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## Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

REPORT TO

KNOX MARTIN KRETCH LTD.

CONTRACT 5

GEOTECHNICAL INVESTIGATION

PROPOSED TRUNK WATERMAINS

CENTRAL PART OF COBALT

(FROM GALENA STREET TO ARGENTITE STREET)

COBALT

ONTARIO

WO: 2002-11005

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## PART I - FACTUAL INFORMATION

### 1. INTRODUCTION

Golder Associates has been retained by Knox Martin Kretch Ltd., Consulting Engineers to the Town of Cobalt and the Ministry of the Environment, to carry out geotechnical investigations of overburden and bedrock conditions along the proposed alignments of the new watermains through the town.

This report, for the Contract 5 area complements an earlier report (GA #851-1172) issued in October 1985 outlining results of extensive surveys of bedrock conditions in the old part of the town. These reports, which should be read together, provide information relating to the routes for the new watermains to be constructed under Contract 5.

### 2. INVESTIGATIONS

In view of the extensive mine workings known to exist within the Contract 5 area, additional searches of the records of Agnico Eagle Mines Limited and Canadaka Mines Limited were carried out in 1986.

On the basis of previous mapping supplemented by this further information, thirteen (13) diamond drillholes were put down to provide data on bedrock and overburden conditions and to locate, where possible any old mine workings. The locations of these new holes, which were



drilled in late August and early September 1986, are shown on Figure 1 together with the locations of earlier investigation probe holes (report #851-1172). Logs of all the new holes included in the area of Contract 5 are presented in Attachment I to this report; the data from the radar traverses and probe holes are presented in the earlier report.

The majority of the investigation holes were located in the southern section of the Contract 5 area where most of the old underground mining workings are concentrated.

Holes GA-10 AND GA-11 were drilled as angle-holes across Highway 11B to determine the location of sub-vertical stopes in the Townsite and City shaft areas. Holes GA-8 and GA-12 were drilled vertically to aid in further definition of the same stoping areas and holes GA-13, GA-14 and GA-15 were drilled to supplement the earlier probe hole drilling in an effort to locate specific near-surface underground openings indicated on old mining record plans. Hole GA-16 was drilled vertically to intersect a geophysical anomaly which probably represented an underground exploratory drift or stope beneath Jamieson Street.

Three holes were drilled in the central section of Contract Area 5.

Hole GA-1 was drilled at an angle across Silver Street to determine subsurface conditions where a zone of extensive stoping was known to occur beneath the alignment of an old buried valley.

Hole GA-9 was also drilled as an angle-hole, this time to define the northern limit of the major series of stopes which occur in the vicinity of the junction

of Galena Street and Grandview Avenue. The third hole, GA-7 was located on Prospect Avenue east of probe hole P-7. It was drilled vertically to determine the characteristics of the overburden/bedrock interface on the steep sidehill slope adjacent to the old Anglican Church.

In the northern section of area 5, two further holes were put down.

One hole, GA-6 was angled southwards to determine the geometry of a bedrock ridge and if possible, to establish the bedrock character adjacent to the old sewer tunnel. The second hole, GA-17 was drilled on the lane sloping down from Silver Street to Argentite Street in the vicinity of the Arena. This hole was drilled principally to determine the depth to bedrock.

All of the holes were drilled by Morrisette Diamond Drilling Co. Ltd. of Haileybury who were responsible for the supply and operation of the drilling equipment. Each of the holes was advanced using rotary washboring methods in the overburden with split spoon sampling (35 mm ID) at regular intervals. Diamond core drilling at NQ-2 size was carried out in the bedrock.

The samples obtained from the split spoon tests and from the routine drilling operations were brought to our Mississauga laboratory for further examination, and where appropriate, classification testing. The NQ-2 rock cores obtained during the investigations were not removed from Cobalt but have been stored by the Town's Works Department.

### 3. SUBSURFACE CONDITIONS

Subsurface conditions in the Contract 5 area are complicated not only by the extensive mining works that have been carried out beneath parts of the town, but also by the significant modifications that have been made to ground surface elevations by old mining fills and construction works.

From a geotechnical standpoint, the Contract 5 area can be divided into three sections; namely:

- o those areas where overburden is deep and within which no underground mining activity is known to have been carried out within the bedrock,
- o those areas where bedrock is exposed or close to surface, and within which no exposed or mining excavations are known to occur close to ground surface, and
- o those areas where extensive underground mining activity has been undertaken in close proximity to the ground surface.

Large parts of Contract Area 5 are characterized by bedrock at or near surface. Only in a narrow ribbon across the central section of the works does extensive overburden exist, principally along a buried valley extending from the Highway 11B/Miller Street junction area, north-eastwards to the Town Square at the corner of Prospect Avenue and its intersection with Lang Street (see Figure 1). The deposits encountered in this old river course and overburden deposits elsewhere in the Contract 5 area are discussed first in section 3.1; section 3.2 discusses most of the remaining Contract 5 area except for those specific zones where extensive

mining works occur. These latter areas, where complicated underground workings exist, are discussed in detail in section 4.0 to complement the data already presented in our earlier report (#851-1172). In this report, details of the information gained from the previous work and from additional review of old mining plans have been combined with recent information from the diamond drillholes in order to assess ground conditions relating to the proposed construction works.

### 3.1 Overburden

Within the Contract 5 area the only zones where significant thicknesses of overburden exist are along the sinuous north-east/south-west trending buried valley that crosses the central section of the old town and in the vicinity of other minor tributary valleys which traverse Contract area 5.

The data from the radar profiling (report #851-1172 - Figure 4) suggests that along the alignments of the proposed watermains, relatively thick overburden deposits occur:

- o throughout the northern section of Silver Street generally south of Prospect Avenue, and
- o in the central section of Cobalt Street predominantly north of Grandview Avenue.

In other parts of the Contract 5 area, overburden depths apparently vary rapidly with bedrock outcropping in many locations between isolated pockets of thin overburden (of 1-2 m thickness typically). This variation is well illustrated by the bedrock profile through the north-western section of Helen and Nickle Streets as shown in section on Figure 2. This profile, which is

derived from a print produced in about 1910, confirms the typical picture seen elsewhere around the town that bedrock is seldom far below ground surface, the maximum depth being only about 1.5 m adjacent to one part of Helen Street.

Observations from exposures along the roads in this area and information from hole GA-7 put down adjacent to the Church at the northern end of this old sewer line (see log in Attachment I) suggest that sand-gravel-cobble fill has been used extensively over the bedrock surface to infill natural bedrock hollows. Three swampy areas and depressions are indicated on the old plan for this part of the Contract 5 area, one near where House 74 Helen Street now exists, one where House 79 Helen Street now exists, and one near catch basin 26A to the east of House 88 Nickle Street. In these areas, (see Figure 2), it is suspected that fill has been placed, probably directly over existing weak deposits.

Based on exposures on the sides of the roads elsewhere around this north-western section of Contract Area 5, a thin cover of peaty topsoil and/or sandy till likely occurs over most areas of natural undisturbed bedrock. Similar conditions of highly variable bedrock topography with infilled pockets of overburden are also inferred to exist over much of the south-eastern section of Contract Area 5, the deepest overburden (sand predominantly) being found in the GA-16 area on Jamieson Street (see log in Attachment I). Sand, or sand and gravel seem to comprise the characteristic overburden materials in much of this southern section of the Contract 5 area: 0.75 m of sand was encountered in P-25, nearly 3 m in GA-16, 0.5 m in GA-13, just over 1 metre in P-10, 1.3 m in P-11 and 0.8 m in GA-14.

Numerous areas also exhibit coarser grained materials, such as rockfill and undifferentiated mine waste, including timbers. Concrete fragments, construction rubble and/or mine timbers were specifically recorded from some of the fill materials recovered from holes GA-1, GA-6, GA-11 and GA-13.

In the areas of thickest overburden along the inferred course of the old river valley, thick sequences of rockfill and mine waste material occur. At P-15, for example, 2.6 m of rockfill occurs. At P-17, a 3.0 m thickness was recorded, at GA-1, just under 2 m and; in the Miller Street/Highway 11B corner area, 1.2 m at GA-10, 0.9 m at GA-8, 1.5 m plus at GA-11 and 1.4 m at GA-12.

These thick fill sequences overlies up to 4 m of natural materials. At GA-1 for example, organic soils overlies cobbles and boulders with some fines (sands and silts). These, in turn, overlies gravels sitting on top of bedrock encountered at approximately elevation 293 m, some 7 m below existing road surface level. Similar conditions were reported some 200 m to the southwest during construction of the new Post Office, for which it is understood that piles were sunk to depths of about 10 m.

Along the southern boundary of the Contract 5 area, various areas of thick overburden also occur on steep bedrock sideslopes. At hole P-9, for example, over 3 m of relatively loose fill was encountered (penetration rate of over 7 m/min. - refer log in Appendix B of report #851-1172). This area is characterized by a rapidly varying ridge and hollow bedrock topography. In consequence, overburden depths vary markedly, from only a few centimetres to, in places, in excess of 2 m.

### 3.2 Bedrock

The rock type encountered in most of the diamond drillholes and exposed in outcrops throughout the Contract 5 area is generally strong, competent conglomerate. In some locations, more flaggy argillite units occur, but in most situations these seem to be confined to narrow bands set within the more usually present conglomerate.

In general, most of the rocks, where undisturbed by mining activity, are competent and at surface, where natural bedrock in an undisturbed state is exposed, usually comprise rounded outcrops of competent conglomerate. In these areas, fracturing is limited to minor, joint-controlled depressions within the rock and to zones of more intense natural jointing associated with faulting and major through-going joints.

Several suites of discontinuity sets occur throughout the rock mass. Many dip near vertically and strike N-S or NE-SW. Most exhibit joint spacings varying from 50 mm to 200 mm within the conglomeratic units and between 5 mm and 100 mm in the more argillitic units. Such jointing forms the dominant discontinuity suite except in close proximity to some of the more important large scale geological features where more schistose units occur, some of which exhibit marked foliation.

In the vicinity of the northeast-southwest trending valley through the centre of the Contract 5 area, some conspicuous 30°-50° eastwardly dipping joints occur, mirroring the attitude of several low angle faults encountered in the mine workings in this area (see Figures 10 and 11 of report #851-1172). This valley constitutes the surface expression of one of these major

faults - the West Fault (see Figure 8 of report #851-1172). Other naturally fractured areas of bedrock undisturbed by mining activity also occur parallel to this trend. Thus, the in situ bedrock structure, particularly adjacent to this central valley, controls to a large extent the ridged nature of the natural topography. Where pronounced ridges occur, the rock is relatively unfractured and between such areas, where the rock is often extensively fractured, overburden infills, sometimes of significant thickness occur.

The thirteen drillholes put down in the Contract 5 area reflect this variation in conditions, holes GA-1, GA-7 to GA-12, and GA-14 to GA-17 exhibiting varying degrees of natural fracturing of the conglomerates, frequently emphasized by proximity to mine workings. In many situations, heavy limonite (iron oxide) coatings are found on fracture surfaces in the conglomerates; natural calcite infilling of fractures is also common in some of these areas as are mineralized veins.

Fractured argillites were encountered in holes GA-7 and GA-16 and in GA-11, GA-12, and GA-13 along the mapped trace of the Galena Fault (see Figure 8 of report #851-1172).

### 3.3 Groundwater

Currently, much of the bedrock within the Contract 5 area is relatively well drained by virtue of the fact that it has been extensively undermined by workings extending from the half dozen shafts known to have been put down in the area. Because of this and the very rapid variation in topography across the town, groundwater levels even



within the deep overburden valley are heavily influenced by subdrainage from the underlying workings.

Groundwater levels within the Townsite No. 1, City and Coniagas No 4 shafts are understood to have stabilized at or about 50 m depth (el. 255 m) when pumping was undertaken in about 1947 from both the City and Townsite shafts (2500 gpm and 1500 gpm respectively). At present, it is understood that groundwater levels are about 10 m down at each of the three shafts. This is also suggested by data from the drillholes and probe holes. The fact that no surge water returns were recorded while drilling the air-flush probe holes in particular, tends to suggest generally dry conditions in the overburden and upper zone of the rock in these areas.

Based on available information, it is anticipated that groundwater levels in Contract Area 5 will, in addition to any control by underdraining, be generally sympathetic to the topography; areas of exposed bedrock ridges being dry and valley areas, where not underdrained, providing seasonal discharge points and exhibiting relatively high groundwater levels. Thus, the likely areas where groundwater levels could be close enough to surface to be encountered in the trenches are:

- o towards the north end of Silver Street adjacent to Prospect Avenue, and
- o in the low area of Grandview Avenue, west of and adjacent to Cobalt Street.

Both of these locations, it will be noted from Figure 1, are within the alignment of the inferred overburden filled bedrock valley and both are in areas away from the zone of major underground stoping in the Miller Street/Highway 11B intersection area.

#### 4. OLD MINING AND CONSTRUCTION WORKS

Extensive near-surface and underground mining exploitation has been undertaken beneath approximately one third of the town area included within the Contract 5 works. The exact extent of these old near-surface mining workings is unknown, much of it having been completed in the 1930's by lessors (refer section 5 of report #851-1172 for further discussion on this point). Nevertheless, some records exist, and based on these and the radar profiling results (ref. Figure 4 of the previous report) locations were selected for the series of diamond drillholes put down in the late summer of 1986.

Three principal areas of particular concern exist within the bounds of the Contract 5 area; namely:

- o the Buffalo No. 5 and Nancy Helens shafts and associated stopes in the vicinity of Galena Street/Grandview Avenue junction, (Figure 3),
  - o the Townsite No. 1 and No. 7 and the City of Cobalt shaft areas adjacent to Highway 11B/Miller Avenue junction, (Figures 4 and 5), and
  - o the area around the Coniagas No. 4 shaft in the intersection area between Prospect Avenue and Silver Street, (Figure 6).
- o Of these three areas, probably most is known about the Galena Street/Grandview Avenue area as the stopes to the west of the road are open to surface and thus can be inspected. Furthermore, two relatively recent collapses have occurred of the overburden and the thin rock cap over the old

openings (ref. Figures 17 and 18 of report #851-1172 for capping information). However, as only the detailed level plans remain, and as these pre-date any activity by the lessors, no absolute dimensions are available to define the configuration of the stopes as they exist today.

The radar traverse records, the data from probe hole P-8 and the core from hole GA-9 provide some information on overburden and bedrock conditions and competence. Both drillholes and the radar traverses show that bedrock is very close to surface; at probe hole P-8 (0.6 m), and at GA-9 (1.50 m). Information from the shaft and road capping works also suggest that overburden is thin, probably everywhere less than 2.0 m.

The bedrock adjacent to the stope as cored by hole GA-9 is relatively competent, Rock Quality Designation (RQD) values being 70-90% over most of the cored length. Only within 1.5 m of the stope sidewall are poor rock conditions encountered (refer Figure 3 and the detailed log of the hole included in Attachment I). The water flush returns also confirm the competence of the rock mass, as water was only lost when less than 1.0 m from intersecting the stope.

- o Conditions in the Highway 11B/Miller Avenue intersection area are even more complex than in the Galena/Grandview area. As shown on Figures 4 and 5, one major NE-SW trending stope on the 'A' and 'P' veins and several minor excavations on other trends occur immediately adjacent to and alongside Highway 11B. These are associated with other workings from the Townsite Mine shafts into the 'B', 'C' and 'S' veins. Rock and overburden conditions in the

vicinity of these stopes (the outlines of which are largely plotted from 1922 mining plans and sections held by Agnico Eagle Mines Ltd.) were investigated by the radar traversing and by the diamond drilling of holes GA-8 and GA-10 (see Figure 4 for locations).

Approximately 1 m of sand and gravel fill occurs over 3 m of natural sands and gravels at the site of hole GA-10. Conditions at the Townsite shafts, on the other side of the road are reported as clays (see Figure 15 of report #851-1172). This suggests that considerable variation in overburden characteristics occurs in this immediate vicinity, possibly as a result of past mining activity.

Rock conditions at GA-8, adjacent to the 'C' vein stopes are reasonably good, RQD values, except near the surface, being above 50% (see log in Attachment I). The situation at GA-10 is completely different; much of the ground, particularly in the near-surface zone is very broken and many of the joints are limonite and haematite stained. Rock conditions improve over the 10 m wide zone from about 25 m along hole depth to about 36 m along hole, corresponding to a zone of competent rock adjacent to the stope (see Figure 5 - section AA).

Flush water returns were lost in this hole from about 10 m inclined depth, reflecting the very open nature of the upper part of the bedrock.

Rock conditions are even worse at GA-11 (see Figure 5 - section BB and log in Attachment I), RQD values for most of the hole being close to zero; however,

flush returns in this hole were the reverse of those in GA-10. No flush water return was recovered prior to reaching about 6 m inclined depth, when a consistent 80% return was obtained until the hole broke through into the stope. As the rock is more argillitic in this hole than at GA-10 (compare sections on Figure 5) this information suggests that, although broken and fractured, the rock at hole GA-10 is relatively tight insitu.

The ground conditions in the entire area of the Highway 11B/Galena Street/Miller Avenue junction are of some concern. Directly under the road intersection at least two raises are known from the 1920's plans to come to surface. It is not known for certain whether these were enlarged in the 1930's by the lessors to continue crown pillar excavation of high grade silver in this area. Nor is it known whether the lessors "robbed" material from the sides of the boundary pillar which is reported to exist under Galena Street (at about the location of the existing bus shelter between the Buffalo 10-32 stope and the City vein 1 stope). However, it is known that part of the north shoulder of Highway 11B collapsed sometime in the 1970's and was subsequently concrete capped at the location shown on Figure 5. The raise that surfaces in the yard of House 45, behind the Senior Citizens Home has continually subsided and it too was capped, again in the 1970's. Furthermore, it is understood that during construction of the Senior Citizens Home in 1972, extensive open workings associated with the City of Cobalt shaft were uncovered necessitating the moving of the building from the site originally proposed.

Because of the very high grade silver found in even the narrower veins in this area, it was a prime

target for uncontrolled mining in the lessors' era of the 1930's and at one time was even considered worthwhile for re-mining post war. In this regard it is understood that attempts were made in the late 1940's to pump down this whole area with a view to re-opening the workings.

In addition to the available information in the Miller/Galena junction area shown on Figure 5, other peculiarities that could reflect the presence of other near-surface underground excavations in the area are:

- the drainage characteristics reported by the resident of House 24 Baker Street and
- the significant nuisance vibrations reported by residents in Houses 27 and 29 Galena Street while drilling was underway on hole GA-11 under Miller Avenue.

The overburden conditions here are also likely to have been complicated by mining activity. Over 1 m of sands and gravels were encountered in probe hole P-10 and up to 2 m of overburden recovered during the drilling of hole GA-12. The data from this latter hole which was drilled adjacent to Miller Avenue, on the south corner with Helen Street (Figure 4) suggests that the bedrock is very broken at surface and may even comprise detached blocks.

- o Conditions in the area around the Coniagas No. 4 shaft are much more difficult to assess in view of the fact that no records were found documenting near-surface workings in the area. However, hearsay information suggests that drifting at least is close to surface under parts of Prospect Avenue and possibly Silver Street, directly adjacent to the shaft house (now a Butcher's shop).

Two areas of extensive stoping are known to have been undertaken in the vicinity to crown elevations of approximately 280 m (i.e. 30 m below ground level).

The traces of these, the vein 32 and the vein 24 stopes on the City of Cobalt property are shown on Figure 6 together with all of the drifts known in the area from the 2nd level of the City of Cobalt mine - all at about elevation 250 m or lower (ie. more than 50 m below existing ground level).

Ground conditions are further complicated by the old river valley which crosses directly across the area (see Figure 6). The natural overburden infill of this valley has been supplemented with extensive mine waste (rockfill etc.) directly from the old Coniagas No. 4 shaft so that in places within the Silver Street/Prospect Avenue intersection area, over 2 m of rockfill may exist overlying natural soils or bedrock.

The highly variable nature of the bedrock topography to the north of this area is a further complication as shown on Figure 7. Here, as at the Presley Street location adjacent to the supermarket (ref. Figure 2 of report #851-1172), the sewer is known to be in tunnel. In order to assess rock conditions alongside this tunnel, hole GA-6 was put down inclined to the south and located in front of Ecole Ste. Therese at the north end of Silver Street. Drilling began in the afternoon of August 28th and was completed the following morning. After penetrating an asphalt layer, considerable difficulty was experienced in drilling through material consisting primarily of construction or old mine timbers. Bedrock was encountered almost immediately below this at an inclined depth of 1.4 m.

The rock in the area appeared to be well drained (probably to sewer invert level) as there were no water flush returns recorded during drilling the entire hole length. Because of the difficulty in drilling this hole, it is suspected that some form of timbered raise and/or other mining excavations occur in this area which may have, where conveniently located, been subsequently utilized for the existing sewer system.

Other old workings were suspected from the radar traverse work in the lower part of Jamieson Street (refer section 4.1 of report #851-1172). In consequence, one diamond drillhole - hole GA-16, was put down to identify the cause of the radar anomaly. Although the hole did not intersect the suspected drift location, a zone of marked fracturing was encountered. Most of the individual fractures were clean, (ie. without limonite staining) and very rough and uneven. Some passed clean through pebble fragments within the conglomeratic rock mass, suggesting that they were of blast or stress-induced origin rather than natural fractures associated with old geological structural weaknesses. In consequence, it is considered that although the hole actually missed intersecting a drift, some old mining excavation exists at about 12.5 m depth, ie. at elevation 295 m approximately (see log in Attachment I).

The summary information from the drilling of hole GA-16 is shown on Figure 8 superimposed on the interpreted radar traverse record for the location. The radar interpreted subsurface conditions and depths, and the actual soil and rock conditions and depths from the drilling are both shown on the diagram for comparison. As can be seen, the interpreted depths are appreciably less than those actually determined from the drilling. This is most probably due to inaccuracies in assumed subsurface radar velocities complicated by groundwater



conditions. However, the variation in rock mass response characteristics seen by the radar profiling (Figure 8) appears to correspond closely to that found by the coring. (This is particularly well illustrated by the RQD% histogram).

## PART II - GEOTECHNICAL DESIGN RECOMMENDATIONS

### 5. INTRODUCTION

In this and the following sections of the report, recommendations are provided on geotechnical design aspects of the works required under Contract 5 based on our interpretation of the rock and overburden conditions and of project requirements. It is stressed that the information in this section is provided for the guidance of the design engineers. Contractors bidding on or undertaking the works should be aware of the highly variable nature of the soil, rock and groundwater conditions along the proposed watermain alignments and should examine the factual results of the investigation, inspect the conditions along the actual alignments and make their own interpretation of the factual data and the site conditions as they affect their proposed construction techniques, schedule and equipment capabilities.

### 6. WATERMAIN TRENCH CONSTRUCTION

General excavation conditions and probable constraints have been discussed in the previous report and summarized in Tables I, II and III of that report (#851-1172).

In the Contract 5 area, because of the presence of extensive old mining works considerable care will need to be exercised during excavation of the trenches required for the new watermains. Specific precautions will be necessary in each of the following areas:

- o the Highway 11B/Miller Avenue/Galena Street junction area,
- o the Galena Street/Grandview Avenue area, and

- o immediately adjacent to the old No. 4 Coniagas shaft at the intersection of Silver Street and Prospect Avenue.

Elsewhere, as no near-surface openings are known to exist in sufficiently close proximity to the proposed new watermain alignments, excavation of the trenches required for the watermains should generally not pose major problems. Unfortunately, because of the lack of complete mining records, all excavations are not known.

Information on the location of several drifts and raises has only come available in recent years as a result of subsidence problems. In consequence, although it is considered that trench excavation throughout most of the town can often be carried out conventionally, certain remedial measures have been outlined in the following sections of this report for use if uncharted underground openings are encountered during the course of the works.

#### 6.1 Excavation

Based on the results of this investigation, the excavations for the watermains throughout the Contract 5 area should encounter a wide range of highly variable subsurface conditions, some of which will only become evident as excavation proceeds.

Whether the trenches are in overburden or in bedrock, all excavations should be carried out in accordance with The Occupational Health and Safety Act 1978, Ontario Regulation 659/79.

It is anticipated that excavation in overburden within most of the zones of ridged bedrock within the Contract 5 area can be carried out using conventional open cut procedures with trenches having nominal side slopes of 1

horizontal to 1 vertical except in areas of significant groundwater seepage where groundwater control will be required to facilitate excavation, pipe installation and backfilling as well as to maintain trench stability. However, major groundwater problems are not anticipated for the excavations required in the majority of the Contract 5 works area except along the old buried valley and in areas where significant thicknesses of mine waste occur.

In the Arena area at the northern end of Argentite Street where the valley has been infilled with silt and sand tailings and where the proposed invert of the trench will be placed below the prevailing groundwater level, seepage into the trench and sidewall stability problems should be anticipated. In this area or elsewhere as, for example, in the low spots around Silver Street where fine grained tailings might have been dumped along with other mine waste rock, blanketing of the cut slopes with free draining granular material may be necessary in addition to pumping from properly filtered sumps. If groundwater levels are high at the time of construction, localized areas may require more positive forms of dewatering such as well points together with trench supports including lateral bracing in order to stabilize the walls and base of the excavation.

In the area along Miller Avenue, and onto Highway 11B, where overburden is thick, excavation of watermain trenches could uncover or destabilize old timber crib cappings to stopes or raises that break through the bedrock to the base of the overburden. In view of this, considerable care and continuous monitoring will be required during excavation in this location.

Elsewhere for most of the Contract 5 area, the proposed inverts for the watermain trenches will be below the

natural bedrock surface and normally excavation by conventional drilling and blasting will be necessary. For those rock excavations away from areas of known extensive mining works, due to the competent nature of the bedrock, it is considered that the required trenches can be cut with steep or vertical sides. Sufficient clearance will, however, be required around the pipes for the placement and compaction of pipe bedding and backfill.

In most situations, where the bedrock has not been damaged by adjacent mining activity, no particular difficulties are anticipated in maintaining steep or vertical trench sides in either the conglomerates or the argillites found in the Contract 5 area. However, where faults or shears occur, notably along stretches of Miller Avenue for example, or where some of the more chloritic, schistose rocks exist, or where the bedrock has been shattered due to previous blasting, the rock mass is considerably more fractured, particularly in the near-surface zone. Such zones of fractures, if unfavourably oriented with respect to the trench sides, could give rise to overbreak and/or sidewall stability problems leading to undercutting of any overlying overburden materials; in such areas trench sides may have to be locally flattened to suit rock conditions.

Where old mining openings are known to exist in bedrock areas in close proximity to the existing ground surface and/or close to the location of the proposed watermain alignments, (eg. along Galena Street, in the Miller Avenue area etc) conventional blasting practices may create unacceptable vibration levels which could affect stope sidewalls adversely and cause excessive damage to adjacent property. It is considered that blasting for the watermain trenches in these parts of the town could

be considerably more hazardous in their effects on adjacent structures than normal trench blasting. This principally is because of the numerous old mining workings that exist, not only in close proximity to the streets, but also under adjacent dwellings. Typically, blast vibration effects in built-up areas, can give rise to minor property damage (cracked plaster etc). In these specific areas, where underground excavations exist and where previous mining blasting has already loosened the rock mass, gas pressures from the trench blasts may extend considerable distances away from the trench, thereby extending the zone of potential damage onto adjacent properties. Therefore, it is recommended that blasting should only be permitted in these areas if relevant blast attenuation data can be compiled prior to excavation in order to control the magnitude of blast vibration levels. The constraints on maximum peak-particle velocities in these areas, as normally specified (in OPSS standards etc.) may therefore be inappropriate.

In these areas as well as for almost the entire remainder of the Contract 5 works, excavations for the proposed watermains will, of necessity, be carried out in relatively close proximity to existing buildings and services. In consequence, all trench blasting will need to be carefully controlled and in accordance with the requirements of Ontario Provincial Standards Specification Section 515 (December 1984). Consequently, it is recommended that prior to undertaking any blasting operations, the services of a blasting control specialist engineer be retained to review blasting pattern designs and procedures, monitor seismic effects and establish attenuation curves for ground vibration intensity.

Where it is intended that blasting take place within 50 m of any area of known stoping, conventional blasting approaches may need extensive on-site modification. For

blasting in these areas, the need for specialist input will be paramount. In this regard, and particularly with respect to undertaking trench excavations in the vicinity of the old workings in the intersection area between Highway 11B, Galena Street and Miller Avenue, it is recommended that extensive pre-construction condition surveys of existing buildings be carried out and appropriate damage criteria specified prior to trench excavation.

## 6.2 Stope Crossings

Because of numerous uncertainties regarding the accuracy of plotting of stope positions and the lack of complete information on old mining works, it is considered likely that some unknown mining excavation will be exposed during the course of trench construction, either by blasting in rock, or by digging through overburden.

Although the actual configuration of such openings will vary depending on the absolute dimensions of the stope or raise that is encountered, the typical geometry could consist of a slot some 2 to 5 m wide extending laterally for some distance along a fracture zone if it is a stope, or square in shape if it is a raise. In either case, a bridge or cap will be required to cross the opening, both to replace the road and to transport the new watermain.

Whether the watermain is in trench cut into the bedrock, or in an overburden trench sitting on bedrock, the geometry of the structural bridge required will be similar. A typical structural bridge as designed by others, is shown on Figure 9; the watermain is to be suspended within a section of oversized corrugated metal pipe from a slab of precast concrete units supported on





Depending on the effectiveness of groundwater control in the excavations, bedding may consist either, of material conforming to Ministry of Transportation and Communications, (MTC) specifications for Granular "A" or, of well graded 20 millimetre clear crushed stone as nominally specified by Ontario Provincial Standards. Water in the excavations or the presence of a wet granular subgrade may render Granular "A" bedding difficult to compact; in such circumstances, crushed stone may be preferable. However, where any bedding material is to be placed adjacent to a uniform fine grained granular subgrade, such as against some of the fine natural or tailings sands in the valley area in the vicinity of Silver Street or around the Arena, a sand filter material should be provided between the bedding and the subgrade in order to minimize potential for piping of the subgrade into the bedding material.

As an alternative to a sand filter material, a geosynthetic (filter cloth) may be used. In this case, the pipe bedding material should be wholly wrapped in the filter fabric. Some typical grain size distributions for tailings materials or sands that may be encountered in the valley area in the vicinity of Silver Street and around the Arena are shown on Figure 10. For these sands, a suitable filter fabric, with an EOS\* of less than 400  $\mu\text{m}$  such as Terrafix 270R (EOS 130  $\mu\text{m}$ ) or equivalent may be used.

For subgrade soils markedly finer in gradation than the sands shown in Figure 10, we suggest that where a filter cloth is to be used, it should be supplemented by a thin layer of concrete sand placed between it and the native subgrade soils.

-----

\*Equivalent opening size

In all cases, notwithstanding the minimum details shown on Drawing OPSD-1102.01, for rigid pipes made of ductile iron or concrete, it is recommended that a minimum of 150 millimetres of bedding material should be placed at the bottom and sides up to at least the springline of the pipe. Fill placed to 300 millimetres above the obvert may consist of sand. If a more flexible pipe such as plastic is used, the bedding material should provide a uniform surround at least 150 millimetres thick.

In areas where it becomes necessary to place bedding onto fine grained materials (such as tailings slimes if such materials are encountered near the Arena), care should be taken to ensure that the trench is kept as dry as possible and that the bedding materials are placed and compacted promptly to minimize further softening of the subgrade due to exposure to water.

#### 6.4 Trench Backfill

Following stripping of unpaved roads or existing pavement materials and topsoil, the underlying materials may be selectively stockpiled for reuse as backfill. Care should be taken not to contaminate such stockpiled materials with water from the trenches, with topsoil or with other deleterious materials.

Since many of the watermain alignments in the Contract 5 area follow existing paved roadways, it will be necessary to limit the magnitude of trench backfill settlement. To this end, only suitable backfill materials such as sand or sand and gravel should be used as general trench backfill. Where they are excavated from below the groundwater level, these materials will generally have natural water contents in excess of optimum for compaction and may thus have to be stockpiled and drained prior to placing as backfill.

In the Contract 5 area, it is possible that the depth of frost penetration along the roadways and on exposed sections of the alignment could exceed 3.0 m. Care should be taken to use non-frost susceptible materials as far as possible; however, to avoid undue differential movements or settlement of the road surface adjacent to and over the trench, the backfill material should match the native material exposed in the trench walls. Backfill within the zone of frost penetration below the bedrock surface should consist wherever possible of non-frost susceptible material, conforming to MTC specifications.

For natural soil backfill, any cobbles and boulders in excess of 200 millimetres will need to be removed from the backfill prior to placement. All such backfill should then be placed in maximum 250 millimetre thick loose lifts and should be compacted to 95 percent of standard Proctor dry density value using suitable vibratory equipment.

As an alternative, consideration could be given to using the blasted rock derived from the trenches as a backfill; however, for these rock types, it is not certain that trench blasting will provide rock of adequate fragmentation to be compacted within the trench using small hand operated equipment. Therefore, if rockfill is proposed as backfill, in order to avoid potential settlement problems only well shattered bedrock should be used. The maximum stone size should not exceed 300 mm, the loose lift thicknesses should be 400 mm or less and the fill should be well sluiced and compacted with suitable vibratory equipment to achieve optimum density. (Such density to be defined by field trials of the rockfill proposed for trench backfill). However, to

avoid damage to the pipe, if such rock fill is to be used, it should only be placed on at least 600 mm of compacted sand backfill immediately overlying the pipe.

General trench backfill in areas not sensitive to settlement may consist of less desirable excavated native materials placed in loose lifts not exceeding 500 millimetres, with compaction to 90 percent of standard Proctor maximum dry density being required.

Where the watermain is to be placed below existing paved roads, in order to minimize the effects of differential settlement within the trench backfill, it is recommended that the placement of the final asphalt wearing surface be deferred until the spring following the completion of trench backfilling operations.

#### 6.5 Thrust Blocks

It is understood that thrust resistance for the bends and tees in the new watermain system is to be provided either by mechanical means or by the use of buried thrust blocks as shown in Ontario Provincial Standard Drawings, OPSD-1103.01 and .02. For design considerations, in areas of natural soils, away from locations where tailings fills have been dumped, the standard thrust block detail proposed is satisfactory, provided that the soil conditions at each specific thrust block location are inspected prior to concreting. Where thrust blocks are required in areas of tailings, such proposed locations should be examined in detail prior to construction so that appropriate bearing pressures may be determined for design of adequate thrust blocks.

7. INSPECTION AND TESTING

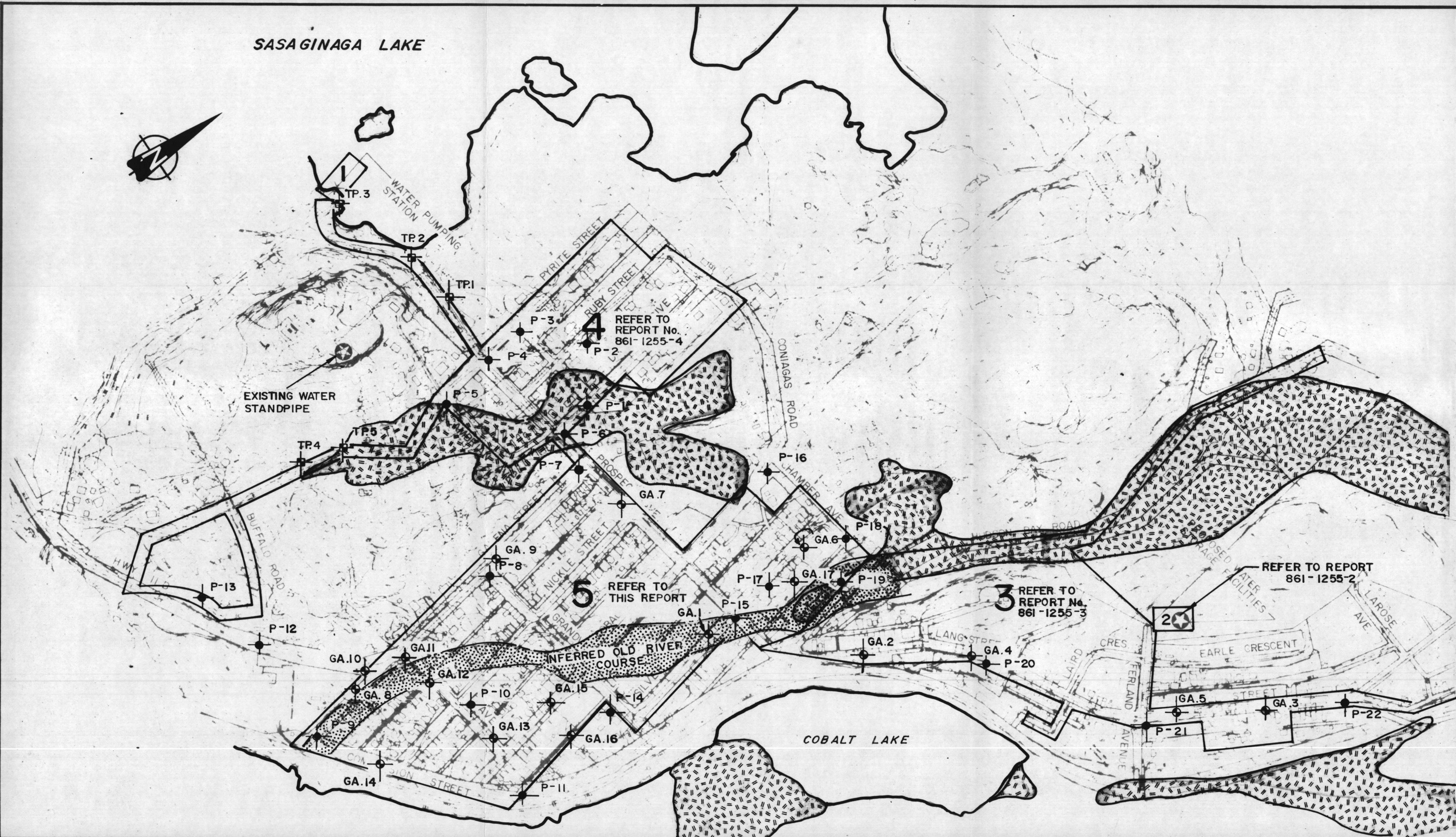
In order to confirm the geotechnical design assumptions and to confirm that the pertinent standards and specifications are being achieved during construction, it is recommended that a programme of geotechnical inspection and materials testing be carried out during construction of the works. The detailed scope and nature of this programme can best be established when the Contract has been awarded and the successful Contractor has submitted his proposed schedule.

GOLDER ASSOCIATES

T.G. Carter, P. Eng.

TGC/dh





LEGEND

- DIAMOND DRILLHOLE LOCATION IN PLAN  
(CARRIED OUT BETWEEN AUG. 25 AND SEPT. 11, 1986)
- AIR TRACK PROBE / HOLE LOCATION  
(CARRIED OUT SEPT. 26, 1985 - REFER TO REPORT No. 851-1172 FOR DETAILS)
- TEST PIT LOCATION IN PLAN  
(CARRIED OUT SEPT. 3, 1986)
- 4 CONTRACT BOUNDARY AND DESIGNATION FOR WATERMAIN CONSTRUCTION
- OLD RIVER COURSE BASED ON RADAR TRAVERSE DATA.
- AREA OF KNOWN MINE TAILINGS DEPOSITION

NOTE

REFER TO FIGURES 4, 7 AND 8 OF GOLDER ASSOCIATES REPORT No. 851-1172 FOR LOCATION OF RADAR TRAVERSE LINES AND ADDITIONAL DATA ON MINE WORKINGS AND TAILINGS AREAS.

REFER TO REPORT 861-1255-2

REFER TO REPORT 861-1255-3

REFER TO THIS REPORT

SCALE 100 0 100 200 METRES

SCALE 1 : 4000 (APPROX.)

Date: NOV 29, 1986  
Project: 861-1255-5

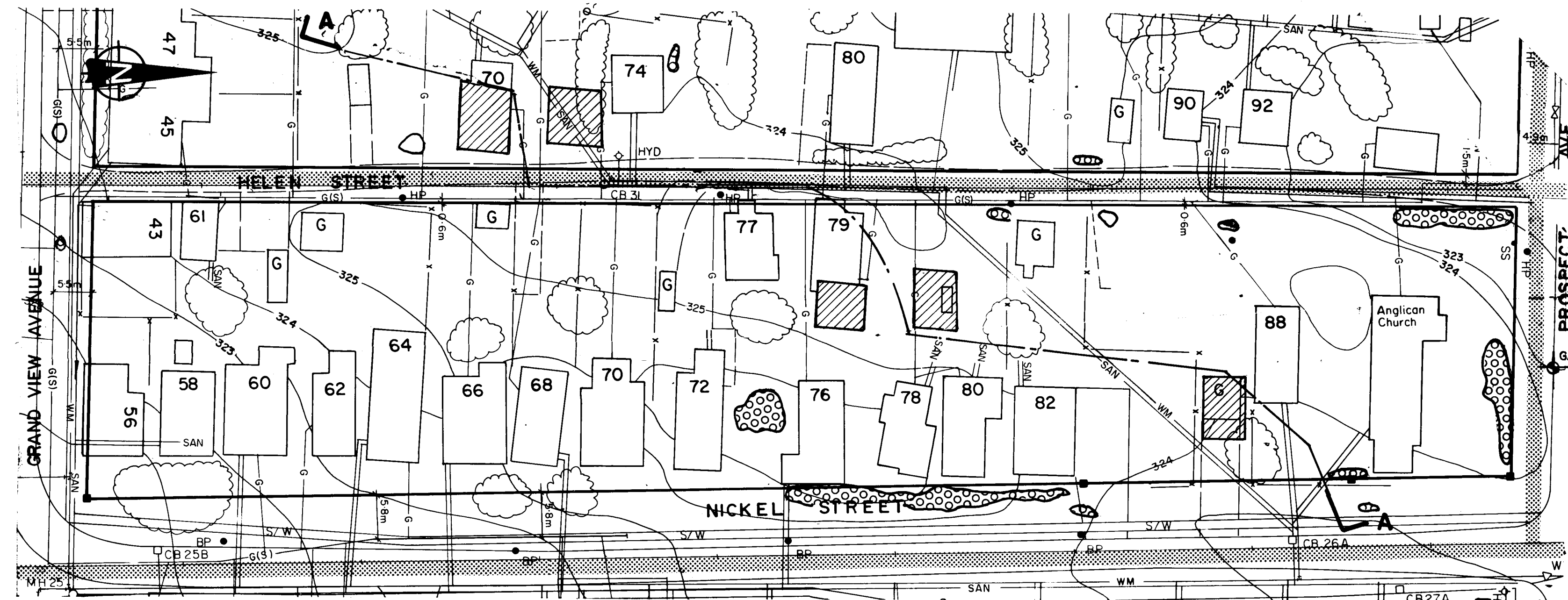
Golder Associates

Drawn: D.M.  
Chkd:



PLAN AND SECTION OF  
HELEN & NICKEL STREET AREA BETWEEN  
GRANDVIEW AND PROSPECT AVENUES

FIGURE 2



LEGEND

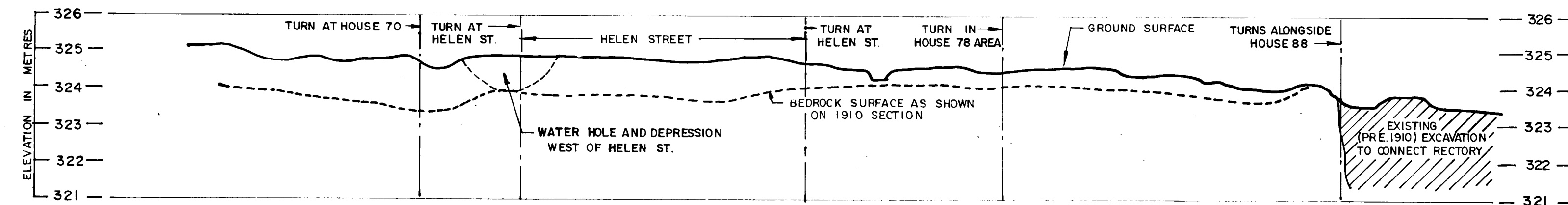
- RADAR TRAVERSE LINES
- APPROXIMATE LOCATIONS OF PREVIOUS (1910) BUILDINGS
- BOREHOLE LOCATION IN PLAN
- BEDROCK OUTCROP

NOTE

SECTION LINE AND SECTION PLOTTED FROM UNDATED (ASSUMED 1910) DRAWING SHOWING PROPOSED SEWER AND WATER LINES FOR HELEN STREET BY LITTLE AND BAKER, ENGINEERS.

SCALE

HORIZONTAL 1 : 500  
VERTICAL 1 : 100

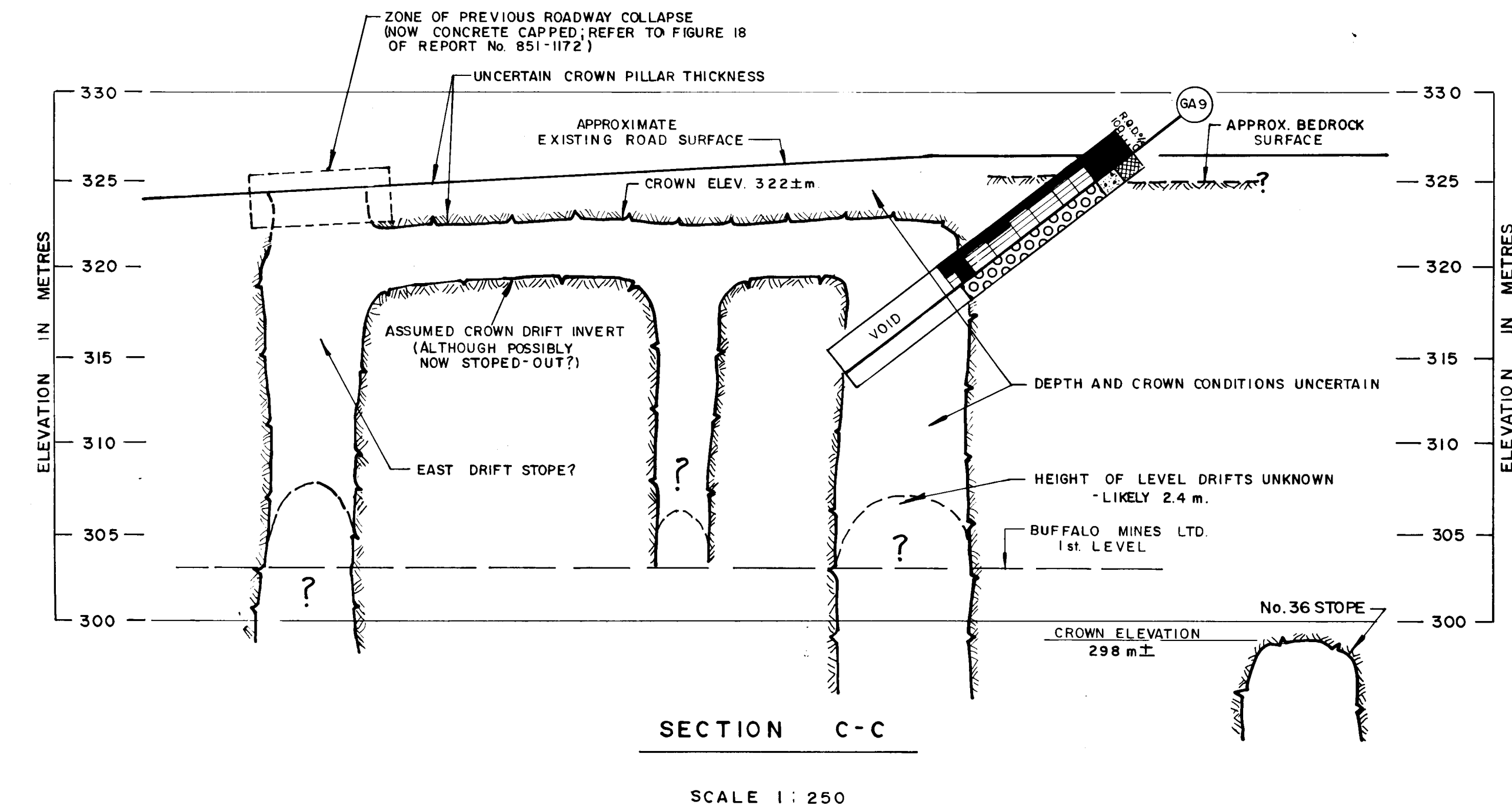
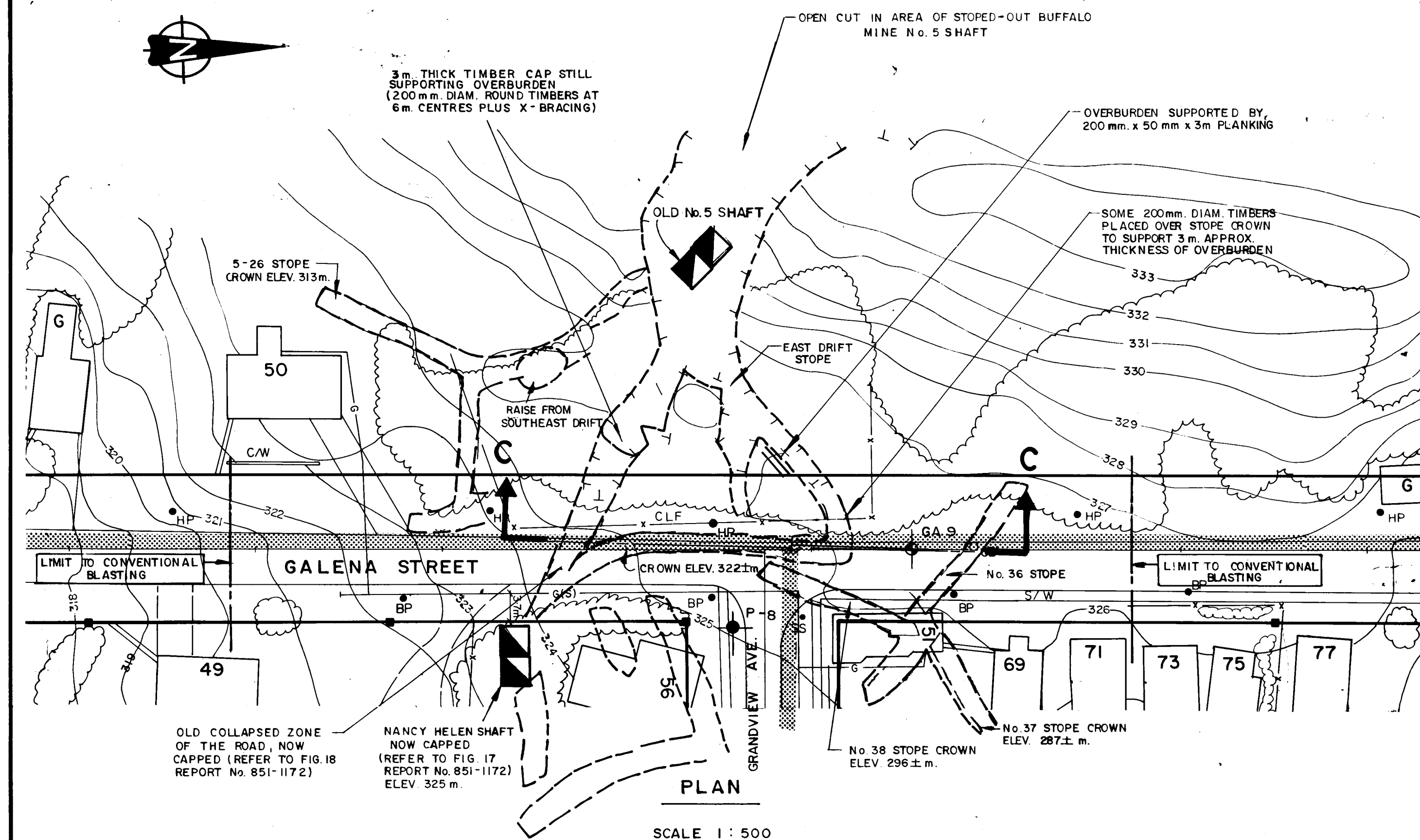


SECTION A-A(MODIFIED FROM 1910 DRAWING FOR PROPOSED SEWER AND WATER LINES)

Date DEC. 4, 1986  
Project 861-1255-5

Golder Associates

Drawn D.M.  
Chkd



LEGEND

- DIAMOND DRILLHOLE LOCATION IN PLAN (CARRIED OUT BETWEEN AUG. 25 AND SEPT. 11, 1986)
- DIAMOND DRILLHOLE IN ELEVATION (REFER TO RECORD OF BOREHOLE SHEETS FOR DETAILS)
- SIMPLIFIED STRATIGRAPHY (SEE BELOW FOR DETAILS)
- ROCK QUALITY DESIGNATION, PERCENT (SEE RECORD OF BOREHOLE SHEETS FOR DETAILS)
- RADAR TRAVERSE LINES
- PLAN OUTLINES OF STOPES AND UNDERGROUND DRIFTS
- LOCATION OF 2 COMPARTMENT SHAFTS

STRATIGRAPHY

- SAND AND GRAVEL (FILL)
- FINE TO MEDIUM COARSE GRAVEL (SUBROUNDED TO ROUNDED) WITH COBBLES OF CONGLOMERATE
- SLIGHTLY WEATHERED, MASSIVE LIGHT TO MEDIUM GREY CONGLOMERATE COMPRISING FINE GRAINED MATRIX AND FINE TO MEDIUM AND COARSE ROUNDED GRAVEL AND COBBLE FRAGMENTS OF GRANITE (GOWGANDA FORMATION)

NOTE

STOPE GEOMETRY EXTRAPOLATED FROM BUFFALO MINES AND NANCY HELEN MINES OLD MINING RECORD, LEVEL PLANS DATING FROM 1908 AND FROM CORRELATION 1:2000 PLAN SHEET 11 OF CUNNINGHAM 1961 REPORT (REFER TO GOLDER ASSOC. REPORT No. 851-1172 FOR DETAILS)





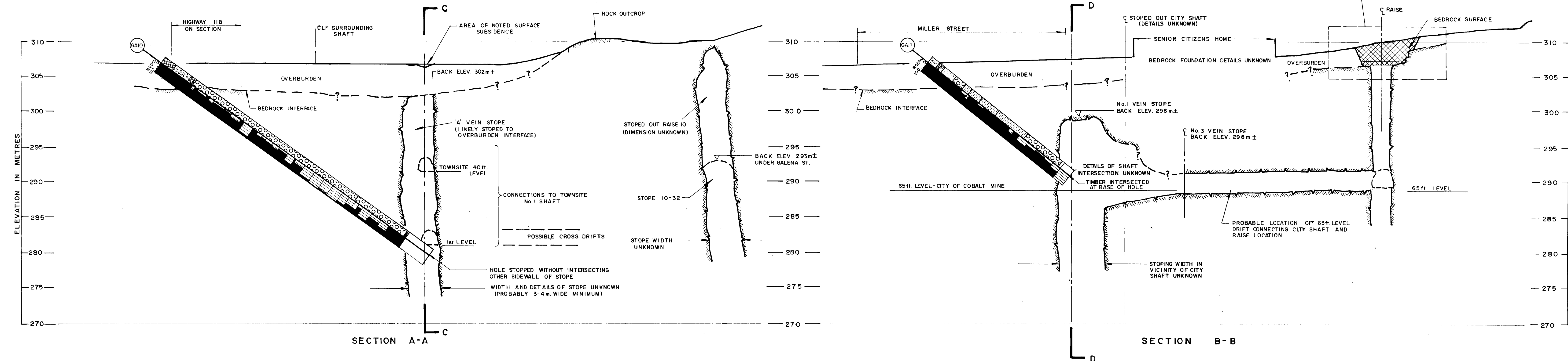
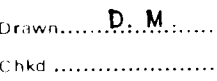


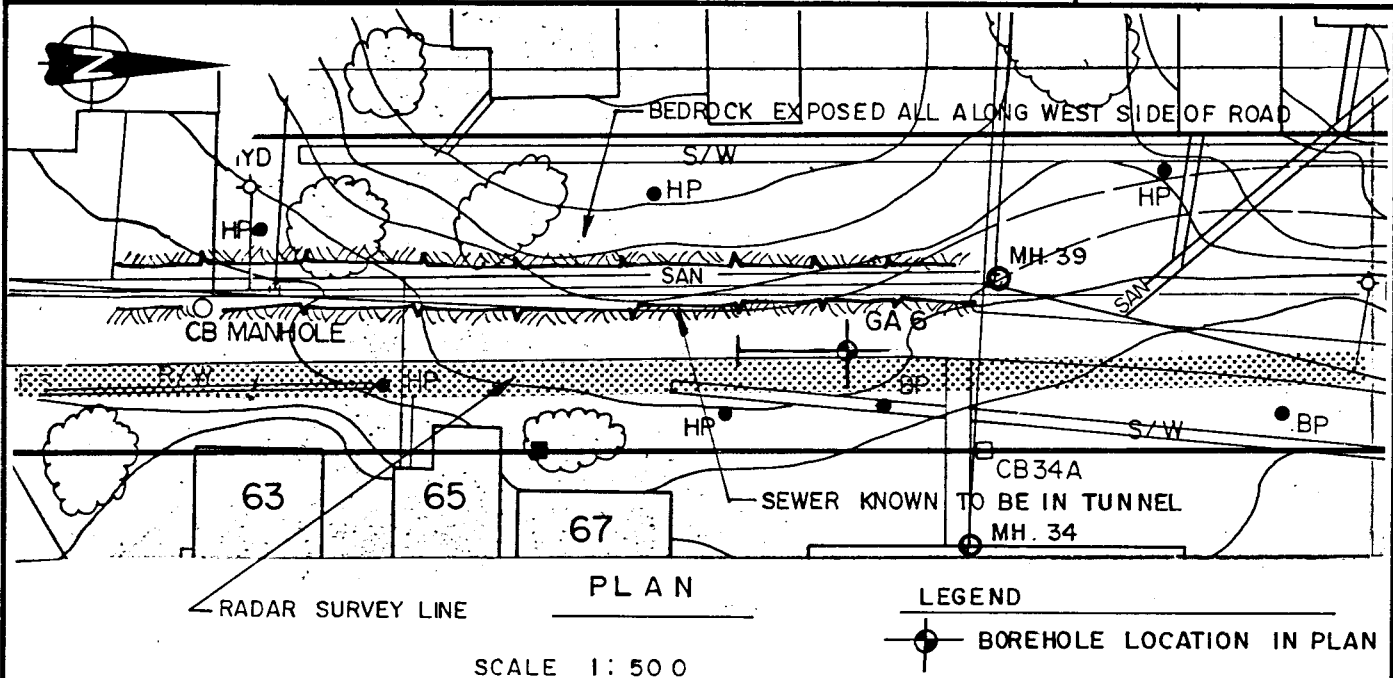


FIGURE 6



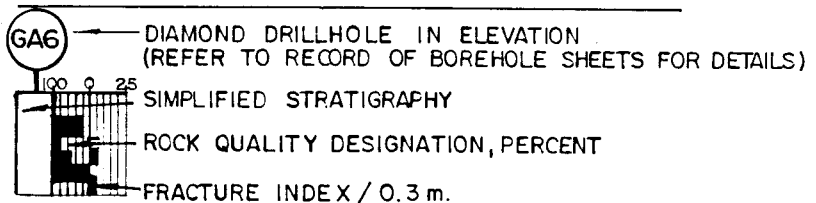
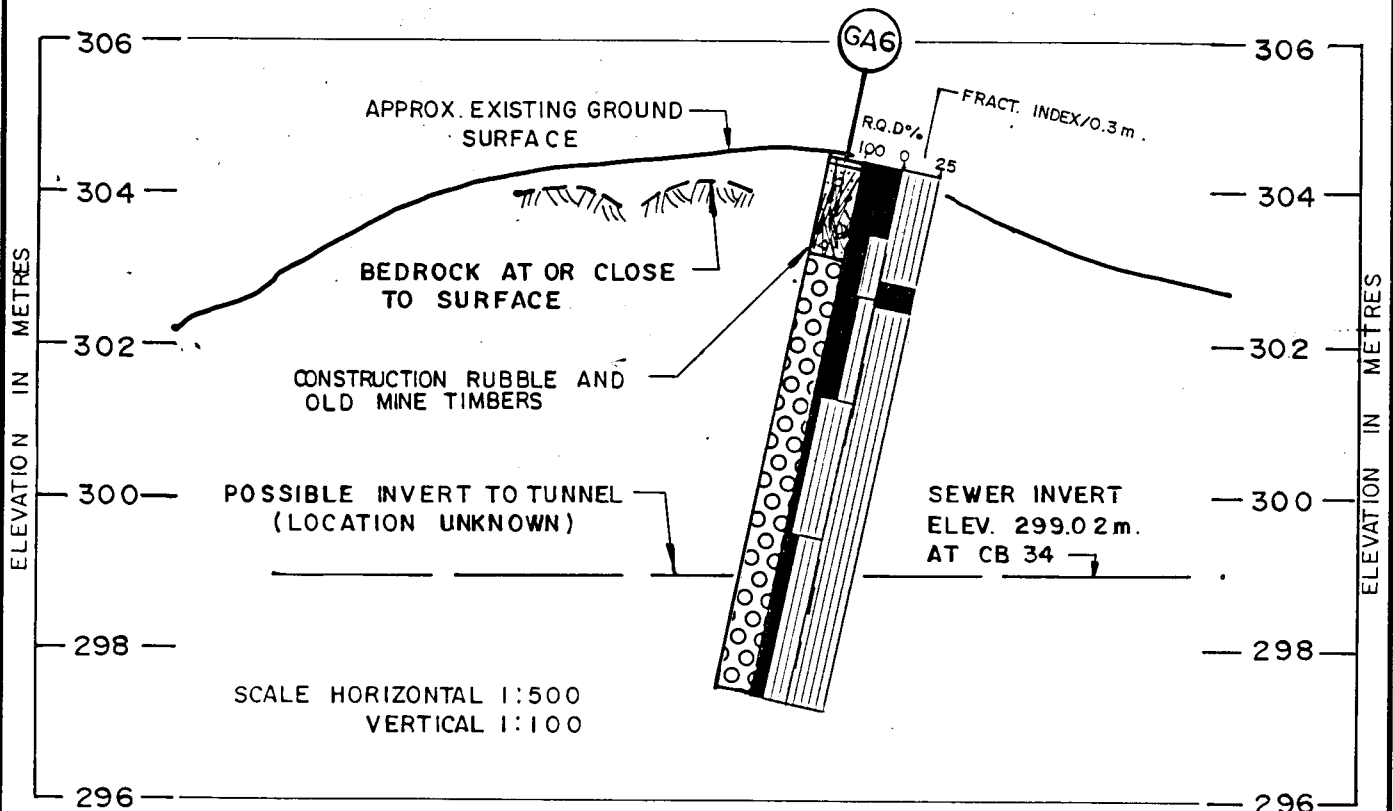
# PLAN AND SECTION OF SILVER STREET ADJACENT TO ECOLE STE. THERESE SHOWING KNOWN SUBSURFACE CONDITIONS

FIGURE 7



## NOTE

FOR DETAILED STRATIGRAPHY REFER TO RECORD OF  
BOREHOLE SHEETS.



Date DEC 5, 1986

Project 861-1255-5

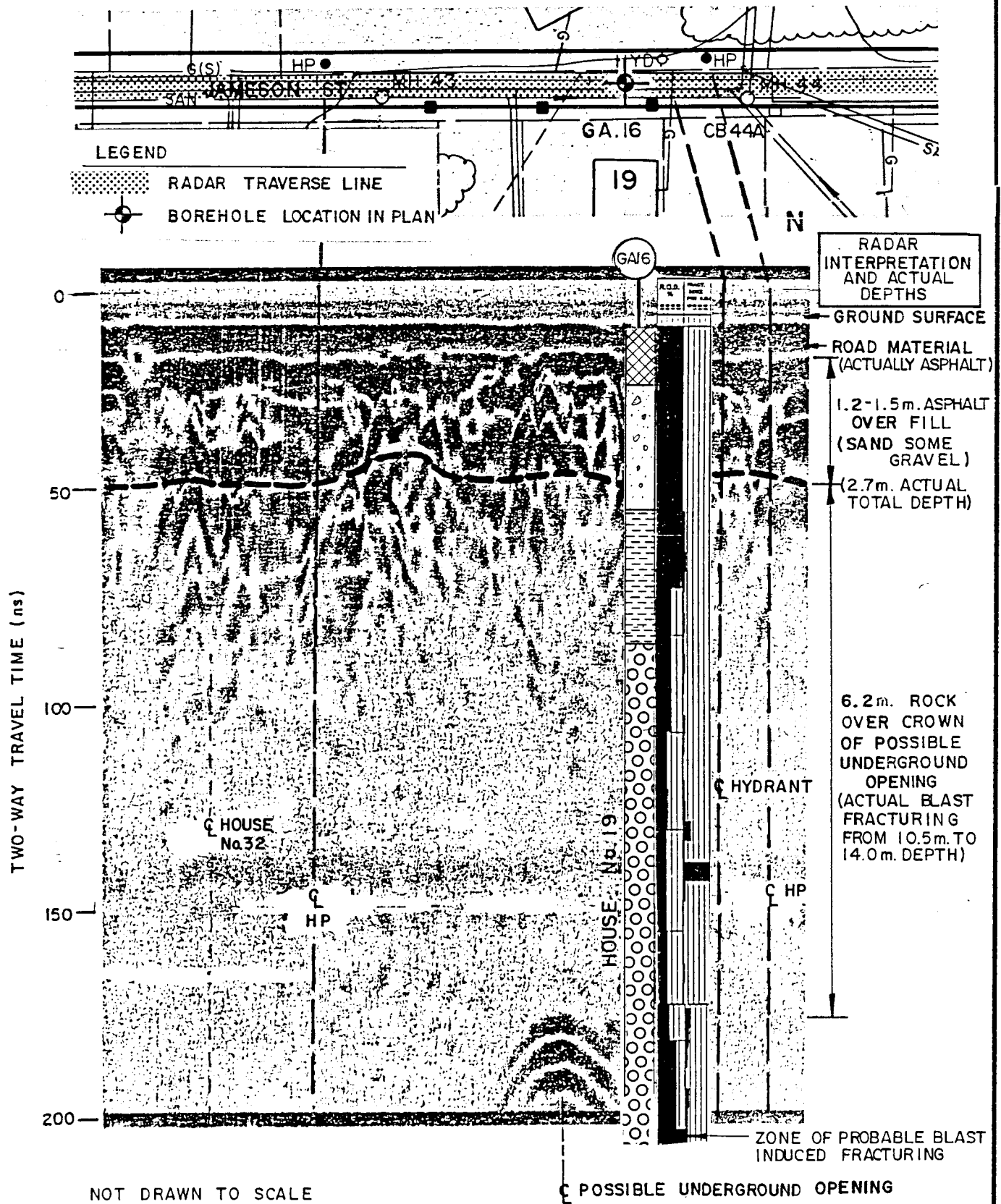
Golder Associates

Drawn D.M.

Chkd. TGC

# INTERPRETED RADAR RECORD AND BOREHOLE INFORMATION FOR PART OF JAMIESON STREET

FIGURE 8



NOTE: VELOCITY FOR CALCULATION OF DEPTHS  
ASSUMED AS 0.06m/ns IN FILL AND AS  
0.11m/ns IN ROCK

Date DEC 8, 1986

Project 861-1255-5

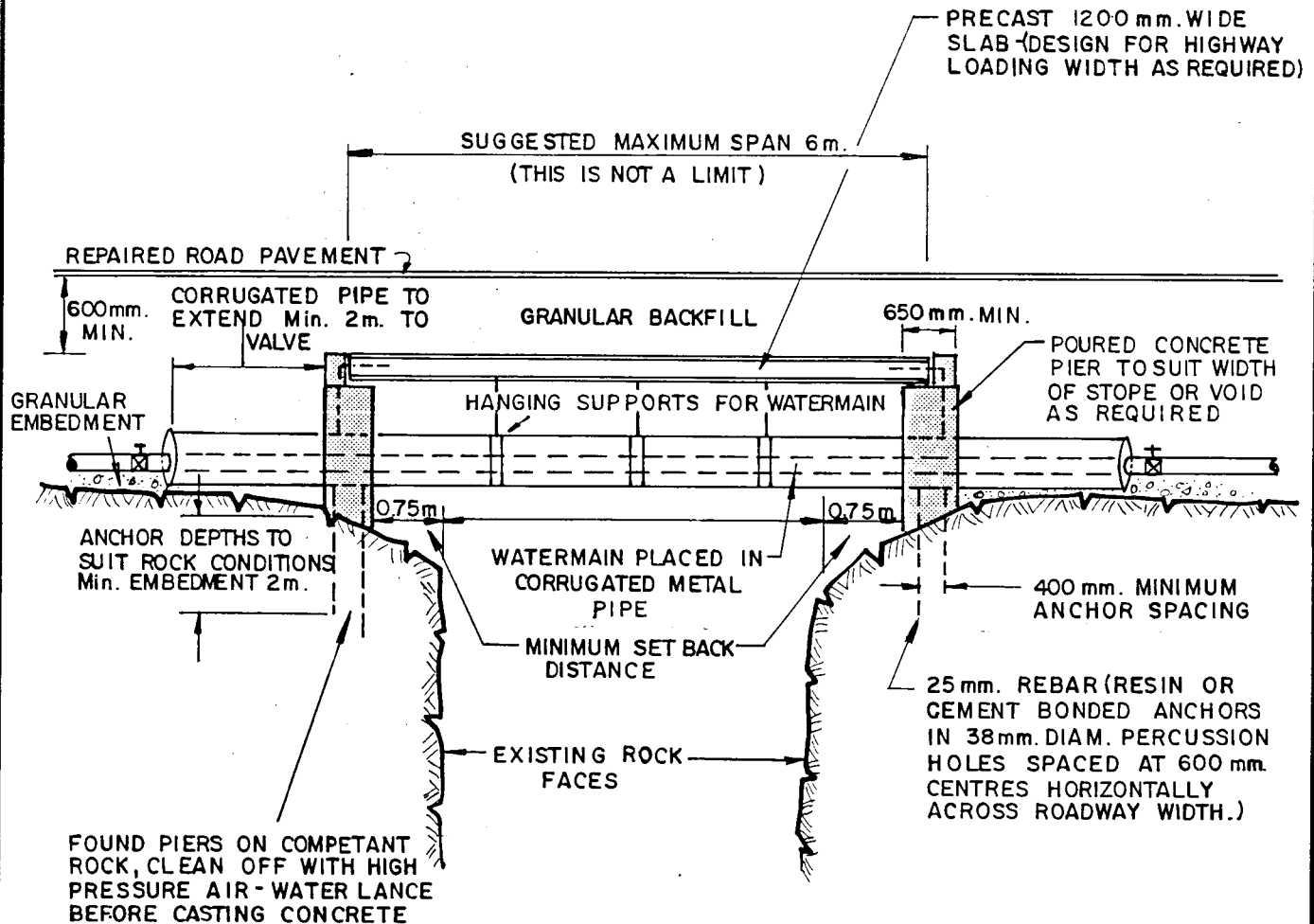
Golder Associates

Drawn D.M.

Chkd. TGC

# SUGGESTED DETAIL FOR ROAD CAPPING TO CARRY WATERMAINS ACROSS ENCOUNTERED UNDERGROUND OPENINGS

FIGURE 9



## REFERENCE

STRUCTURAL BRIDGE DETAILS  
PROVIDED BY RICHARD DRAY  
ENGINEERING INC.

NOT DRAWN TO SCALE

Date DEC. 18, 1986  
Project 861-1255-5

Golder Associates

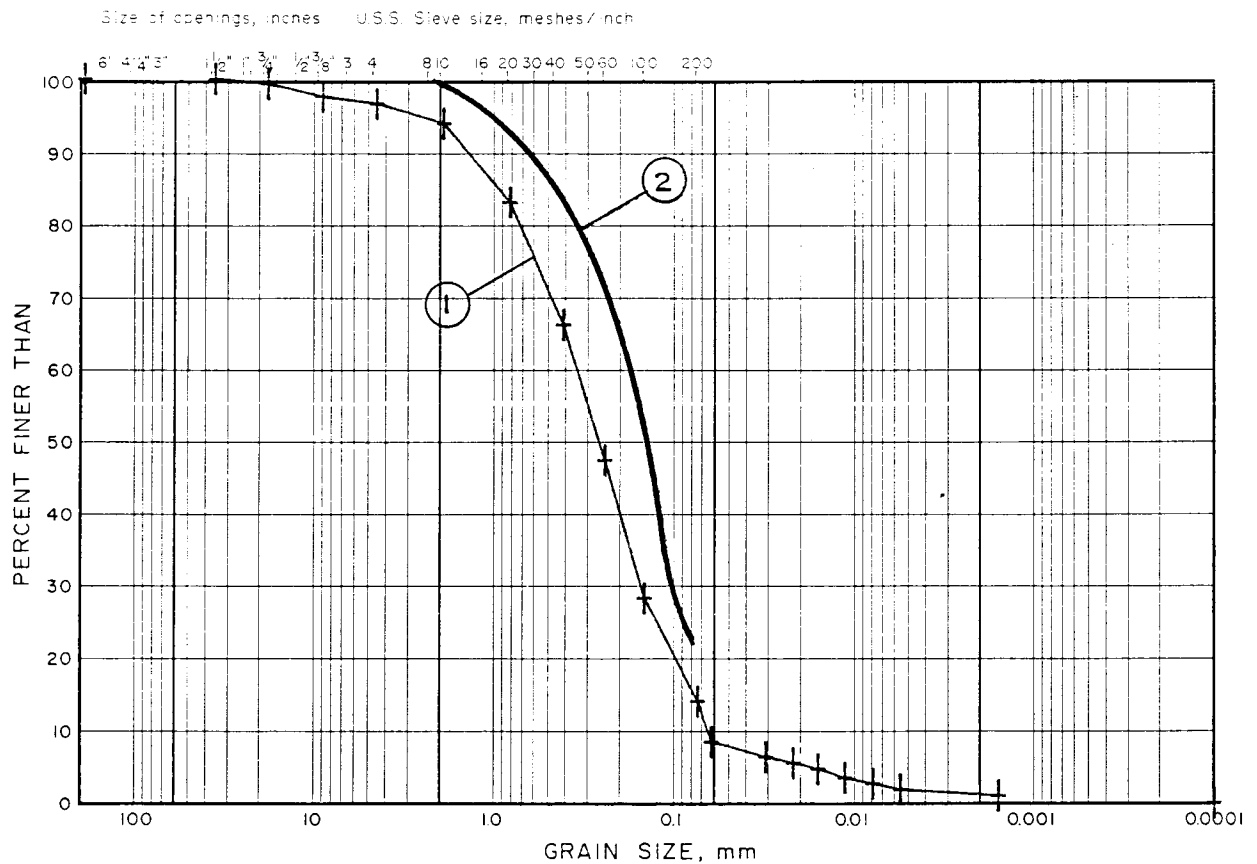
Drawn D.M.  
Chkd. TGL

FORM PRODUCED JUNE 1986

Form G.A.-D-4m (metric)

# GRAIN SIZE DISTRIBUTIONS FOR TYPICAL COBALT TAILINGS MATERIALS

FIGURE 10



ATTACHMENT I  
GEOTECHNICAL LOGS  
HOLES GA-1 AND  
GA-6 TO GA-17  
INCLUSIVE

March 1987

851-1255-5



# RECORD OF DRILLHOLE GA1

SHEET 1 of 2

LOCATION 5249770m.N; 599150m.E

DRILLING DATE AUG.28,1988

DATUM GEODETIC

INCLINATION -37 deg. AZIMUTH N 075 E(MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE



PROJECT 86-1255

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R -ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W -WAVY C -CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.5M	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY L / DIV / SEC											
								TOTAL CORE %	SOLID CORE %			DIP W/LL CORE AXES	TYPE AND SURFACE DESCRIPTION												
								0	10			20	30		40	50	60	70	80	90	100				
0		GROUND SURFACE		300.00																					
		Sidewalk CONCRETE with angular and subrounded clasts.		0.00																					
		ASPHALT (old road surface)		299.78																					
				0.48																					
1																									
		Old cement FILL (mostly sand and gravel)			1	0.08	0%																		
2				298.28																					
3				2.88																					
		COBBLES, GRAVEL (drillers description- no recovery)																							
4				297.25	2	0.35	10% /BROWN																		
				4.57																					
5		ORGANICS/PEAT (brown flush- rapid penetration)		296.70																					
				5.48																					
6																									
7		COBBLES, BOULDERS, some fines			3	0.21	0%																		
8				294.87																					
9		Coarse GRAVEL, some rounded, some fines		8.53	4	0.16	25% /BROWN																		
10				293.98																					
		CONTINUED ON SHEET 2		10.00																					

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE SEPT.5,1988

CHECKED *AWM*

# RECORD OF DRILLHOLE GA1 cont'd.

SHEET 2 OF 2

LOCATION 5249770m.N :599150m.N

DRILLING DATE AUG.25,1988

DATUM GEODETIC

INCLINATION -37 deg. AZIMUTH N 075 E(MAG)


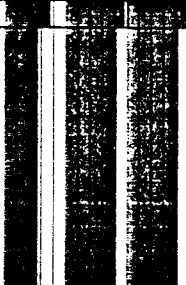
DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE



PROJECT 861-1266

DEPTH SCALE  
METRES  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20

DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R -ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W -WAVY C -CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
							RECOVERY		R.O.D. %	FRACT. INDEX PER 0.5M	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec											
							TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION													
							80 60 40 20	80 60 40 20																
	CONTINUED FROM SHEET 1		293.98																					
AUG.25.86 NQ-2	Faintly to moderately weathered medium grey CONGLOMERATE comprising fine grained argillite matrix with coarse rounded granitic clasts (GOWGANDA FORMATION)		10.08	4	0.16	26%																		
				5	0.08	0%																		
			292.85																					
	END OF HOLE		11.88																					

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE SEPT 5, 1988

CHECKED *LM*

# RECORD OF DRILLHOLE GA6

SHEET 1



LOCATION 5249970m.N; 599150m.E.

DRILLING DATE AUG.28,1986

DATUM GEODETIC

INCLINATION -36 deg. AZIMUTH S 010W(MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1256

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH & RETURN COLOUR	FR-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION	
								CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN			
								SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY			
								VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED			
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.5M CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec								
TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION										
0		GROUND SURFACE		304.50										
		ASPHALT		0.08										
1	NW CASING	Construction rubble and old mine TIMBERS		303.66	1	0.12	0%							
2		Faintly weathered to fresh medium grey thinly bedded ARGILLITE with minor bands of fine clastic conglomerate notably at 7.3m.depth.		1.43	2	0.15	0%							
3				3	0.12	0%								
4				4	0.15	0%								
5				5	0.12	0%								
6				6	0.06	0%								
7														
8	NO-2													
9			END OF HOLE		299.36	8.75								
10														

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE SEPT.5,1986

CHECKED *the*

# RECORD OF DRILLHOLE GA7

SHEET 1



LOCATION 5249810m.N; 598920m.E.

DRILLING DATE AUG.29,1988

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 801-1266

DEPTH SCALE  
1: 50

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION	
								CL-CLEAVAGE	J-JOINT	R -ROUGH	UE-UNEVEN			
								SH-SHEAR	P-POLISHED	ST-STEPPED	W -WAVY			
								VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C -CURVED			
RECOVERY								R.O.D. %	FRACT. INDEX PER 0.5M	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		
TOTAL CORE %	SOLID CORE %	TYPE AND SURFACE DESCRIPTION												
0		GROUND SURFACE		323.00										
		ASPHALT		0.08										
		coarse gravel, cobbles (FILL)		322.40										
1	NW CASING			0.80	1	0.10	10% /GREY							
2		faintly weathered to fresh light to medium grey CONGLOMERATE comprising fine grained matrix and rounded gravel and cobble fragments of granite. Conspicuous basal conglomerate at elev. 320.9- 320.6m.			2	0.10	20% /GREY							
3				319.50										
				3.50	3	0.10	10% /GREY							
4														
		faintly to moderately weathered, laminated to thinly bedded, dark to medium grey ARGILLITE			4	0.10	10% /GREY							
6														
				317.00	6									
6	AUG.29/88 NO-2	END OF HOLE		8.00										
7														
8														
9														
10														

Golder Associates

LOGGED AWM/TGC  
DATE SEPT.5.1988  
CHECKED *Th*

# RECORD OF DRILLHOLE GA8

SHEET 1



LOCATION 5249320m.N; 598850m.E.

DRILLING DATE AUG.29.1988

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1265

PROJECT 861-1255	SCAL METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (u/min)	FLUSH % RETURN COLOUR	FR-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	HYDRAULIC CONDUCTIVITY K, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN			
									SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY			
									VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED			
RECOVERY									R.O.D. %	FRACT. INDEX PER 0.5M	DISCONTINUITY DATA				
TOTAL CORE %		SOLID CORE %								TYPE AND SURFACE DESCRIPTION					
40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20	40 20		
0		GROUND SURFACE		307.00											
0.06		SAND and GRAVEL		306.09	1										
0.91		coarse GRAVEL including boulder of pinkish white quartzite		306.09	2										
0.10					3	0.10									
0.15					4	0.15									
0.09					6	0.09									
6.85		END OF HOLE		6.85											

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE SEPT.5.1988

CHECKED *TLW*

# RECORD OF DRILLHOLE GA9

SHEET 1 OF 3



LOCATION 5249610m.N; 598850m.E.

DRILLING DATE SEPT.2,1988

DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH S 010 W(MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 801-1286

SCAL METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	HYDRAULIC CONDUCTIVITY K, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
0		GROUND SURFACE		328.50										
		ASPHALT		0.06										
1		sand and gravel (FILL)		325.66	1	0.10	50-80% /BROWN							
2		fine to medium coarse GRAVEL (subrounded to rounded) with cobbles of conglomerate		1.37	2	0.08	90% /BROWN							
3	NW CASING			325.00										
				2.43	3	0.06	80-90% /GREY							
4		Slightly weathered, massive, light to medium grey CONGLOMERATE comprising fine grained matrix and fine to medium and coarse rounded gravel and cobble fragments of granite (GOWGANDA FORMATION)			4	0.1	80% /GREY							
5					6	0.12	80% /GRY/WHITE							
6														
7		Numerous joints at 45deg. to core axis at 25 to 30cm. spacing (2.4m to 5.5m. depth)			6	0.16	80% /GRY/WHITE							
8		Joints becoming limonite stained from 5.5m. to 9.8m. depth.			7	0.08	80% /GRY/WHITE							
9		Altered zones (9.8m. to 9.9m. depth and 11.9m. to 12.1m. depth) Light grey groundmass with calcite infilling, vuggy.												
0	SEPT.2/88 NQ-2			320.34	8		80% /GREY							
		CONTINUED ON SHEET 2		10.00										

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE SEPT.5,1988

CHECKED *th*

# RECORD OF DRILLHOLE GA9 cont'd.

SHEET 2 OF 3

LOCATION 5249810m.N; 598850m.E.

DRILLING DATE SEPT 2,1988

DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH S 010 W(MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE



PROJECT 861-1266

DEPTH SCALE  
1: 50

METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (N/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN		
								SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY		
								VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED		
RECOVERY								R.Q.D. %	FRACT. INDEX PER 0.3M	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	
TOTAL CORE %		SOLID CORE %								TYPE AND SURFACE DESCRIPTION			
00	20	00	20	00	20	00	20	00	20	00	20	00	20
00	20	00	20	00	20	00	20	00	20	00	20	00	20
00	20	00	20	00	20	00	20	00	20	00	20	00	20
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00	20	00	20	00	20	00	20	00	20	00	20	00	20
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00	20	00	20	00	20	00	20						

DEPTH SCALE

Golder Associates

LOGGED AWM/TGC

DATE SEPT.5,1988

CHECKED *TH*

# RECORD OF DRILLHOLE GA9 cont'd.

SHEET 3 OF 3



LOCATION 5249810m.N; 598850m.E.

DRILLING DATE SEPT.2,1988

DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH S 010 W(MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN			
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY			
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED			
		RECOVERY		R.O.D.		FRACT.		DISCONTINUITY DATA		HYDRAULIC							
		TOTAL		SOLID		INDEX		TYPE AND SURFACE		CONDUCTIVITY							
		CORE %		CORE %		PER 0.25M		DESCRIPTION		K, cm/sec							
		100		100		100											
		0		0		0											
		10		10		10											
		20		20		20											
		30		30		30											
		40		40		40											
		50		50		50											
		60		60		60											
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		90		90		90											
		100		100		100											
		110		110		110											
		120		120		120											
		130		130		130											
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		1070		1070		1070											
		1080		1080		1080											
		1090		1090		1090											
		1100		1100		1100											
		1110		1110		1110											
		1120		1120		1120											
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		1150		1150		1150											
		1160		1160		1160											
		1170		1170		1170											
		1180		1180		1180											
		1190		1190		1190											
		1200		1200		1200											
		1210		1210		1210											
		1220		1220		1220											
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		1260		1260		1260											
		1270		1270		1270											
		1280		1280		1280											
		1290		1290		1290											
		1300		1300		1300											
		1310		1310		1310											
		1320		1320		1320											
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		1360		1360		1360											
		1370		1370		1370											
		1380		1380		1380											
		1390		1390		1390											
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		1470		1470		1470											
		1480		1480		1480											
		1490		1490		1490											
		1500		1500		1500											
		1510		1510		1510											
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		1560		1560		1560											
		1570		1570		1570											
		1580		1580		1580											
		1590		1590		1590											
		1600		1600		1600											
		1610		1610		1610											
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		1660		1660		1660											
		1670		1670		1670											
		1680		1680		1680											
		1690		1690		1690											
		1700		1700		1700											
		1710		1710		1710											
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		1730		1730		1730											
		1740		1740		1740											
		1750		1750		1750											
		1760		1760		1760											
		1770		1770													



# RECORD OF DRILLHOLE GA10

SHEET 1 OF 5



LOCATION 5249380m.N; 598840m.E.

DRILLING DATE SEPT.3-5,1988


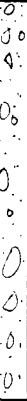


DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH 0 (MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (U/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION	
								CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN				
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY				
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED				
								RECOVERY		R.O.D. %	FRACT. INDEX PER 0.5M	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec				
TOTAL CORE %		SOLID CORE %		TYPE AND SURFACE DESCRIPTION		CORE AXES												
0		GROUND SURFACE		307.00				40	40	40	40	40	40	40	40			
1		sand and fine gravel (FILL?)		0.00	1	0.07	60% /BRN/GRY											
2				305.84	2		60% /BRN											
3				1.98	3	0.07	50% /GREY											
4		BOULDERS; including a thin lense of coarse sand and gravel			4	0.08	80% /GREY											
5				304.31	6													
6				4.57	7													
7		COBBLES and rock fragments		303.98	8	0.05	80% /GRY											
8				5.18	9													
9					10													
10		Faintly weathered CONGLOMERATE comprised almost entirely of sand sized matrix with a few fine gravel sized granitic clasts			11	0.06	20% /GREY											
11					12	0.07	20%											
12					13	0.06	20% /GREY											
13					14	0.04	5% /GREY											
14																		
15		(9.2m. to 12.6m.) As above but with larger granitic clasts.		301.12														
16		CONTINUED ON SHEET 2		10.00														

# RECORD OF DRILLHOLE GA10 cont'd.

SHEET 2 OF 5



LOCATION 5249380m.N; 598840m.E.

DRILLING DATE SEPT.3-4,1988

DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH 0 (MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

PROJECT 861-1256	SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE		F-FAULT		SM-SMOOTH		R-ROUGH		FL-FLEXURED		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE		J-JOINT		R-ROUGH		FL-FLEXURED					
									SH-SHEAR		P-POLISHED		ST-STEPPED		UE-UNEVEN					
									VN-VEIN		S-SLICKENSIDED		PL-PLANAR		W-WAVY					
															C-CURVED					
RECOVERY		R.O.D. %		FRACT. INDEX PER 0.5M CORE AXIS		DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K <sub>eff</sub> cm/sec												
TOTAL CORE %	SOLID CORE %	80	60	40	20	10	5	TYPE AND SURFACE DESCRIPTION												
100	100	100	100	100	100	100	100													
80	80	80	80	80	80	80	80													
60	60	60	60	60	60	60	60													
40	40	40	40	40	40	40	40													
20	20	20	20	20	20	20	20													
CONTINUED FROM SHEET 1											PL.CALCITE									
CONGLOMERATE (cont'd.)											PL.(LIMONITE)									
											PL.(LIMONITE)									
											PL.(CALCITE)									
											PL/UE (CALCITE)									
(12.6m. to 12.8m.) Calcite infilled joint plane parallel to core axis.											UE.CALCITE									
											R.CALCITE									
											R									
											R									
											R.minor CALCITE									
(13.7m. to 18.6m.) Conglomerate is intensely mineralized; numerous cross veins of calcite; most with disseminated sulphides, silver and arsenopyrite											UE/ST									
											C									
											R.CALCITE									
											R.LIMONITE									
											PL.CALCITE									
(15.4m. to 16.6m.) Large granite clast											PL.minor CAL.									
											PL.CALCITE									
											PL									
											PL/ST.min.CAL.									
											R.CALCITE									
											PL.CALCITE									
											PL.CALCITE									
(16.6m. to 18.0m.) Conglomerate matrix is more argillitic											PL.CALCITE									
											R									
											PL.									
											R									
											R.CALCITE									
											PL.LIM.									
											R.CAL.									
CONTINUED ON SHEET 3																				

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1988

CHECKED *th*

# RECORD OF DRILLHOLE GA10 cont'd.

SHEET 3 OF 5



LOCATION 5249380m.N; 598840m.E.

DRILLING DATE SEPT 4, 1986

DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH 0 (MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (W/MIN)	FLUSH % RETURN COLLAR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R -ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W -WAVY C -CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								RECOVERY				R.O.D. %	FRACT. INDEX PER 0.5M CORE AXES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K <sub>s</sub> CM/SEC							
								TOTAL CORE %	SOLID CORE %	DIP W.I.L. CORE AXES	TYPE AND SURFACE DESCRIPTION														
20		CONTINUED FROM SHEET 2		295.24																					
				20.00	23	0.01	0%																		
21		CONGLOMERATE (cont'd.)			24	0.09	0%																		
22		(22.3m. to 23.2m.) -Mineralized zone-minor sulphides			25	0.12	0%																		
					26		0%																		
23					26		0%																		
					27		0%																		
24					27		0%																		
25					28	0.06	0%																		
26		(24.1m to 27.4m.) -Matrix of CONGLOMERATE progressively becoming sandier Minor granite clasts over gravel size																							
					29	0.06	0%																		
27																									
		(27.4m. to 28.7m.) Granite clasts becoming large up to 30mm.diam.Rock very competent ;most joints and veins calcite covered																							
28					30	0.04	0%																		
29		(28.7m. to 33.5m.) Minor intercalations of granitic clasts in matrix; some calcite veinlets.																							
					31		0%																		
30		CONTINUED ON SHEET 4		289.37																					
				30.00																					

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1986

CHECKED *742*



# RECORD OF DRILLHOLE GA10 cont'd.

SHEET 5 OF 5



LOCATION 5249320m.N; 598840m.E.

DRILLING DATE SEPT 5, 1988

DATUM GEODETIC

INCLINATION -38 deg. AZIMUTH 0 (MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 801-1266

PROJECT 861-1266	SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R -ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W -WAVY C -CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
									RECOVERY		R.O.D. %	FRACT. INDEX PER 0.5M CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	TYPE AND SURFACE DESCRIPTION										
									TOTAL CORE %	SOLID CORE %			DIP W/L CORE AXIS													
									10 20 30 40 50 60 70 80 90 100	10 20 30 40 50 60 70 80 90 100																
40			CONTINUED FROM SHEET 4		283.49																					
			CONGLOMERATE (cont'd.)		40.00	38		0%																		
			Highly broken core (blast/ stress damaged) with numerous			39		0%																		
			hackly fracture surfaces also			40		0%																		
41			wood fragments			41		0%																		
			(40.2m to 41.9m)			42		0%																		
					282.37																					
42	SEPT. 6/86 NO-2		Stull support or shaft timber		282.28	43		0%																		
			(wood)		42.09																					
43																										
44			VOID			44																				
45																										
46																										
47					279.70																					
			END OF HOLE		46.44																					
48																										
49																										
50																										

DEPTH SCALE

1: 50

Golder Associates

LOGGED AM/TGC

DATE OCT. 14, 1988

CHECKED *the*

# RECORD OF DRILLHOLE GA11

SHEET 1 OF 3



LOCATION 5249410m.N; 598880m.E

DRILLING DATE SEPT.5-8,1988

DATUM GEODETIC

INCLINATION -39 deg. AZIMUTH N 035 E(MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1255

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN			
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY			
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED			
								RECOVERY		R.O.D. %	FRACT. INDEX PER 0.5M CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec			
								TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION					
0		GROUND SURFACE		307.00				100	100	100	100	100	100	100	100		
		ASPHALT		306.89				100	100	100	100	100	100	100	100		
				0.18				100	100	100	100	100	100	100	100		
1		Compact SAND with cobbles and boulders		306.18	1		0%	100	100	100	100	100	100	100	100		
				1.31				100	100	100	100	100	100	100	100		
		COBBLES and BOULDERS		305.97				100	100	100	100	100	100	100	100		
2		SAND,BOULDERS -30mm.diam.5mm.thick metal plate encountered at 2.13m.		1.84	2		0%	100	100	100	100	100	100	100	100		
				305.57	3		0%	100	100	100	100	100	100	100	100		
				2.28				100	100	100	100	100	100	100	100		
3								100	100	100	100	100	100	100	100		
		Mainly SAND some coarse gravel and boulders			4	0.2	0%	100	100	100	100	100	100	100	100		
4								100	100	100	100	100	100	100	100		
		Broken rock;could be rockfill or heavily blast damaged insitu bedrock.Core comprised angular fragments of siliceous CONGLOMERATE (mostly matrix few clasts).Some fragments exhibit chloritic and/or clay coatings on fracture surfaces		304.28	6	0.04	0%	100	100	100	100	100	100	100	100		
6				4.35				100	100	100	100	100	100	100	100		
					8		0%	100	100	100	100	100	100	100	100		
6		Relatively competent core of dark grey siliceous ARGILLITE some qtz/carbonate veins evident,much of core shattered (6.6m. to 7.3m.) Zone of numerous hackly fractures at various angles to core axis (? blast/stress fractures)		303.19	9		80% /GREY	100	100	100	100	100	100	100	100		R.CALCITE
				6.08				100	100	100	100	100	100	100	100		R.CALCITE
7					10	0.08	80% /GREY	100	100	100	100	100	100	100	100		R.CALCITE
				302.44				100	100	100	100	100	100	100	100		
				7.25	11	.08	80%	100	100	100	100	100	100	100	100		R/UE/PL
8		Highly broken moderately weathered core including fragments of granite clasts up to 30cm.diam.originally, but mostly grey matrix material.Some fragments appear brecciated ?FAULT ZONE.			12	.08	80%	100	100	100	100	100	100	100	100		
					13	.08	80%	100	100	100	100	100	100	100	100		HVY.CALCITE
9				301.30	14	.08	80% /gry	100	100	100	100	100	100	100	100		
		More competent pinkish grey QUARTZITE with several stringers of quartz carbonate		9.05			80% /GREY	100	100	100	100	100	100	100	100		R.CALCITE
				300.98	16	0.09		100	100	100	100	100	100	100	100		C.QTZ.
				9.57				100	100	100	100	100	100	100	100		UE.CAL/LIM.
10				300.71				100	100	100	100	100	100	100	100		UE.HVY.CALCITE
				10.00				100	100	100	100	100	100	100	100		
		CONTINUED ON SHEET 2						100	100	100	100	100	100	100	100		

# RECORD OF DRILLHOLE GA11 cont'd.

SHEET 2 OF 3



LOCATION 5249410m.N; 598880m.E

DRILLING DATE SEPT 5-9,1988

DATUM GEODETIC

INCLINATION -39 deg. AZIMUTH N 35 E (MAG)

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

PROJECT 861-1256	DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE				F-FAULT				SM-SMOOTH				FL-FLEXURED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE				J-JOINT				R-ROUGH				UE-UNEVEN					
									SH-SHEAR				P-POLISHED				ST-STEPPED				W-WAVY					
									VN-VEIN				S-SLICKENSIDED				PL-PLANAR				C-CURVED					
									RECOVERY		R.O.D. %	FRACT. INDEX PER 0.5M CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, CM/DAY											
TOTAL CORE %		SOLID CORE %		TYPE AND SURFACE DESCRIPTION																						
10			CONTINUED FROM SHEET 1		300.71																					
11			As previously; highly broken fragmented core, mostly dark grey siliceous ARGILLITE matrix material, some quartz- carbonate veins, some pinkish zones and some weathered sections (10.4m. to 17.2m.) Numerous quartz-carbonate veins																							
12																										
13			(12.2m. to 17.2m.) -Slickensided CHLORITE/ SERICITE coated joints (12.3m. to 12.4m.) -Core exhibiting some cobalt bloom and filigree silver on fractures (13.7m. to 13.9m.) -Numerous fragments containing feldspar/carbonate veining or brecciation																							
14																										
15																										
16			(14.9m. to 15.6m.) -Zones of hackly fractures																							
17			(16.3m. to 16.6m.) -Zone of hackly fractures																							
18					296.18																					
19					17.22																					
20			Medium grey highly silicified CONGLOMERATE, matrix relatively sandy, with included clasts up to small cobble size Core is relatively competent but exhibits numerous 45 deg. quartz-carbonate veins																							
21																										
22																										
23																										
24																										
25																										
26																										
27																										
28																										
29																										
30																										
31			CONTINUED ON SHEET 3		294.41																					
32					20.00																					

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1998

CHECKED *Th*





**DRILLING CONTRACTOR MORISSETTE**

PROJECT 881-1266

CHECKED *Thy*

# RECORD OF DRILLHOLE GA13

SHEET 1



LOCATION 5249420m.N; 599040m.E

DRILLING DATE SEPT.9,1986

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 881-1266

SCAL METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE		J-JOINT	R-ROUGH	UE-UNEVEN					
								SH-SHEAR		P-POLISHED	ST-STEPPED	W-WAVY					
								VN-VEIN		S-SLICKENSIDED	PL-PLANAR	C-CURVED					
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.5M	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY L. cm/sec											
TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION	DIP WILL CORE AXES												
0		GROUND SURFACE	305.00														
		CONCRETE (present sidewalk)	0.00														
		Core fragments recovered Include angular rock chips set in cement matrix (OLD SIDEWALK OR MINING FOUNDATION CONCRETE) some cobbles and boulders possibly natural ground.	0.15														
1			303.79	1			0%										
		Soft SANDY SILT recovered from split spoon sample.	303.54														
		Rounded GRAVEL and angular rock fragments	303.33	2	0.11		0%										
2			1.67														
	NW CASING			3	0.11		80% /LT.GRY										
				4	0.06		0%										
3		Moderately weathered at top becoming faintly weathered with depth, dark grey sandy ARGILLITE		6	0.06		0%										
4		-Numerous clay coated and limonite stained joints to 4.28m. depth		6	0.03		0%										
		-Some subvertical quartz- carbonate veins, notably at 4.6m., 5.5m. and 5.9m.		7	0.04		0-60% /GREY										
6		-Some hackly (?blast type) fractures evident in core from 3.8m. to 4.3m.		8	0.09		0-60% /GREY										
6	SEPT.9/86 NO-2		298.94														
		END OF HOLE	8.06														
7																	
8																	
9																	
10																	

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1986

CHECKED *th*

# RECORD OF DRILLHOLE GA14

SHEET 1



LOCATION 5249280mN; 598950mE.

DRILLING DATE SEPT.9-10,1988

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 801-1266

SCAL METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
0		GROUND SURFACE		307.50									
		ASPHALT											
		Coarse gravel with sand (FILL)		0.08									
				306.89									
1	NW CASING	Faintly to mod. weathered CONGLOMERATE comprising dark grey argillite matrix with pink rounded granite clasts. Numerous subhorizontal to 45 deg. quartz-carbonate coated fractures.		0.81	1	0.09	80% /LT.GREY						
2		-Zone of subvertical hackly fractures most Fe-stained (1.2m. depth)			2	0.12	80% /GRY/GRN						
3	SEPT.9/88	-Zone of horizontal and vert. fractures exhibiting 1-3mm. thick quartz-carbonate infill. Most fractures also Fe-stained (3.0m. to 3.5m.)			3	0.06	80% /LT.GRY/GRN						
4		Broken core comprising numerous fine gravel size angular fragments, most coated with silt and limonite (4.0m. to 5.3m.)			4	0.06	80% /LT.GRY/GRN						
5		Several subvertical and oblique hackly fractures some with slick surfaces (?blast damaged)			5	0.04	80% /LT.GRY/GRN						
6	SEPT.10/88 NO-2				6		80%						
7		END OF HOLE		6.24	7		80%						
8													
9													
10													

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1988

CHECKED *th*

# RECORD OF DRILLHOLE GA15

SHEET 1



LOCATION 5249520m.N; 599060m.E.

DRILLING DATE SEPT.10,1988

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

METRES	DRILLING RECORD	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
							RECOVERY		R.O.D. %	FRACT. INDEX PER 0.25M CORE AXIS	DISCONTINUITY DATA		TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS
							TOTAL CORE %	SOLID CORE %			DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS	DIP WLL CORE AXIS
							40-60	40-60																
0	GROUND SURFACE		307.00																					
	ASPHALT		0.09																					
	Coarse sand and gravel (FILL)		306.55																					
			0.45																					
1				1	0.07	80% /BRN.GREY																		
2				2	0.12	0%																		
3	Faintly to moderately weathered medium grey silicified CONGLOMERATE; some quartz-carbonate veins			3	0.16	80% /GREY																		
4	-Fairly coarse conglomeratic zone from 3.0m. to 3.5m. with several heavily limonite stained fractures.																							
5	-Grading to argillite matrix below 4.9m. depth.			4	0.15	80% /GREY																		
6				6		80% /GRY																		
6	SEP 10/88 NO-2		300.91																					
6	END OF HOLE		0.09																					
7																								
8																								
9																								
10																								

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1988

CHECKED *tw*

# RECORD OF DRILLHOLE GA16

SHEET 1 OF 2



LOCATION 5249510m.N; 599120m.E.

DRILLING DATE SEPT 10-11/88

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1266

SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R -ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W -WAVY C -CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								RECOVERY				R.O.D.				DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec					
								TOTAL CORE %		SOLID CORE %		%		%		FRACT. INDEX PER 0.5M COREAGE		DP WALL CORE AXIS		TYPE AND SURFACE DESCRIPTION					
								10-20	20-30	10-20	20-30	10-20	20-30	10-20	20-30	10-20	20-30	10-20	20-30						
0		GROUND SURFACE		308.00																					
		ASPHALT		0.03																					
		Sand,gravel (FILL) occasional cobbles and boulders.			1	0.12	60% /BROWN																		
1				305.09																					
				0.91																					
2		Compact golden brown SAND with occas.cobbles and boulders.			2	0.08	60% /GOLD/BRN.																		
				303.28																					
				2.74																					
3		Dark grey laminated ARGILLITE some subvertical heavily limonite stained joints notably at 4m.depth																							
	NW CASING			301.28																					
				4.72																					
4					3	0.06	30% /GREY																		
5					4	0.20	80% /GREY/GRN.																		
6		Medium to dark grey CONGLOMERATE comprising dark grey matrix material with some granitic clasts up to 8mm.diam.evident;with conspicuous zone of sandy inclusions at 15m.depth			5	0.16	80% /GREY/GRN.																		
7					6	0.12	80% /GREY/GRN.																		
8		Several zones of markedly hackly fracturing (?blast induced) most notably between 11.9m and 13m depth, also between 11.3m and 11.7m depth.			7	0.16	80% /GREY/GRN.																		
9																									
10	SEPT.10.88 NO-2			296.00																					
		CONTINUED ON SHEET 2		10.00																					

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1988

CHECKED *AW*

SHEET 2 OF 2

DRILLING DATE SEPT 10-11/88

# DATUM GEODETIC

DRILL RIG BOYLES BROS.(MOD.)

# DRILLING CONTRACTOR MORISSETTE



PROJECT 861-1255

1 : 50

**Golder Associates**

LOGGED AWM/TGC

DATE OCT.14,1988

CHECKED *Th*

# RECORD OF DRILLHOLE GA17

SHEET 1



LOCATION 5249920m.N; 590180m.E.

DRILLING DATE SEPT 11,1988

DATUM GEODETIC

INCLINATION -90 deg. AZIMUTH

DRILL RIG BOYLES BROS.(MOD.)

DRILLING CONTRACTOR MORISSETTE

PROJECT 861-1256

SCALES METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED				HYDRAULIC CONDUCTIVITY K <sub>o</sub> cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								RECOVERY		R.O.D. %	FRACT. INDEX PER 0.3M CORE AXIS	DISCONTINUITY DATA		TYPE AND SURFACE DESCRIPTION	DIP WILL CORE AXIS	DIP WILL CORE AXIS	DIP WILL CORE AXIS	DIP WILL CORE AXIS	DIP WILL CORE AXIS	DIP WILL CORE AXIS						
								TOTAL CORE %	SOLID CORE %																	
0		GROUND SURFACE		299.00																						
1		ASPHALT		0.06	1	0.06	0%																			
2		FILL and natural ground to 0.6m.depth comprising angular cobbles and gravel, some areas of sand;below 0.6m.depth cobbles and boulder size fragments-could be dislodged or disturbed bedrock			2	0.1	0%																			
3		-Soft zone at 1.8m.;attempt split spoon (recovered cobble and trace brown sand)			3	0.06	0%																			
4		-Below 1.9m.,as before; probably loose bedrock.			4	0.2	0%																			
5				295.58																						
6		Faintly to moderately weathered CONGLOMERATE;some sizeable granite clasts (notably at 4.9m.depth);mostly matrix is sandy, medium to dark grey in colour.Some angular hackly fractures evident at 5.5m.depth; elsewhere,most of fractures planar,a few are Fe-stained.		3.44	6	0.12	0%																			
7																										
8																										
9																										
10																										
		END OF HOLE		293.21																						
				6.79																						

DEPTH SCALE

1: 50

Golder Associates

LOGGED AWM/TGC

DATE OCT.14,1988

CHECKED *tw*