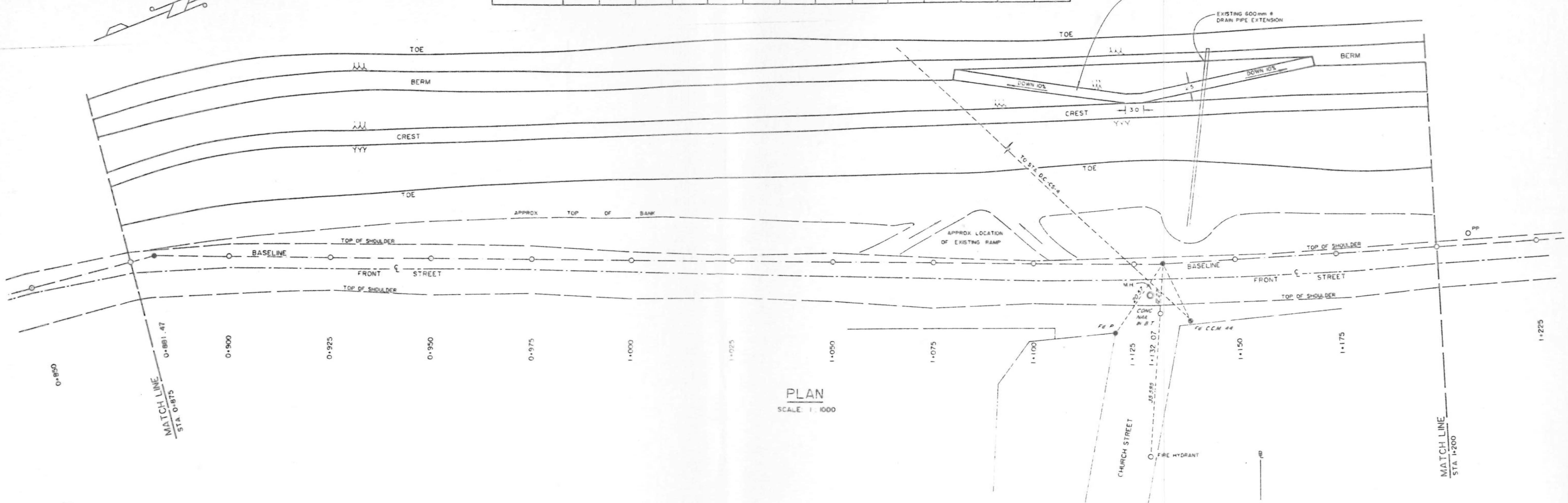
DATE: JAN. 22/87 | SCALE: AS SHOWN

PROJECT No.: PB 3601-02 | DRAWING No.: D3005

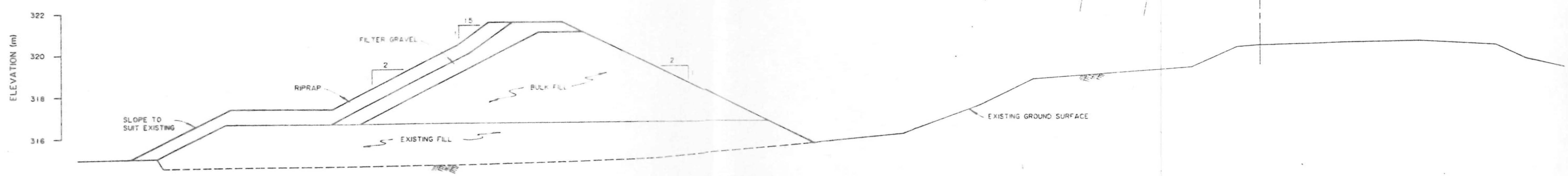
Figure 11

DYKE SCHEDULE

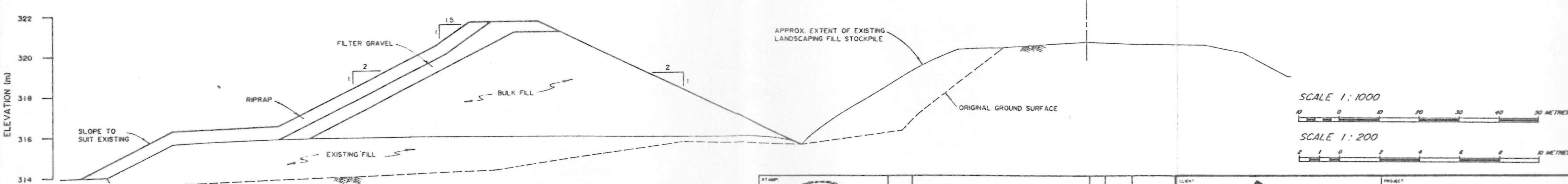
STATION	0+875	0+900	0+925	0+950	0+975	1+000	1+025	1+050	1+075	1+100	1+125	1+150	1+175	1+200
ELEVATION b	321.63	321.61	321.60	321.58	321.57	321.55	321.54	321.52	321.51	321.49	321.48	321.46	321.45	321.43
DISTANCE a (m)	22.7	29.5	31.0	32.3	33.0	34.6	35.6	36.6	37.5	38.5	40.0	40.0	39.2	38.7



PLAN
SCALE 1:1000



SECTION AT STA. 1+075
SCALE: 1:200



SECTION AT STA. 0+925
SCALE: 1:200

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PROJECT: DAWSON DYKE RECONSTRUCTION

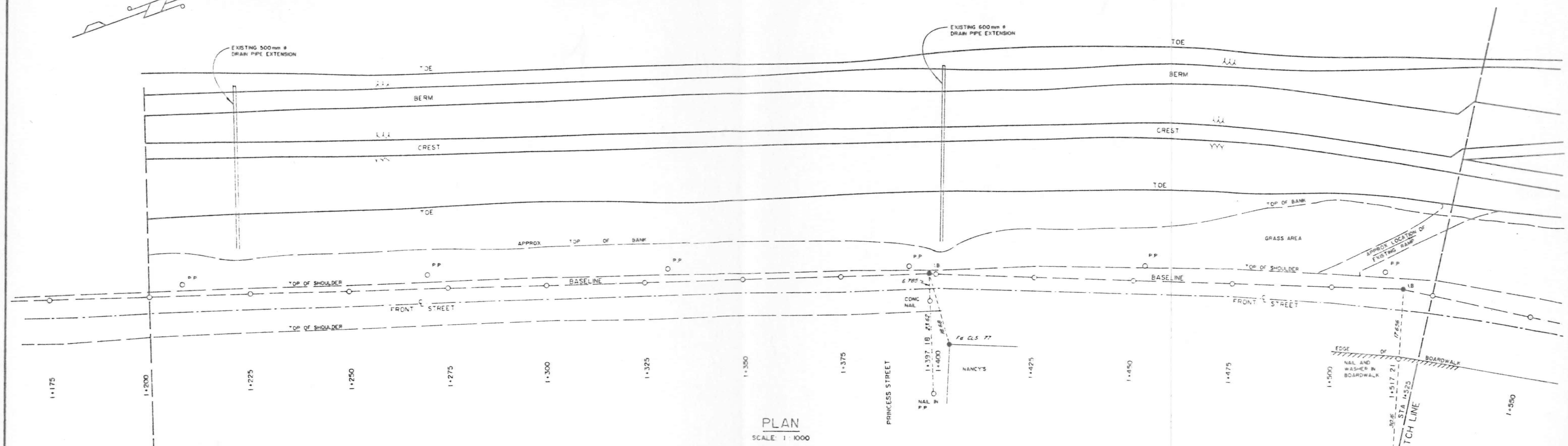
TITLE: PLAN AND SECTIONS STA 0+875 TO 1+200

DATE: JAN. 22/87 | SCALE: AS SHOWN

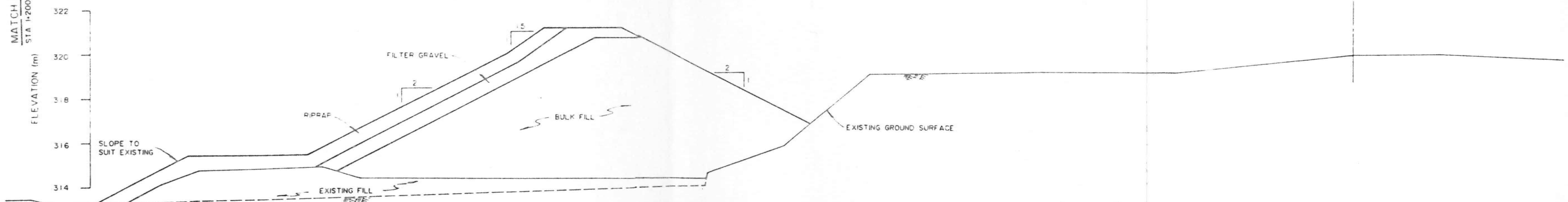
PROJECT No. PB 3601-02 | DRAWING No. D3006

Figure 12

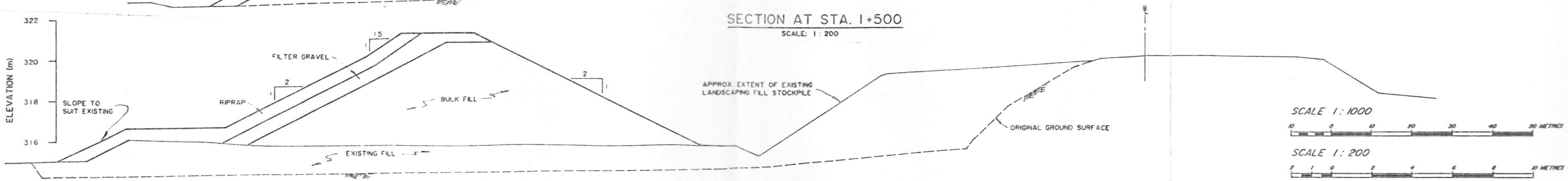
DYKE SCHEDULE														
STATION	1+200	1+225	1+250	1+275	1+300	1+325	1+350	1+375	1+400	1+425	1+450	1+475	1+500	1+525
ELEVATION b	321.43	321.42	321.40	321.39	321.37	321.36	321.34	321.33	321.31	321.30	321.28	321.27	321.25	321.24
DISTANCE a (m)	38.7	38.2	37.7	37.5	37.5	37.5	37.5	37.0	37.6	38.4	39.8	39.2	37.0	34.9



PLAN
SCALE 1:1000



SECTION AT STA. 1+500
SCALE 1:200



SECTION AT STA. 1+300
SCALE 1:200

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Yukon Community and Transportation Services

KLOHN LEONOFF YUKON LTD.

PROJECT: DAWSON DYKE RECONSTRUCTION

TITLE: PLAN AND SECTIONS STA 1+200 TO 1+525

DATE: JAN. 22/87 — SCALE: AS SHOWN

PROJECT No: PB 3601-02 — DRAWING No: D3007

Figure 13

DYKE SCHEDULE														
STATION	1+525	1+550	1+575	1+600	1+625	1+650	1+675	1+700	1+725	1+750	1+775	1+800	1+825	1+850
ELEVATION b	321.24	321.22	321.21	321.19	321.18	321.16	321.15	321.13	321.12	321.10	321.09	321.09	321.08	321.07
DISTANCE a (m)	34.9	36.2	37.8	38.0	38.7	38.6	—	22.8	22.8	34.5	34.3	32.6	31.3	29.8

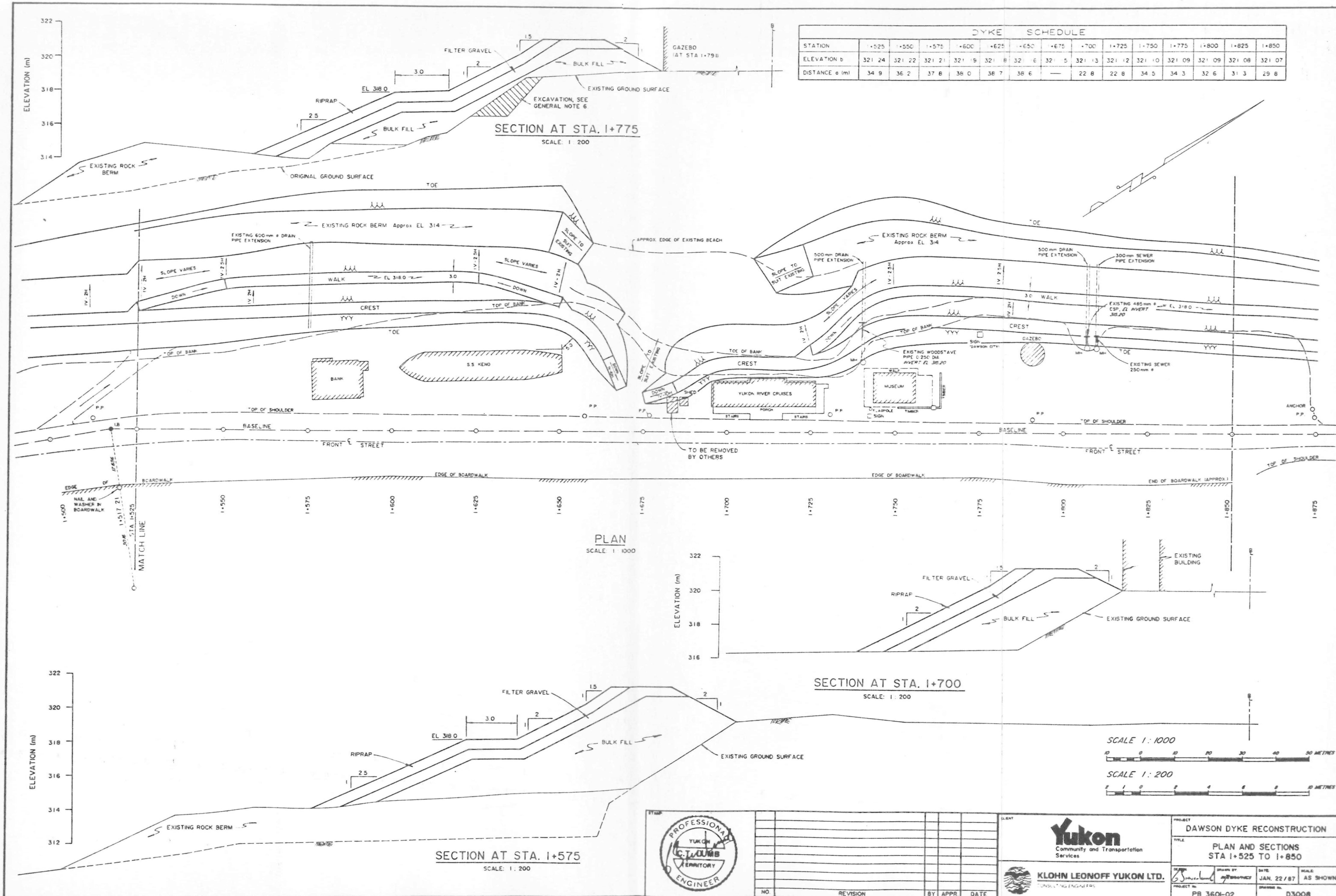


Figure 14

STATION	1+850	1+875	1+900	1+925	1+950	1+975	2+000	2+025	2+050	2+075	2+100	2+125	2+150	2+175
ELEVATION b	321.07	321.06	321.06	321.05	321.04	321.03	321.03	321.02	321.01	321.00	321.00	320.99	320.98	320.97
DISTANCE a (m)	29.8	28.3	13.6	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	13.6	20.2

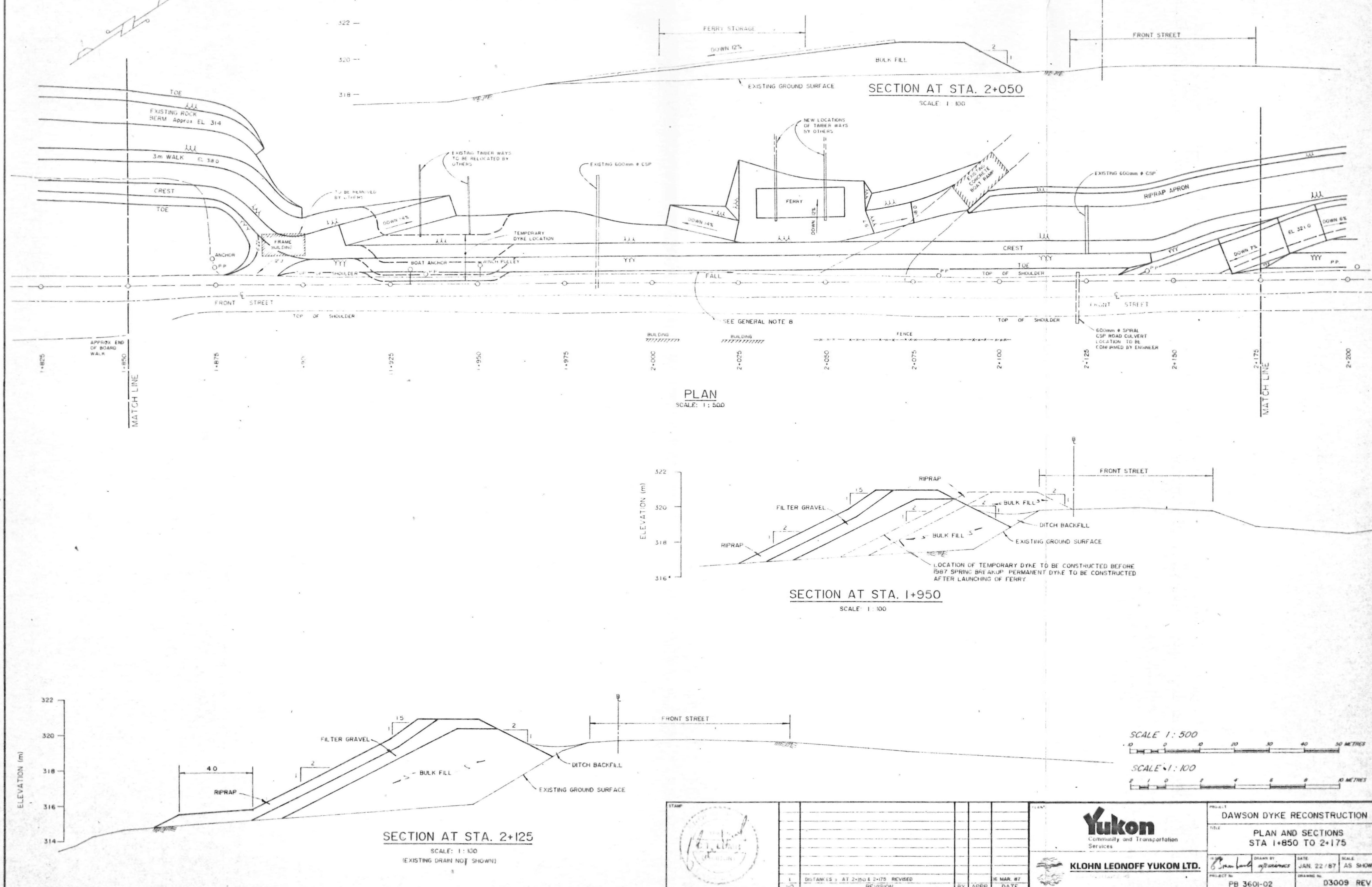
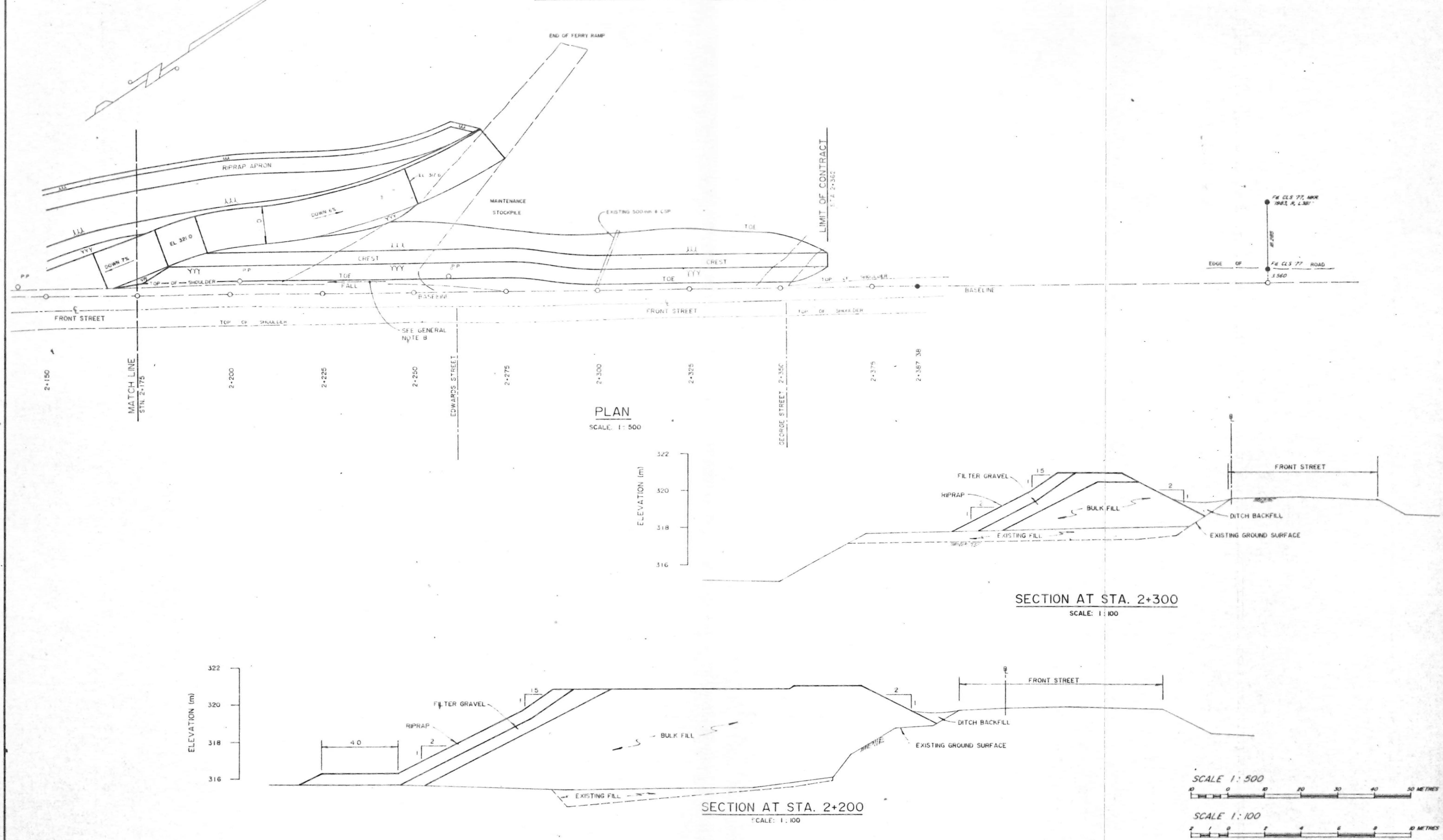


Figure 15

DYKE SCHEDULE										
STATION	2+175	2+200	2+225	2+250	2+275	2+300	2+325	2+350	2+375	2+400
ELEVATION b	320 97	320 97	320 96	320 95	320 94	320 94	320 93	320 92	320 91	----
DISTANCE a (m)	20 2	11 5	11 5	11 5	11 5	9 5	9 5	9 5	9 5	—



NO	REVISION	BY	APPR.	DATE
1	DISTANCE a AT 2+175 REVISED			16 MAR 87

STAMP

Yukon Community and Transportation Services

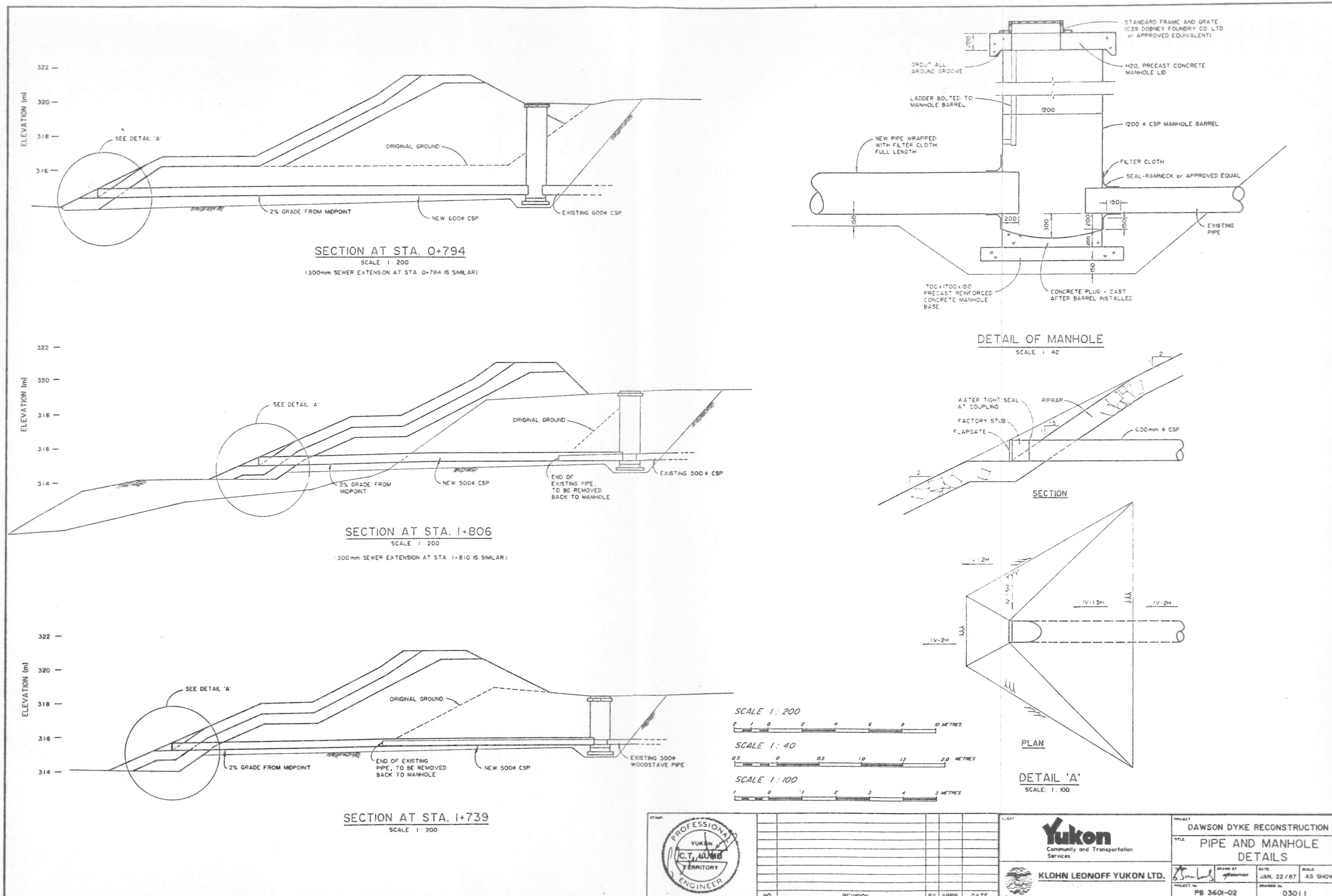
KLOHN LEONOFF YUKON LTD.

PROJECT: DAWSON DYKE RECONSTRUCTION

TITLE: PLAN AND SECTIONS STA 2+175 TO 2+400

DRAWN BY: INTERGRAPHICS | DATE: JAN. 22/87 | SCALE: AS SHOWN

PROJECT No: PB 3601-02 | DRAWING No: D3010 REV 1


SECTION AT STA. 0+794
SCALE 1:200
(300mm SEWER EXTENSION AT STA. 0+784 IS SIMILAR)
ELEVATION (m)
322
320
318
316
SEE DETAIL 'A'
ORIGINAL GROUND
2% GRADE FROM MIDPOINT
NEW 600ø CSP
EXISTING 600ø CSP
SECTION AT STA. 1+806
SCALE 1:200
(300mm SEWER EXTENSION AT STA. 1+810 IS SIMILAR)
314
END OF EXISTING PIPE, TO BE REMOVED BACK TO MANHOLE
NEW 500ø CSP
EXISTING 500ø CSP
SECTION AT STA. 1+739
SCALE 1:200
EXISTING 300ø WOODSTAVE PIPE
STANDARD FRAME AND GRATE (C39 DOBNEY FOUNDRY CO. LTD or APPROVED EQUIVALENT)
GROUT ALL AROUND GROOVE
H20, PRECAST CONCRETE MANHOLE LID
LADDER BOLTED TO MANHOLE BARREL
1200
1200 ø CSP MANHOLE BARREL
NEW PIPE WRAPPED WITH FILTER CLOTH, FULL LENGTH
FILTER CLOTH
SEAL-RAMNECK or APPROVED EQUAL
EXISTING PIPE
1700 x 1700 x 150 PRECAST REINFORCED CONCRETE MANHOLE BASE
CONCRETE PLUG - CAST AFTER BARREL INSTALLED
DETAIL OF MANHOLE
SCALE 1:40
WATER TIGHT SEAL AT COUPLING
FACTORY STUB
FLAPGATE
RIPRAP
600mm ø CSP
SECTION
1V:2H
1V:1.5H
PLAN
DETAIL 'A'
SCALE: 1:100
SCALE 1:200
10 METRES
SCALE 1:40
2.0 METRES
SCALE 1:100
5 METRES
PROFESSIONAL ENGINEER
YUKON TERRITORY
C.T. LUMB
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BY
APPR.
DATE
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Community and Transportation Services
KLOHN LEONOFF YUKON LTD.
DAWSON DYKE RECONSTRUCTION
PIPE AND MANHOLE DETAILS
JAN. 22/87
AS SHOWN
PB 3601-02
D3011

Figure 17