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WO 85-6-3003 DIST 19

HWY 622 STR SITE

Remedial Works For
"Highway 622 Dams"

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GEOCRES 52B-10 DATE APR 29 1988

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FOUNDATION INVESTIGATION REPORT

For

Remedial Works For

"Highway 622 Dams"

W. O. 85-6-3003

District #19, Thunder Bay (Atikokan)

1. INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the above-noted site between 86 11 11 and 86 11 12, and presents recommendations for remedial works for the Highway 622 dams.

A section of this highway was constructed by Caland Ore Company Ltd. in the early 1950's to access their open pit mine in the East Arm of Steep Rock Lake. As illustrated on Dwg. 8563003-A and B in the Appendix, the highway acts as a dam retaining up to 4.9 m of water. The highway prevents the runoff from a 2.4 square km drainage area from flowing westerly into the Southeast Arm of Steep Rock Lake where it would require pumping. Instead, Caland excavated channels and bore a tunnel to divert the water in an easterly direction, thus flowing into the Rawn Reservoir. This diversion system is known as the Auxiliary Rawn Reservoir and it consists of three earth fill dams under Highway #622, two excavated channels totalling 1,128 metres and a 1.8 metres by 2.1 metres tunnel through rock, 260 metres long.

Three small dams are located on Highway #622, about 6.5 km north of Atikokan as illustrated on Dwg. 8563003-A and B in the Appendix. The dams form part of the road embankment for Highway #622. The northern dam, Dam No. 3 is less than 5 metres in height, while the southernmost dam, Dam No. 1 is higher than the two northern dams and is about 10 metres high. Dam No. 2, which is in between Dam No. 1 and Dam No. 2, was not surveyed since this dam is so small.

The site investigation consisted of advancing 5 boreholes in the area along Highway #622. The boreholes, identified as BH 1 through 5, were advanced by means of hollow stem augers and N Q rock coring techniques. The boreholes ranged in depth from 5.9 to 16.4 m below the ground or pavement surface.

BH 1 was advanced through the pavement surface, while the remaining boreholes were advanced through the ground surface immediately adjacent to the pavement. All borehole stations are located relative to Sta. 10 + 000 at the junction between Hwy. #11B and Hwy #622.

2. SITE DESCRIPTION

2.1 General

This investigation was carried out at the dams on Hwy. #622 north of the Atikokan. These dams are probably constructed more like road embankments rather than water retaining dams. Plans and sections of these dams are given in Drawings 8563003-A and B.

The northern dam, Dam No. 3 is less than 5 metres in height and has upstream and downstream slopes which range from 1.4 horizontal to 1.0 vertical to 2.5 horizontal to 1.0 vertical, with the typical slope being 1.5 horizontal to 1.0 vertical. The crests of the road dams range from about 2.1 to 3.3 m above the Auxiliary Rawn Reservoir. The northern portion of Dam No. 3 has a 0.46 m diameter culvert exiting on the downstream side of the dam with only a minor flow through the culvert. The culvert was not visible on the upstream side of the dam and is probably blocked. The downstream slope of this dam appears to be stable and no seepage was observed at the abutments. However, part of the downstream toe of this dam was submerged below pond water due to beaver dam blockage downstream. Therefore, it was not possible to detect seepage at the toe.

Dam No. 2 is located approximately 250 m southeast of Dam No. 3 on Highway 622. The downstream toe essentially abuts a rock slope cut so the possibility of instability of this dam is relatively small. However, it should be noted that the southern portion of the downstream toe of this dam was submerged below water because of a small pond immediately downstream of Dam No. 2. A small diameter culvert exiting downstream of the dam was found with a minor flow through the culvert. The culvert was not visible on the upstream of the dam and is also probably blocked. Since the height of the dam is relatively small, the downstream slope of this road dam appears to be stable and no seepage was observed at the abutments.

The southernmost dam on Highway #622, Dam No. 1, is located approximately 150 m south of Dam No. 2. This dam is higher than the two northern dams and is about 10 metres high. The upstream slope averages about 3.6 horizontal to 1.0 vertical and the downstream slope is about 1.6 horizontal to 1.0 vertical.The cross-sections for Dams No. 1 and 3 are shown on Drawings 8563003-A and B.

The north and south abutments are granitic bedrock covered with a couple of metres of fluvial sand. This fluvial sand may occur over bedrock, beneath the dam as well and may be the cause of seepage observed at the toe of the dam. The seepage zone is located at the bottom of the valley, nearer the south abutment. The seepage was measured with a V-notch weir at the end of June, 1987 and the quantity of seepage is essentially constant at about 13 imperial gallons per minute. Since some amount of seepage by-passes the weir, the actual quantity of seepage is probably about twice as much, that is about 30 imperial gallons per minute. The seepage from the toe of this dam forms a small stream which drains into the Southeast Arm of Steep Rock Lake.

Seepage at the downstream toe of the Dam No. 1, should not be allowed to continue without some remedial measures. The seepage could lead to piping and this would cause washout and failure of the road dam and cut Highway #622. The water in the Auxiliary Rawn Reservoir would drain into the Southeast Arm.

For these reasons, a limited site investigation has been undertaken on Dam No's. 1 and 3 during November, 1986, consisting of drilling five (5) bore-holes to determine the nature of the fill material used for the highway dams, and to determine the nature of the foundation soil located beneath the highway fill. Standpipes and piezometers were also installed along the crest of the highway road dams to determine the groundwater levels.

2.2 Borehole Locations

The location of each of the 5 boreholes is shown on Dwg. No. 8563003-A and B. The following table summarizes the locations both in reference to the established Highway #622 stationing as follows:

BOREHOLE NO.	STATION	O/S	DAM NUMBER
1	16 + 505.2	3.1 RT.	1
2	16 + 532.8	3.1 RT.	1
3	16 + 506.1	4.0 LT.	1
4	17 + 374.1	2.8 RT.	3
5	17 + 296.9	3.3 LT.	3

2.3 Subsurface Conditions

Details of the subsurface conditions encountered in the boreholes, in-situ test results and groundwater levels are shown on the Record of Borehole Sheets in the Appendix. The location of each borehole is shown in plan Dwg. 8563003-A and B together with 3 stratigraphical sections.

Sand and Gravel

The fill material overlying the original ground surface consists of either sand with/some gravel or sand and gravel. Well compacted sand and gravel fill was encountered in all boreholes with the exception of Borehole #2 where a loose layer of sand was encountered during the drilling operation. Based on laboratory index testing and Standard Penetration Test 'N' values obtained during the field investigation, the sand and gravel fill appears to be well compacted. The various proportions of silt and clay within the sand and gravel fill vary, but are generally less than 25% of each. The ranges of gradations for sand or sand and gravel fill are summarized on Figure 2. The thickness of the sand and gravel fill was found to range between 4 and 9.8 m.

Silt with some sand

Underlying the sand and gravel fill Borehole #1 encountered a layer of silt with some sand and trace of gravel and clay as shown on Figure 3. The measured 'N' value within the silt stratum was about 41 blows per foot at the borehole location.

Sand and Silt

Underlying the dam fill materials in Borehole #4, a layer of sand and/with silt approximately 2.7 m thick was encountered. A layer of sand with silt was also encountered in Borehole #1 beneath the sand and gravel fill material. The results of grain size distribution analyses carried out on samples of the sand are shown in Figure 4.

Silty Clay and Sand

In Borehole #2, a layer of silty clay and some sand with trace of gravel was encountered immediately below the sand fill of the dam. This layer is very stiff with a measured 'N' value of about 23. The natural water content of this layer was about 18 percent. The liquid and plastic limits of the silty clay and sand were 42 and 19.5 percent respectively based on single Atterberg Limit determination (See Figure 1). A typical grain size distribution curve is shown on Figure 5.

Peat

A thin layer of peat with sand was encountered immediately below the sand and gravel fill of Dam No. 1 at the Borehole #3. The thickness of this peat was found to be about 0.3 m. The peat is very soft and a mixture with sand. Based on site investigation, it's our opinion that the surface of peat was the original ground surface before Highway #622 was constructed. No laboratory test was carried out on this sample.

Sand

In Borehole #2, a deposit of fine to medium sand was encountered below the natural silty clay as shown on Figure 6. Based on visual classification and a gradation analysis, this deposit can be described as fine to medium sand, trace gravel, silt and clay as shown on Figure 6. Standard Penetration 'N' value was about 16 blows/0.3 m and indicates that this material is in a compact state. A medium to coarse sand layer was encountered in Borehole #3, #4and #5. The thickness of this sand layer was found to be 0.7 m in Borehole #3, 2.5 m in Borehole #4 and 1.9 m in Borehole #5 immediately above probable bedrock. Based on the results of gradation analyses, this deposit can be described as a well graded sand with some silt, trace clay as shown on Figure 7. Standard Penetration 'N' values ranging between 13 blows/0.3 m to 84 blows/0.3 m indicate that this material is in a compact to very dense state.

Silty Clay to Plastic Silt

Underlying the sand with silt, Borehole #4 encountered a layer of silty clay to plastic silt as shown on the Record of Boreholes. Based on the site investigation, it was found to have a thickness of at least 2.8 m. Two samples of this deposit were tested for the Atterberg Limits. The results are plotted on the Record of Borehole #4 in the Appendix. Based on the results it can be stated that the fine particles consist of a silt of slight plasticity to a silty clay of low plasticity. The results of the Atterberg Limits Testing can be summarized as follows:

	Range
Moisture Content (W)	23.5 - 25.0%
Liquid Limit (W_L)	25.5 - 29.5%
Plastic Limit (W_p)	20.5 - 21.0%
Plasticity Index (I_p)	5.0 - 8.5%

The grain size distribution tests were carried out on two samples. The results are shown on Figure 8. This material can be described as a silty clay to plastic silt with trace of sand.

Based on the Standard Penetration Test 'N' values ranging between 30 and 34 blows/0.3 m, this material can be considered to have a consistency of hard.

Rock

Bedrock was proven by obtaining 1.5 m of N Q rock core in Borehole #1. The recovered core was visually identified by Eric Magni (MTC Geologist) and the detailed description is included in the Appendix for reference.

The bedrock at this location consists primarily of greywake containing quartz veins (10%) of Early Precambrian Age up to 130 mm thick. This rock is unweathered, but has widely spaced joints. The rock core recovery was about 86% and R Q D was about 84% as shown on the Record of Borehole Sheet in the Appendix.

Probable bedrock or boulders were also encountered in the other boreholes. However, no rock core samples were taken from these boreholes.

2.4 Groundwater Conditions

Standpipes and piezometers were installed at representative locations not only to establish stabilized water levels, but also to determine if artesian conditions exist within the original ground.

Standpipes were installed in Boreholes #1, #2, and #4. Piezometers were installed in Borehole #1 and #3. The location of the standpipes and piezometresare shown on the Record of Borehole Sheets in the Appendix and are shown on the stratigraphical sections Drawings 8563003-A & B. Groundwater levels are also indicated.

In Borehole #1, one piezometer was installed within the original ground between the silt layer and sand and silt layer, while a standpipe was installed within the sand and gravel fill.

In Borehole #2, only one standpipe was installed within the original ground and sealed with bentonite below the sand and gravel fill.

In Borehole #3, a piezometer was installed within the original ground and sealed with bentonite.

In Borehole #4, one standpipe was installed at the bottom of the borehole within the original ground and sealed with bentonite.

Based on monitoring of the piezometers and standpipes subsequent to the installations, it appears that the groundwater level within the dam and foundation occurs between 3.5 and 9.0 m below the crest of dams. However, it should be noted that the actual phreatic surface through the dam appears to be somewhat different from the water level measured in boreholes, since the tips of some piezometers and standpipes are installed within the dam foundation below the sand and gravel fill. Probable phreatic surface levels through the body of dam are shown on the stratigraphical sections.

It should be also noted that based on the observed water level in Borehole #1, the water levels recorded in the piezometer installed within the dam foundation demonstrated the existence of a downward hydraulic gradient within the foundation soil. This lower water level appears to indicate that no artesian pressure exists within the foundation soil of the dams. Furthermore, if a downward hydraulic gradient truly existed, the groundwater would have moved downward and outward towards the toe of Dam No. 1 not only through the dam, but also through the foundation.

More details will be discussed later in Discussion and Recommendations.

3. DISCUSSION AND RECOMMENDATIONS

3.1 Discussion

As outlined previously, the Highway #622 dams are essentially part of the road embankment constructed of sand and gravel fill materials.

Since the height of Dam No's. 2 and 3 is relatively small (less than 5 metres), the upstream and downstream slopes of these dams appear to be stable and no seepage was observed at the toe of these dams. No immediate remedial action would be required for these dams.

However, some seepage was detected at the Dam No. 1 (southernmost dam). The seepage from the toe of this dam forms a small stream which drains into the Southeast Arm of Steep Rock Lake. Seepage at the downstream toe of the Dam No. 1 should not be allowed to continue without any remedial action, since this could lead to piping and would cause washout and failure of the road dam and cut Highway #622.

For these reasons, a site investigation has been carried out on Highway #622 dams. Five boreholes were drilled to determined the nature of the dam fill material and the foundation soil. Piezometers and standpipes were installed in these boreholes to determine the groundwater levels. The following sections of this report discuss, in some detail, the results of the investigation and present recommendations for future remedial work of the dam required.

Embankment Fill

The results of the site investigation indicate that the fill materials for the Dam No. 1 consisted of predominantly sand and gravel fill. Based on the results of the standard penetration tests carried out within the fill, sand and gravel fill is well to densely compacted throughout the dam with the exception of Borehole #2 where a loose layer of sand and gravel was found to exist during the drilling. Further, based on the samples taken, the fill consists of various proportions of silt and clay as shown on Figure 2. The thickness of the sand and gravel fill at Dam No. 1 ranges from 9.3 to 9.8 m as shown on the stratigraphical sections.

Foundation Soils

Various foundation soils were encountered underneath the fill materials. Based on the results of the investigation at Dam No. 1, foundation materials consist of silt with some sand, sand and silt, sand with gravel, and fine to medium sand as shown the stratigraphical sections. Detailed descriptions for each material were made in the previous section.

Piezometric Levels

The piezometric readings obtained since their installations were discussed briefly in the previous section. More detailed discussions are summarized in this section.

Two distinct features can be noted from the piezometric information to date.

a) Foundation Piezometric Levels

Water levels in the piezometers sealed into the sand and silt, fine to medium sand, and silt soils that form the foundation for the embankment, vary on the downstream of the Dam No. 1.

The results of the piezometric levels recorded in the foundation soils suggest that, in general, there is a significant head loss between the reservoir and the foundation soils and a slight horizontal gradient exists within the stratum toward the downstream side as shown on the stratigraphical section.

b) Embankment Piezometric Levels

The piezometric levels recorded in the sand and gravel fill material in the dam indicate that there are significant downward hydraulic gradients in the dam fill materials as shown on the stratigraphical section (Borehole No.1). These downward hydraulic gradients suggest that the sand and silt foundation soils are acting as an effective underdrain for the dam section.

Seepage Observations

The seepage was observed at the toe of Dam No. 1 nearer the south abutment. The quantity of seepage was measured to be about 13 imperial gallons per minute. However, taking into account some amount of seepage by passing, the actual quantity of seepage is probably estimated to be about 30 imperial gallons per minute. The seepage from the toe of the dam forms a small stream as previously mentioned. It should be noted that if some remedial measures are not taken, seepage at the Dam No. 1 could lead to piping and would cause washout and failure of the dam.

3.2 Recommendations

The results of this investigation indicate that the piezometric levels observed in the dam are generally reasonable and that the sand and silt foundation soils are acting as an underdrain for the dam. Further, the sand and gravel fill of the dam is effective in controlling the piezometric levels throughout the body of the dam.

However, based on the results of this investigation, the seepage at the downstream toe of Dam No. 1 that is being observed could possibly be the result of a loss of fine soil particles from within the sand and gravel fill or dam foundation soils.

In order to prevent finer soil particles from further migration, consideration is being given to the installation of proper filter system with select drainage channel. Three alternatives are considered for the remedial works at the Dam No. 1. The following are our recommendations for the design and construction of the filter system and drainage channel from approximately Sta. 16 + 455 to Sta. 16 + 555 on Higway #622.

Alternative #1 (Filter system with natural materials)

The gradation limits for sand and gravel fill for Dam No. 1 on Highway #622 are shown on Figure 2 and summarized as follows:

Sand and Gravel Fill [Dam Fill]			
D 85 s = 5.0	-	32	mm
D 60 s = 0.85	-	6.0	mm
D 50 s = 0.42	-	2.7	mm
D 15 s = 0.023	-	0.18	mm
D 10 s = 0.009	-	0.12	mm

Based on the above gradation, it can be seen that the sand and gravel fill can be classified as coarse and broadly graded soils. In the last 20 years there have been a number of incidents in which sinkholes (craters) have appeared on the crests and slopes of embankment dams comprised of remarkably similar coarse and broadly graded soils (Sherard, 1979).

The troubles can be explained by the fact that the broadly graded coarse soils are internally unstable, in the sense that the fine portion is not compatible with the coarse particles from the standpoint of a filter. The sinkhole is caused by erosion of a concentrated leak causing the finer soil particles to migrate out of the compacted soil mass, exiting through cracks in the foundation rock, or through filters which are too coarse to retain and selectively retain fines.

These experiences support the conclusion that fine to medium sand filters should be considered for these dams. Also consideration should be given to sealing cracks in rock foundation under dam shells of these materials, in addition to the installation of inverse filter system at the downstream toe of the dam.

Internal erosion causing collapse and sinkholes on the surface has been described in the literature as occuring at the following dams:

Balderhead (Vaughan, et al 1979);
Hyttejuvet (Wood, et al 1976);
Yards Creek Upper Reservoir (Sherard, 1973);
Viddalsvate (Vestad, 1976);
Messaure, Seitevare and Bastusel (Bernell, 1976); and
Churchill Falls Dykes (Boivin, et al 1973; Seemel, et al 1976)

In all these dams, the erosion and sinkholes developed in embankment material of glacial origin of very similar properties to the sand and gravel fill at Dam No. 1, being comprised of a widely graded mixture ranging from coarse gravels and cobbles down to silt and clay size particles.

For these reasons, based on the current accepted design criteria for filters (Cedergren, 1977; Lambe and Whitman, 1969; Vaughan, 1978), gradation limits for the required select filter to the sand and gravel fill placed at Dam No. 1 and for the required select drain material to the select filter have been established as shown on Figure 9 and summarized as follows:

Select Filter Material	Select Drain Material
D 85 F = 1.3 - 5.5 mm	D 85 D = 13.5 - 30 mm
D 50 F = 0.52 - 2.36 mm	D 50 D = 6.7 - 19 mm
D 15 F = 0.175 - 0.87 mm	D 15 D = 2.6 - 9.3 mm
D 10 F = 0.155 - 0.73 mm	D 10 D = 2.0 - 7.7 mm

Based on the required gradation limits for select filter and select drain materials, the gradation limits for the M.T.O. granular materials and concrete aggregates, which are commercially available, have been reviewed in order to find out proper materials. As shown on Figure 10, the gradation limits for concrete fine aggregate are perfectly fit within those of the required select filter, while the gradation limits for concrete coarse aggregate (nominal 19 mm) fall within those for the required select drain material. It should be noted that concrete fine aggregate and concrete coarse aggregate can be used for the select filter and select drain material, respectively.

As shown on Figure 9, since the gradation limits for the required select filter are much finer than those for select drain material, direct placement of the select drain material against the sand and gravel fill could cause fine particles to migrate into the select drain and possibly clog the drainage system.

It is therefore recommended that for the Alternative #1 (natural filter system), select filter material be placed against the downstream toe of the dam and within the drainage trench between select drain material and foundation soil. The details of this filter system are presented on the schematic drawings (Plans and Sections, see Figures 11 to 15.

A minimum 0.3 m (1 ft.) of select filter material should be placed beneath the select drain. It should be noted that since the depth of frost penetration is estimated to be about 2.4 m at the Atikokan area, frost protection material be placed over the filter system in order to prevent the drainage system from freezing. A minimum 15 cm of suitable earth cover should be placed over the frost protection for future vegetation. The construction details are shown on Figures 11 to 15.

<u>Alternative #2 (Select Drain Material with filter fabric)</u>

Alternatively, the geotextile, known as Filter Fabric, can be used. In this case, 'filter fabric' should be wrapped around a granular or select drain materials to act as a filter or separator.

In assessing drainage, the principal design problem is definition of the flow characteristics of the filter fabric under varying loading conditions and hydraulic gradients. Flow through or across a filter fabric is a function of the fabric size. In present practice, assessment of fabric pore size is made by testing for the equivalent opening size (EOS), generally defined as equivalent to the smallest uniform spherical particles of which 95 percent by weight are retained on the geotextile after a specified period of mechanical sieving.

Kenney et al (1985) have studied the controlling constriction size of granular filters. They define the controlling constriction size as a size characteristic of void network in a granular filter and equal to the diameter of the largest particle, Dc, which can possibly be transported through the filter by seepage. Their test data shows that for granular filters, of uniformity ($^{D60}/_{D10}$) less than 15, the controlling constriction size, Dc, can be expressed as:

$$\frac{Dc}{D15} < 0.2$$

From this expression, Milligan et al (1984) compared the controlling constriction size of a filter to that for an equivalent fabric and found that the equivalent controlling "constriction" size to soil filter is about the same as the equivalent opening size (EOS).

However, problems have occured with broadly graded cohesionless soils used as cores for earth dams (Sherard, 1979) and with similar materials as subgrades in roads or railroads. For such materials ($^{d60}/_{d10}$ >50), it appears that the d85 size criterion is not applicable and, if used, may be dangerous. From this experience, it suggested that, as a general guide, as relatively cohesionless base soils become more broadly graded, the greater the possible degree of invalidity of the commonly accepted d85 retention criterion. This comment applies both to soil and fabric filters for dams and roads and, in many respect, corresponds to the concerns raised by Giroud (1982).

He suggested the following formula:

$$EOS = 095 < 18 \times \frac{d50}{C'u}$$

$$\text{where: } C'u = \frac{d'100}{d'0}$$

Based on the above criteria, the equivalent opening size of filter fabric for the Dam 622 was calculated to be 350 μm.

It is therefore recommended that for the Alternative #2, a smaller size trench (o.6 m in width) be excavated, then filter fabric (Class I, non-woven) be placed against the trench, and select drain material be placed within the filter fabric. The details of this filter system are presented on the schematic drawings (Figures 11 to 15).

A minimum 2.2 m of frost protection material should be placed over the filter system in order to prevent the drainage system from freezing. A minimum 15 cm of suitable earth cover should be placed over the frost protection for future vegetation.

Alternative #3 (Perforated Drain Pipe)

Another alternative is the use of perforated drain pipe. For this scheme, a 10.2 cm diameter perforated drain pipe with 0.64 cm diameterholes can be used. The details of this filter system are presented on the schematic drawings (Figures 11 to 15).

As shown on the above drawings, a perforated drain pipe should be surrounded with select drain material and be wrapped with a 350 μm opening size of filter fabric to prevent the finer material from migration. A minimum 0.3 m (1 ft.) of select filter material should be placed beneath the select drain. Frost protection material should be also placed over the filter system. A minimum 15 cm of suitable earth cover should be placed over the frost protection for future vegetation. The construction details are shown on Figures 11 to 15.

3.3 Other Considerations

Dewatering

The filter system should be placed "In The Dry". However, since the fill and foundation materials are a granular deposit and the water table is at or immediately below the existing groud surface, it will be necessary to prevent the base of the excavation from boiling due to an unbalanced excess hydrostatic head.

It is therefore our opinion that a positive dewatering scheme would be required for this project. One method of achieving this is carrying out the excavation by means of oversize perimeter ditches and constantly pumping out from the ditches as shown on Figure 16. Alternatively, a steel sheet piling method can be used as shown on Figure 17.

Construction

As mentioned above, a trench will be excavated through a granular deposit. If a steel sheet piling method is not used, the excavation wall could not stand for a long period of time. It is therefore recommended that a stage excavation and filling method be adopted for the installation of a filter system. It is our opinion that 5-6 m of excavation and backfill at a time would be appropriate. It should be noted that if filter fabric is used for the filter system, it should be overlapped at least 1 m on each side to prevent the filter fabric from slipping away.

Care should be exercised to ensure that under no circumstances is there to be a mixture of filter and select drain material which might occur during construction. It is, therefore, recommended that pre-made forms be used to place the filter system and that experienced geotechnical personnel direct and supervise the placement of the filter system.

4. MISCELLANEOUS

The field work for this investigation was carried out during the period of 86-11-11 to 86-11-12, under the supervision of Lou Politano (former Project Foundations Engineer). The equipment was owned and operated by Dominion Soil Investigation Ltd. of Toronto.

This report was written by T.C. Kim and reviewed by M. Devata, Chief Foundation Engineer (East).

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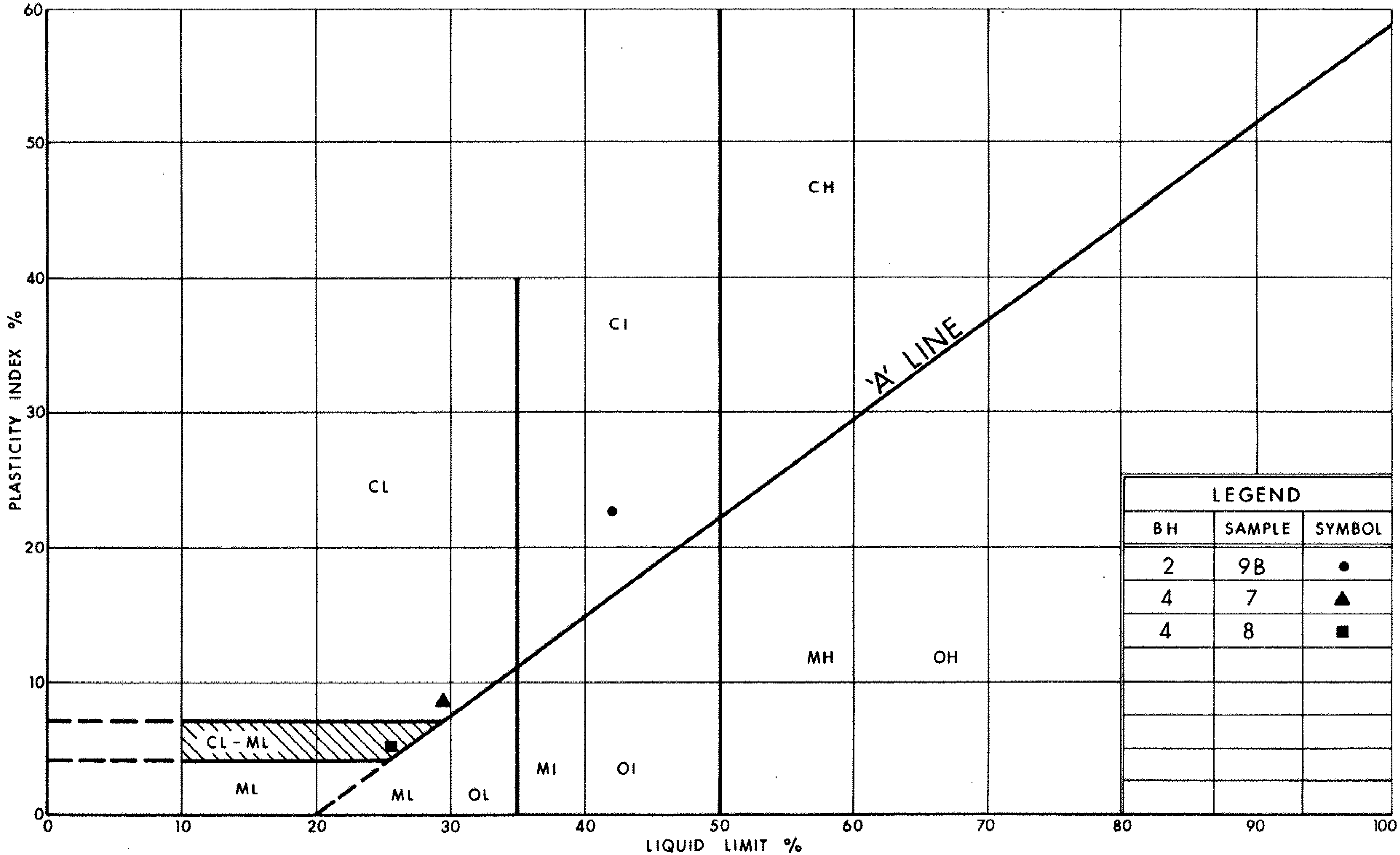
APPENDIX

DESCRIPTION OF ROCK CORE - W.O. 85-6-3003

BOREHOLE NUMBER	DEPTH (m)	% CR*	% RQD*	CORE DESCRIPTION DEPTH (m)	CORE DESCRIPTION DESCRIPTION
1	14.94-16.38	86	84	14.94-16.38	GREYWACKE containing quartz veins (10%) up to .13 m thick, unweathered, widely spaced joints; core loss believed to be due to core left in hole.

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

Oct 75, FF-S-21



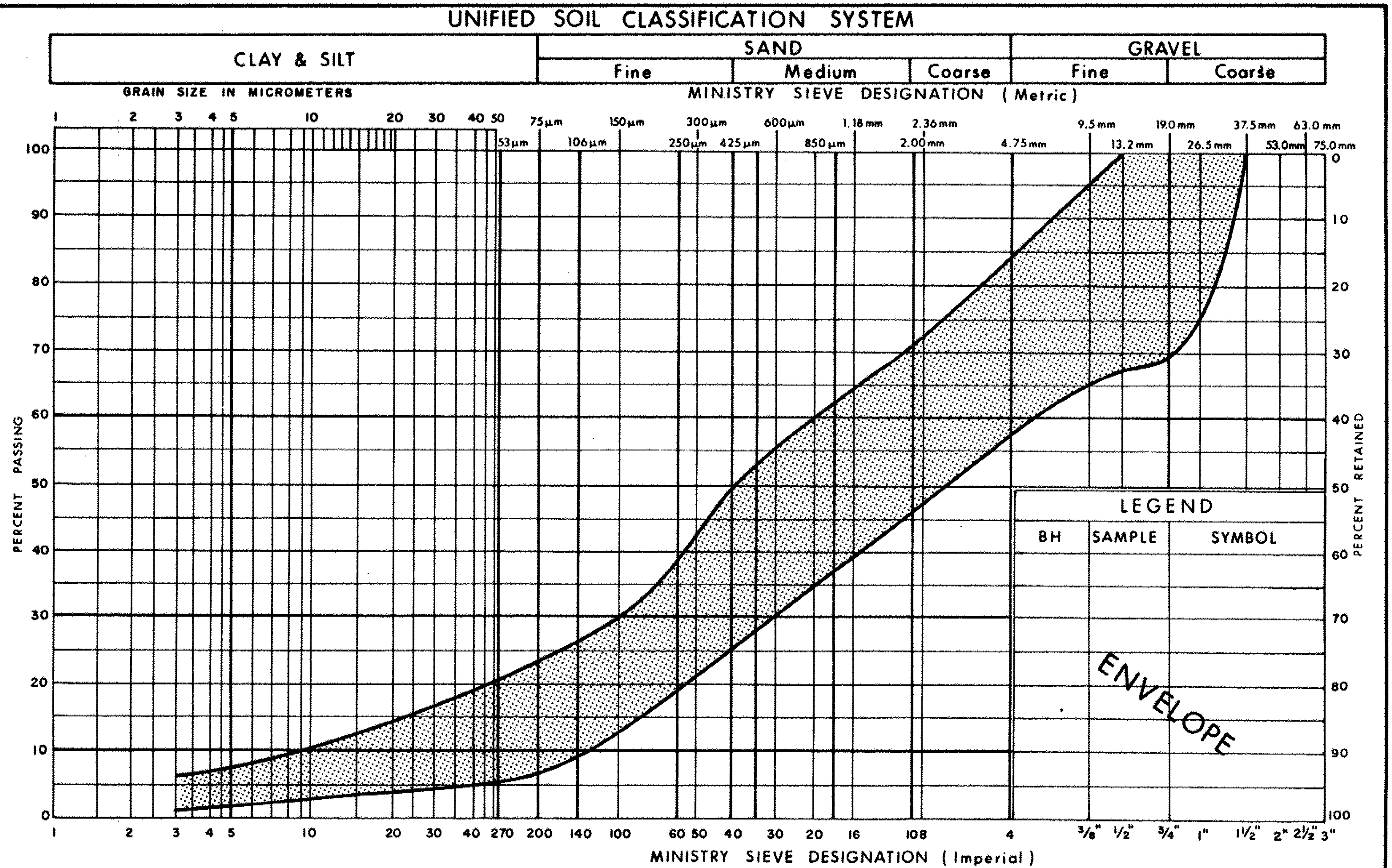
LEGEND		
BH	SAMPLE	SYMBOL
2	9B	●
4	7	▲
4	8	■

Ministry of Transportation
Ontario

PLASTICITY CHART
SILTY CLAY TO PLASTIC SILT

FIG No 1
WO 85-6-3003

78 12 M



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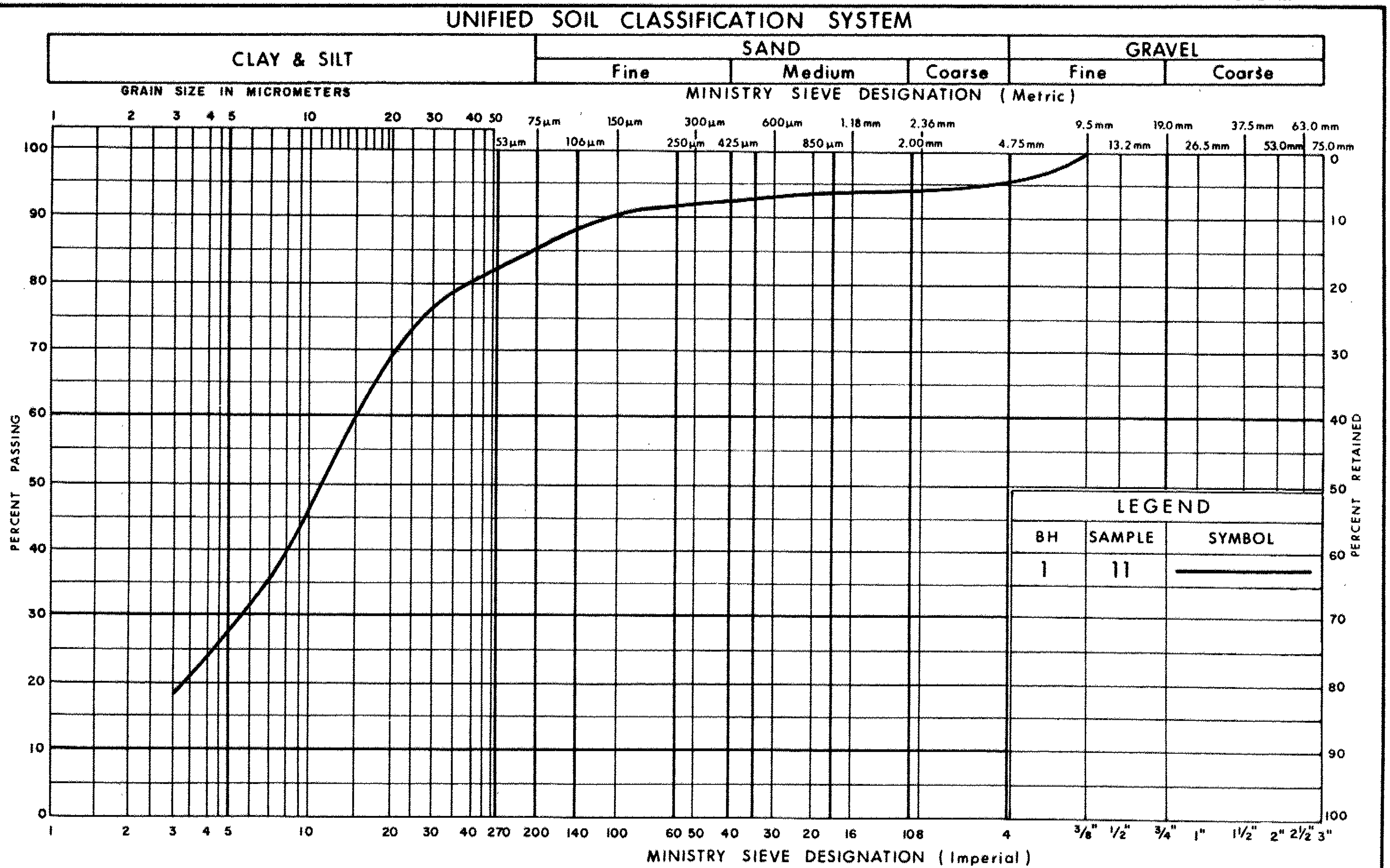
GRAIN SIZE DISTRIBUTION

SAND & GRAVEL, SOME/TRACE SILT TRACE CLAY (FILL)

FIG No 2

WO 85-6-3003

78 12 M



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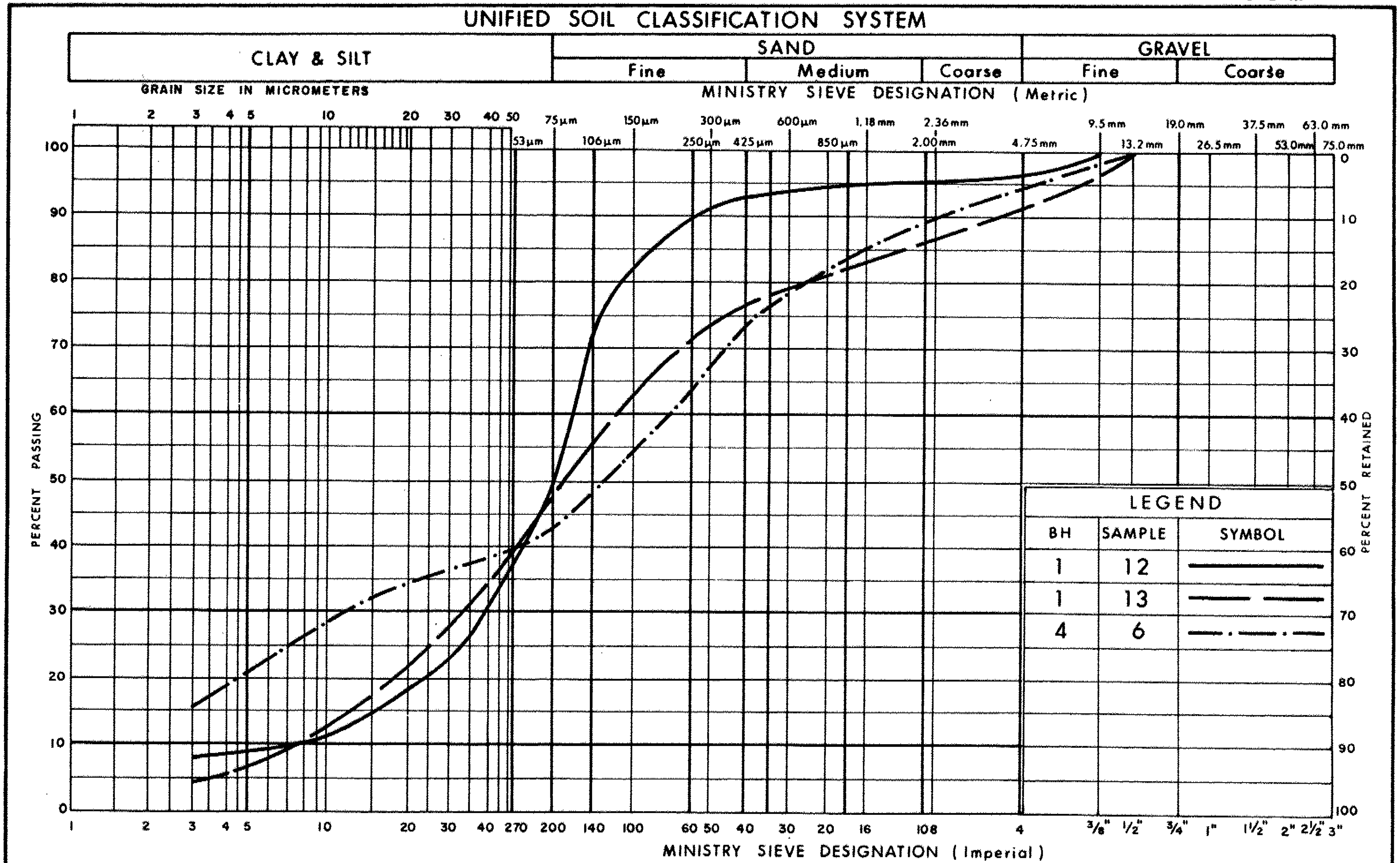
GRAIN SIZE DISTRIBUTION

SILT, SOME SAND TRACE GRAVEL AND CLAY

FIG No 3

W O 85-6-3003

78 12 M



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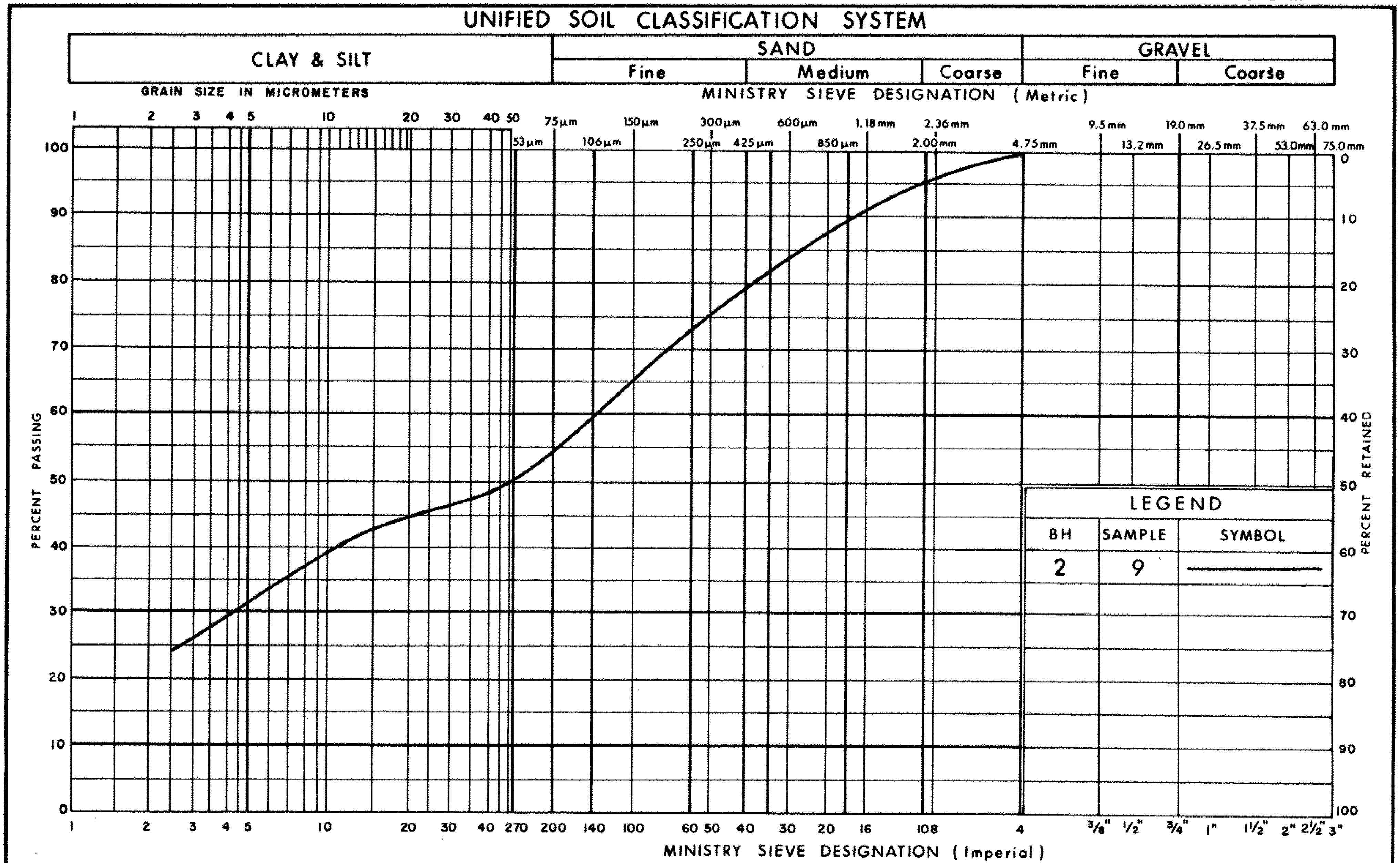
GRAIN SIZE DISTRIBUTION

SAND AND/WITH SILT, TRACE GRAVEL & CLAY

FIG No 4

WO 85-6-3003

78 12 M



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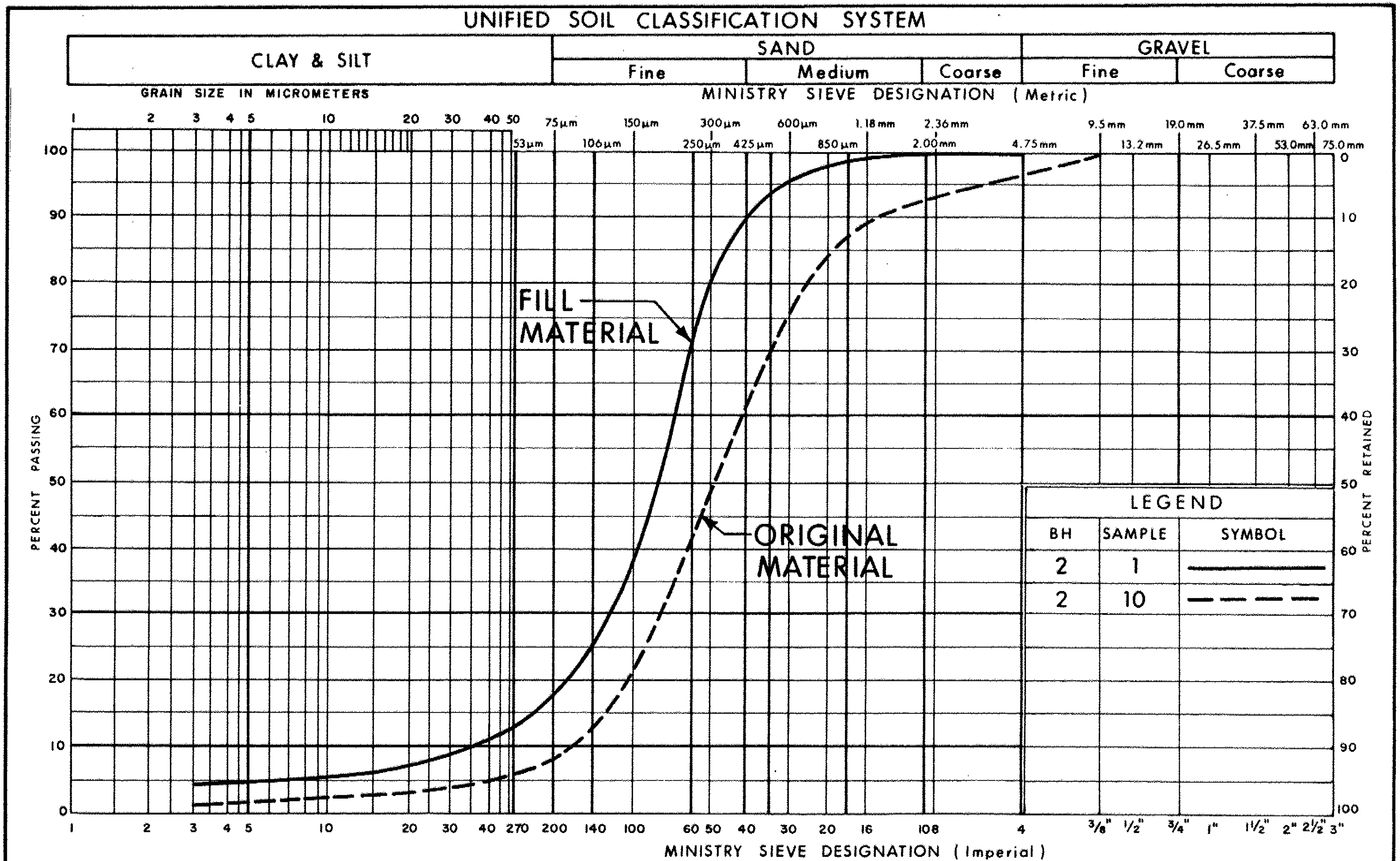
GRAIN SIZE DISTRIBUTION

SILTY CLAY AND SAND, TRACE GRAVEL

FIG No 5

WO 85-6-3003

78 12 M



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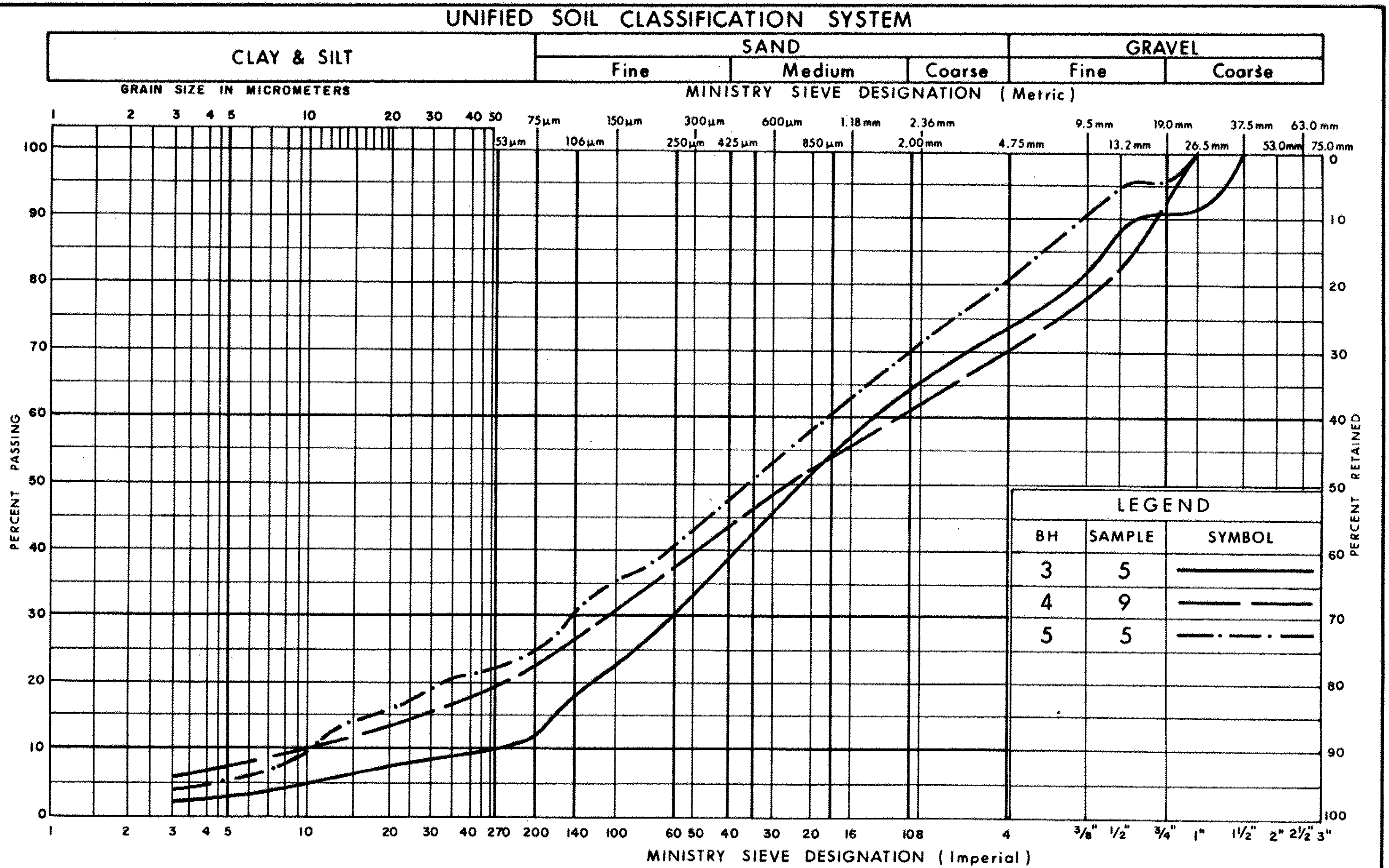
GRAIN SIZE DISTRIBUTION

FINE TO MEDIUM SAND

FIG No 6

W O 85-6-3003

78 12 M



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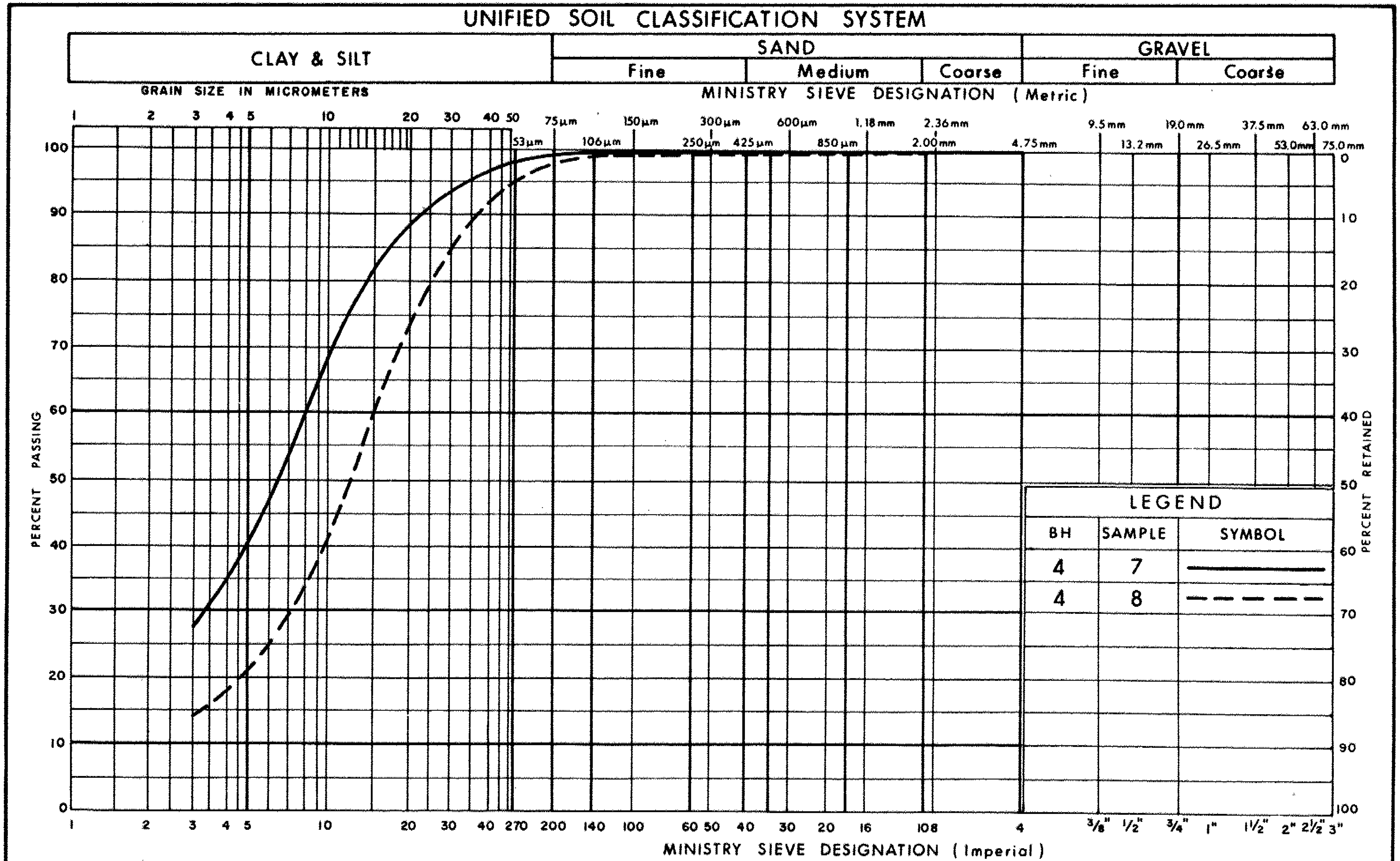
GRAIN SIZE DISTRIBUTION

SAND WITH/ SOME GRAVEL, SOME SILT TRACE CLAY

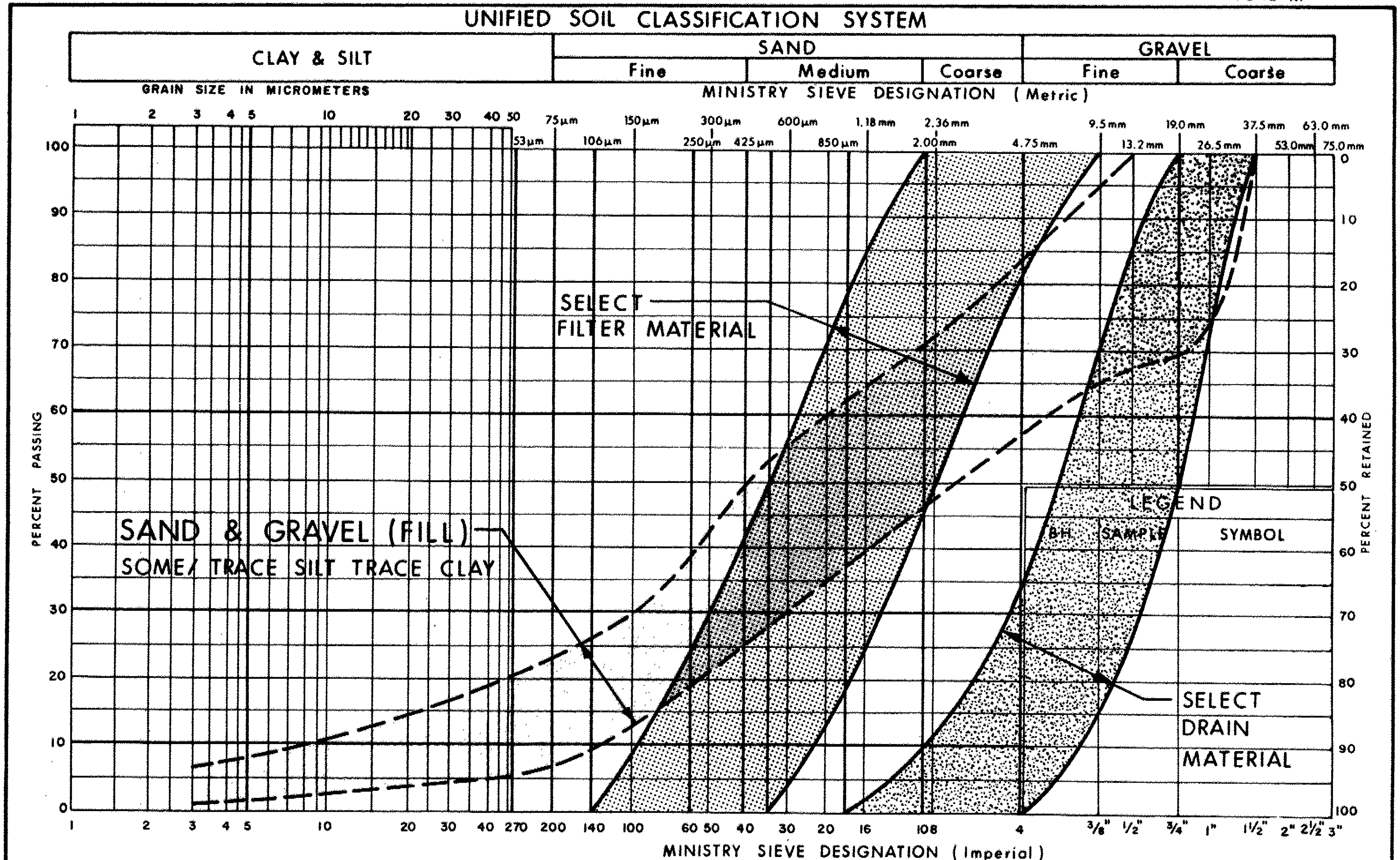
FIG No 7

W O 85-6-3003

78 12 M



Ministry of Transportation and Communications, Ontario	GRAIN SIZE DISTRIBUTION	FIG No 8
	SILTY CLAY TO PLASTIC SILT, TRACE SAND	WO 85-6-3003



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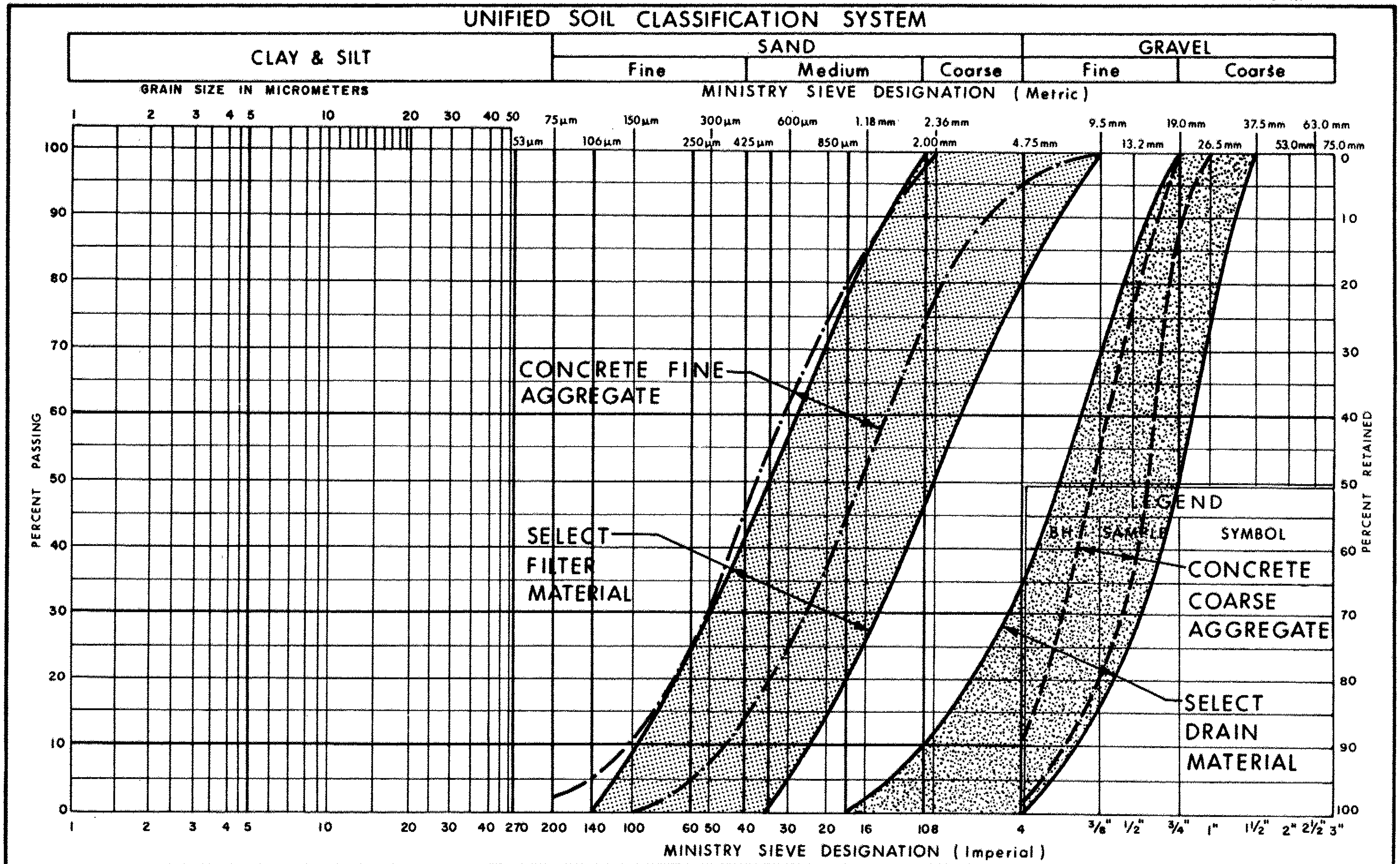
GRAIN SIZE DISTRIBUTION

GRADATION LIMITS FOR SELECT FILTER AND SELECT DRAIN MATERIAL

FIG No 9

W O 85-6-3003

78 12 M



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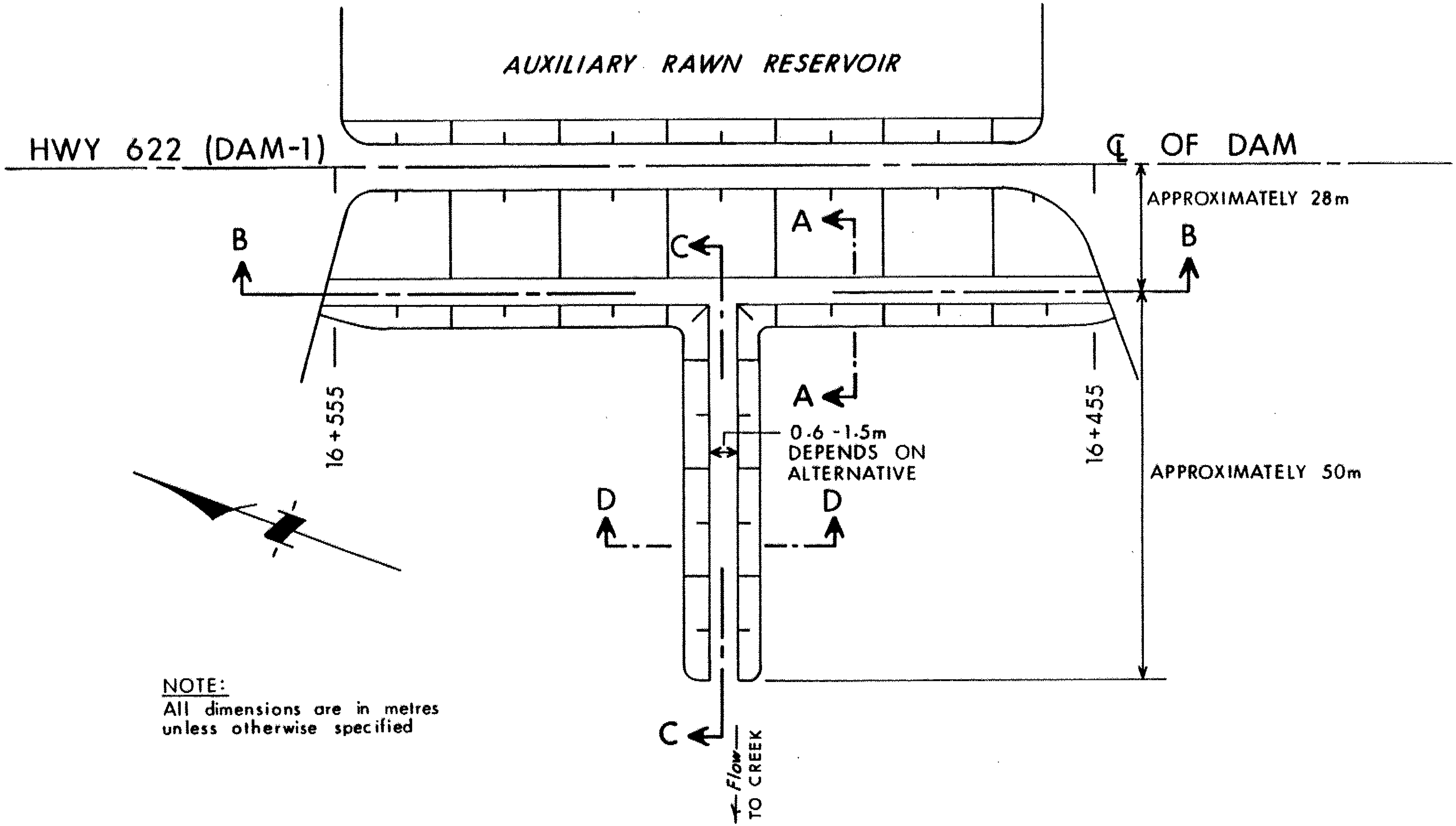
GRAIN SIZE DISTRIBUTION

GRADATION LIMITS FOR CONCRETE FINE AGGREGATE AND COARSE AGGREGATE (NOMINAL 19.0 mm)

FIG No 10

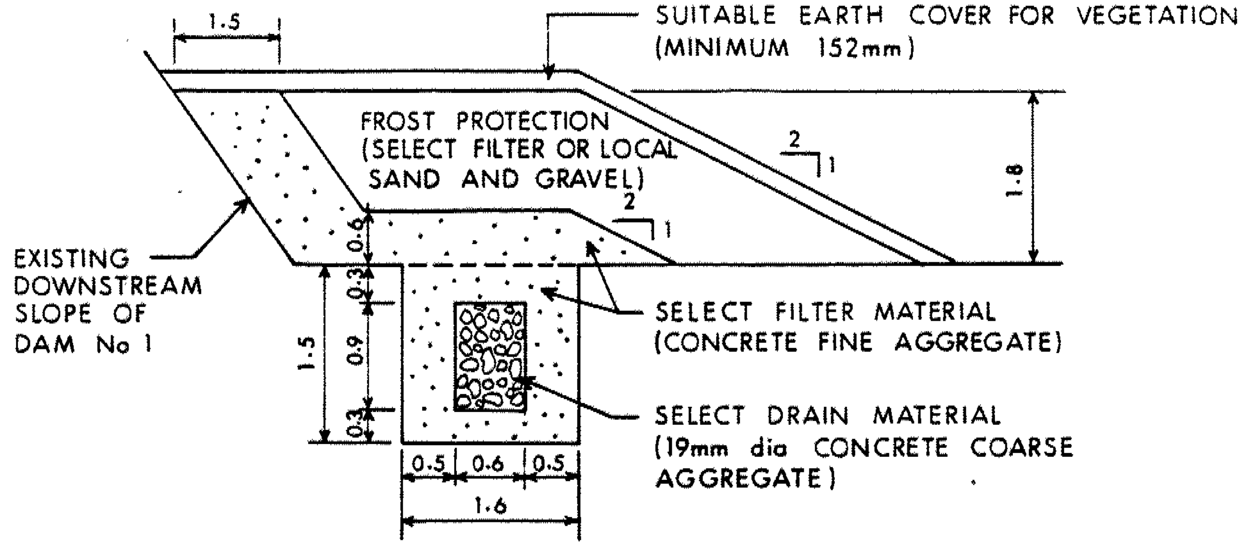
W O 85-6-3003



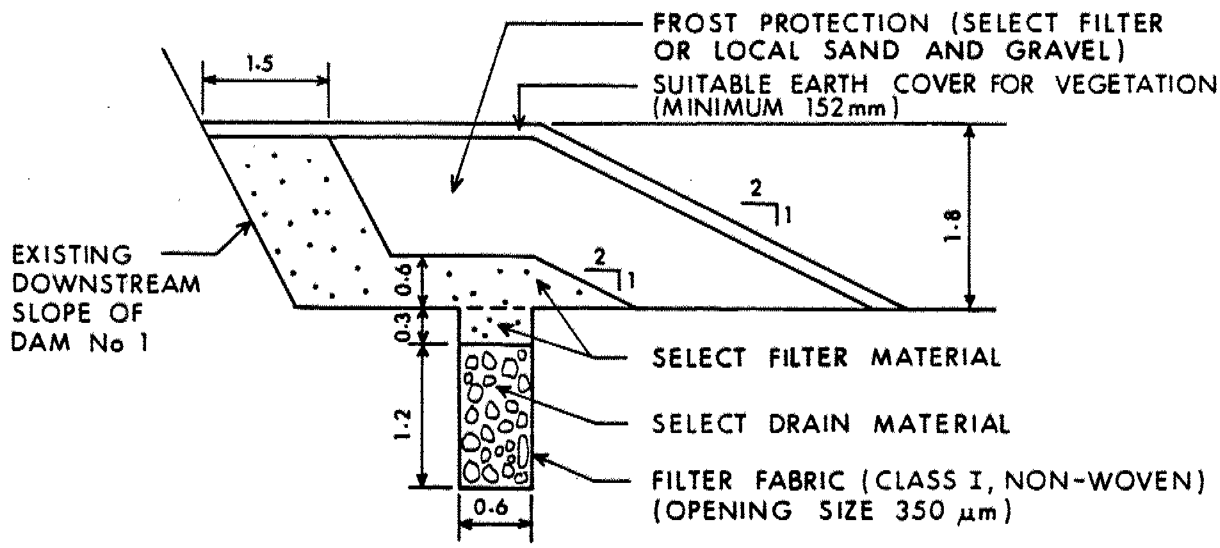
PLAN (NTS)

Fig 11

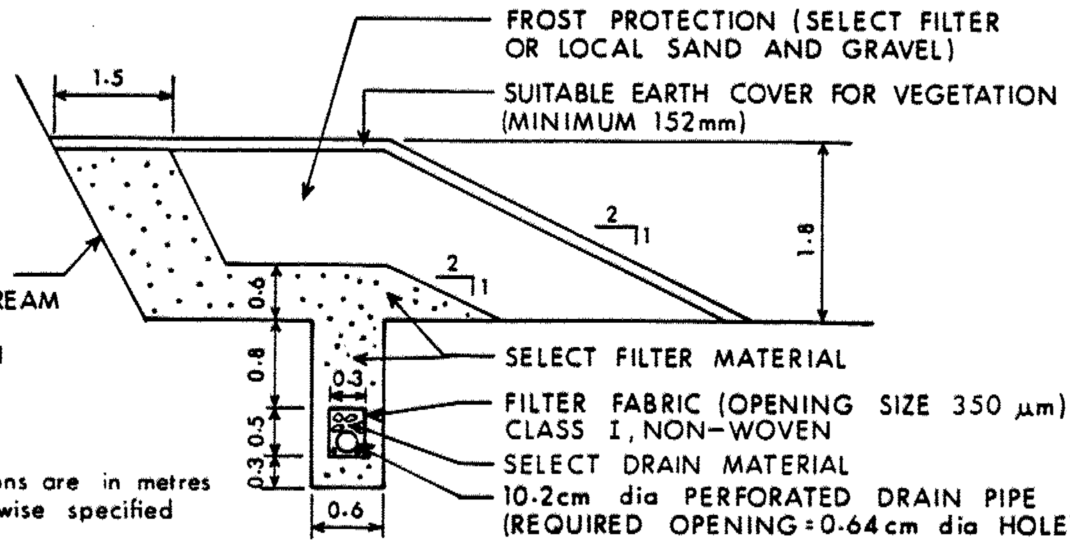
WO 85-6-3003



ALTERNATIVE -1 (NATURAL FILTER)



ALTERNATIVE-2 (SELECT DRAIN MATERIAL WITH FILTER FABRIC)



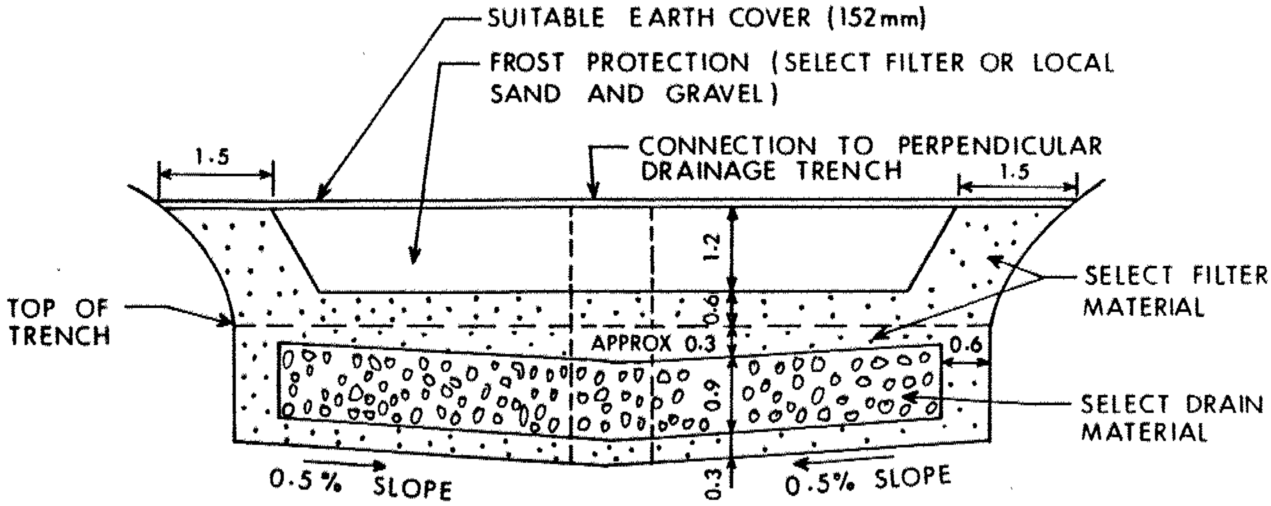
NOTE:
All dimensions are in metres unless otherwise specified

ALTERNATIVE-3 (PERFORATED DRAIN PIPE)

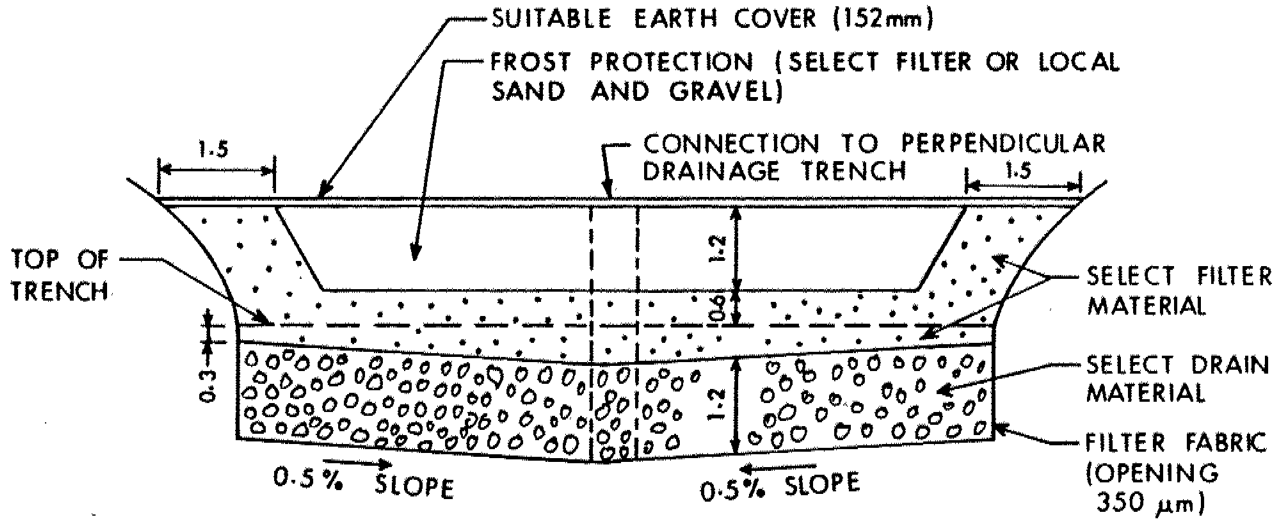
SECTION A-A (NTS)

Fig 12

WO 85-6-3003

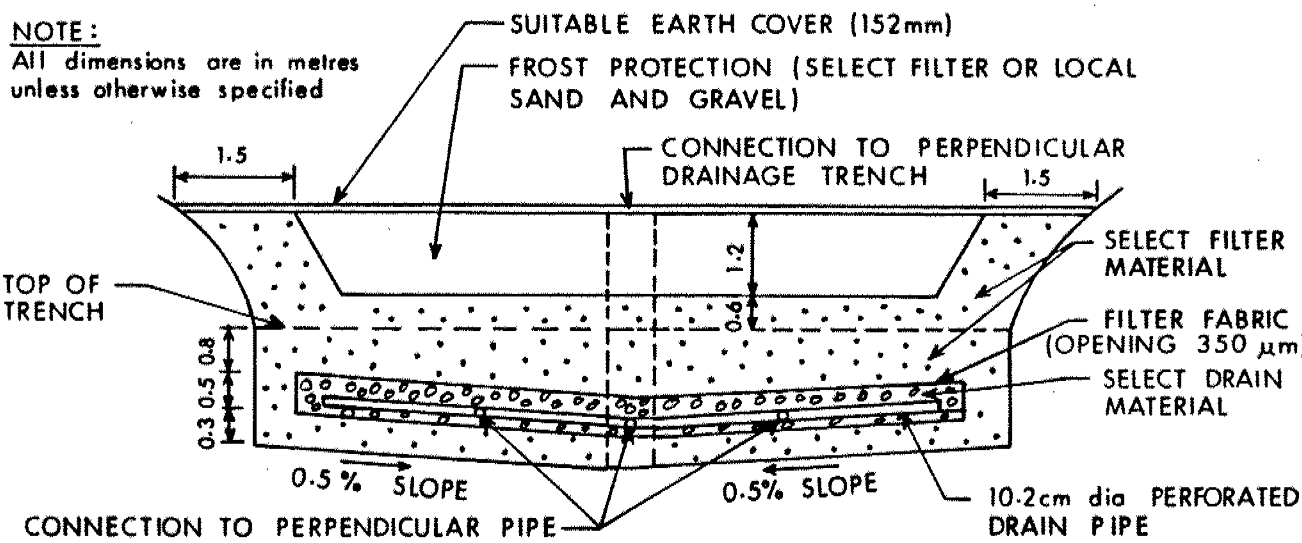


ALTERNATIVE -1 (NATURAL FILTER)



ALTERNATIVE-2 (SELECT DRAIN MATERIAL WITH FILTER FABRIC)

NOTE:
All dimensions are in metres unless otherwise specified

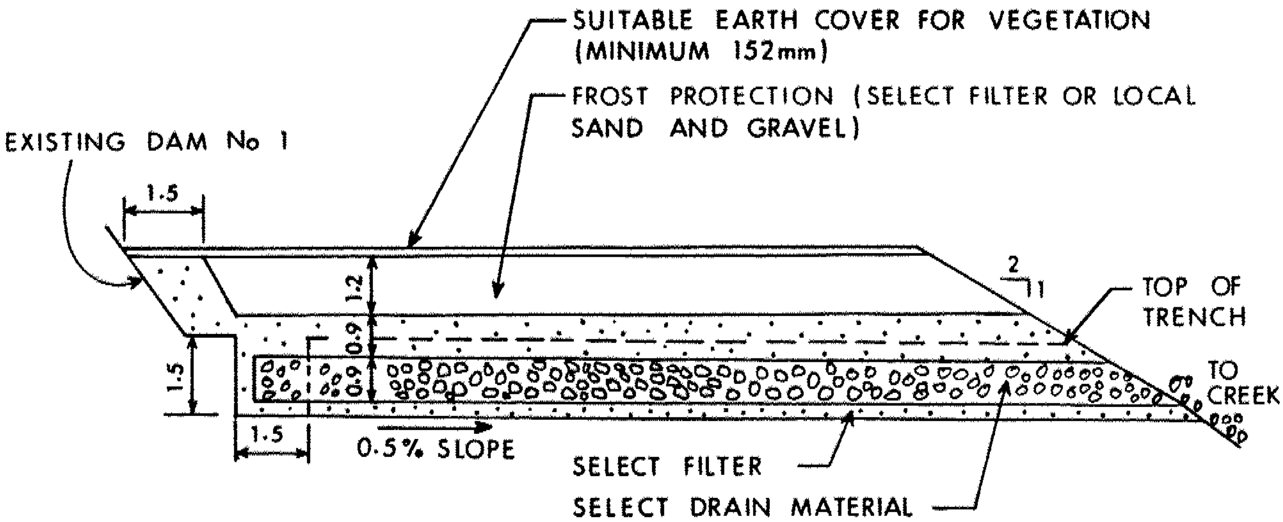


ALTERNATIVE-3 (PERFORATED DRAIN PIPE)

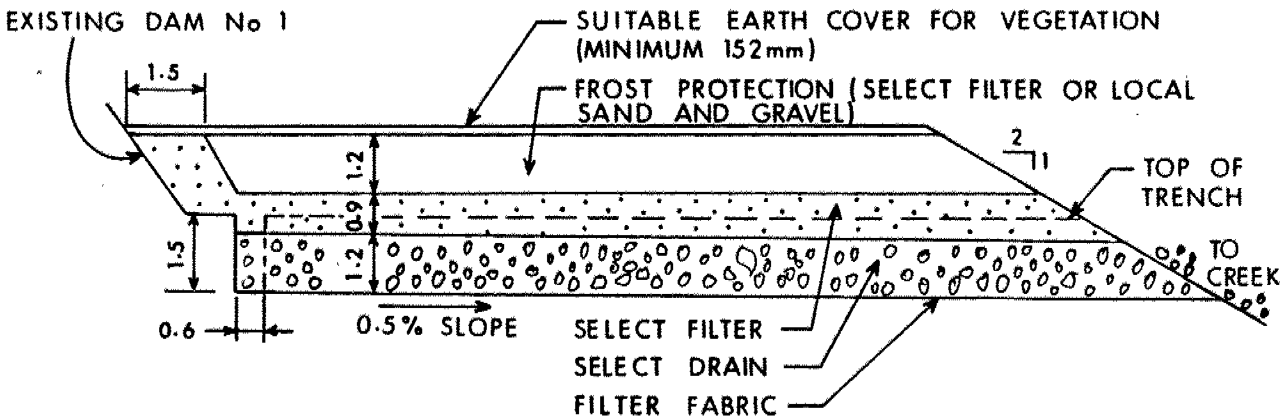
SECTION B-B (NTS)

Fig 13

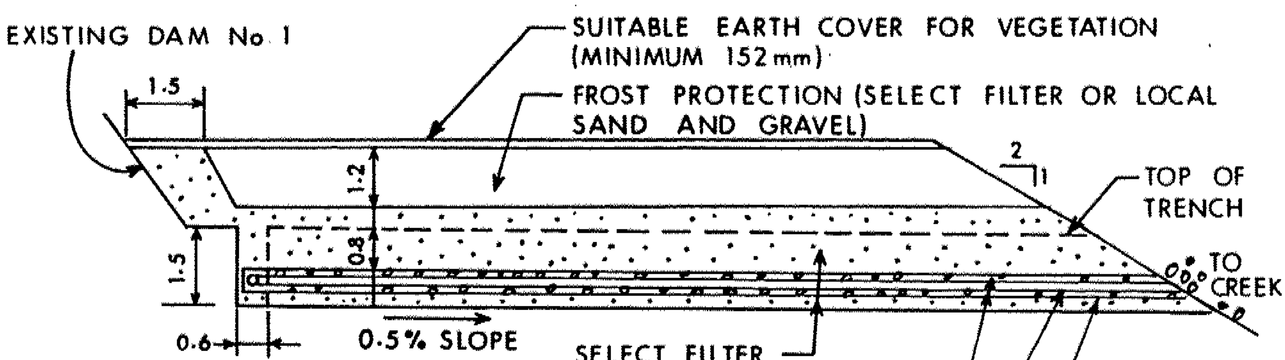
WO 85-6-3003



ALTERNATIVE -1 (NATURAL FILTER)



ALTERNATIVE-2 (SELECT DRAIN MATERIAL WITH FILTER FABRIC)



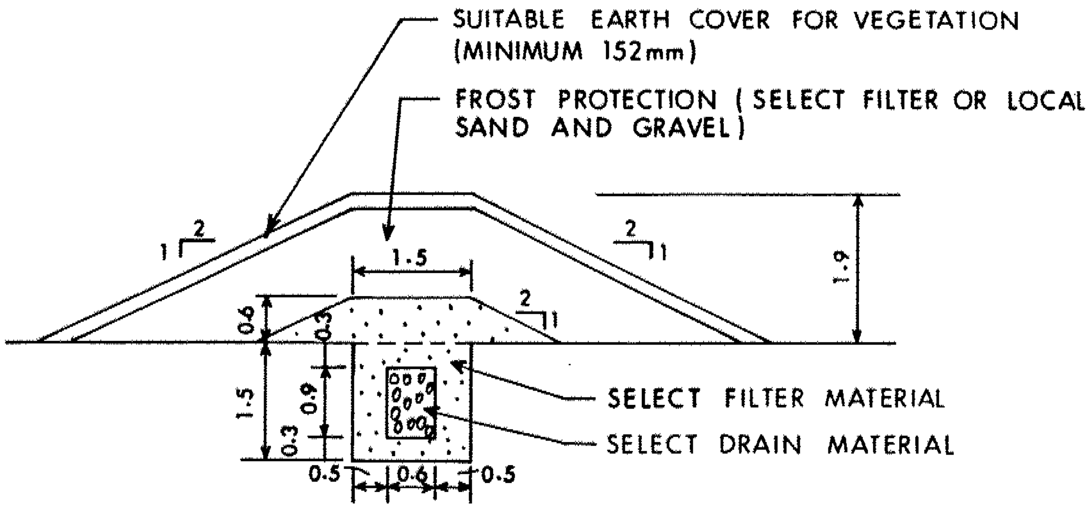
NOTE:
All dimensions are in metres unless otherwise specified

ALTERNATIVE-3 (PERFORATED DRAIN PIPE)

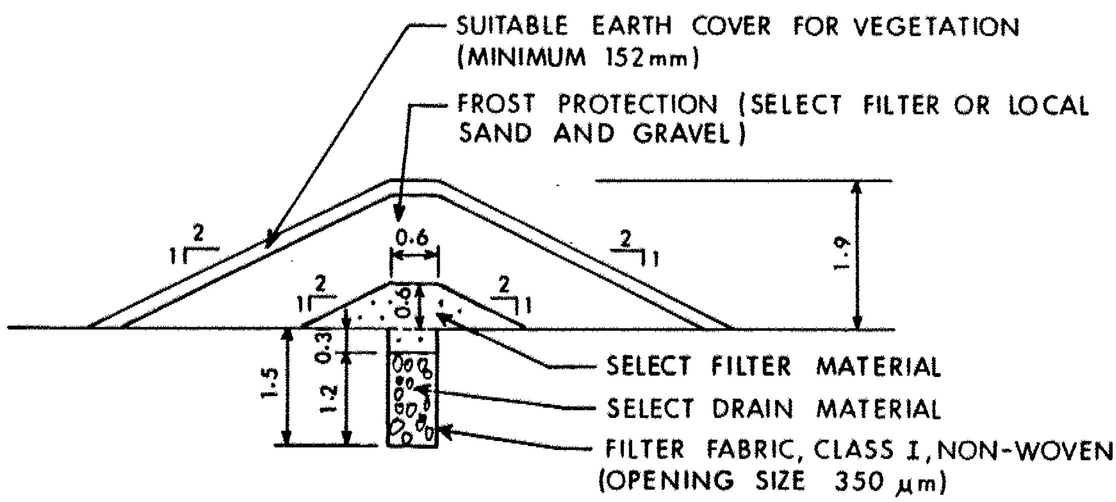
SECTION C-C (NTS)

Fig 14

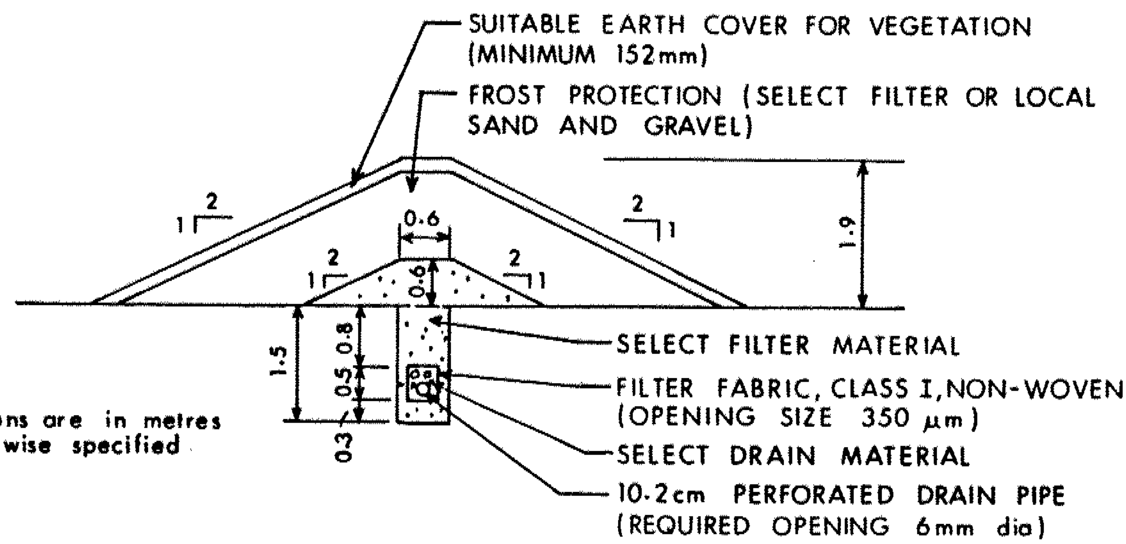
WO 85-6-3003



ALTERNATIVE -1 (NATURAL FILTER)



ALTERNATIVE-2 (SELECT DRAIN MATERIAL WITH FILTER FABRIC)

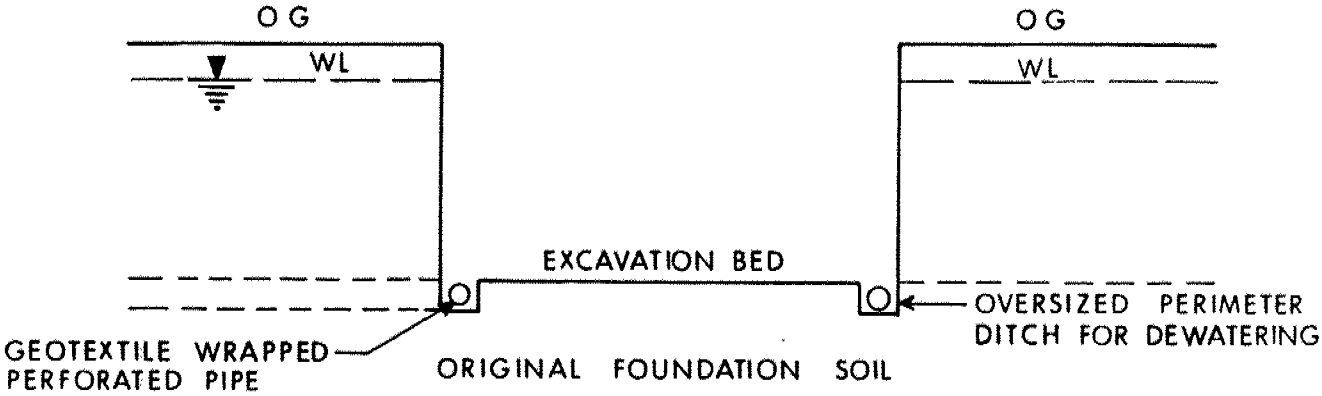


NOTE:
All dimensions are in metres unless otherwise specified

ALTERNATIVE-3 (PERFORATED DRAIN PIPE)

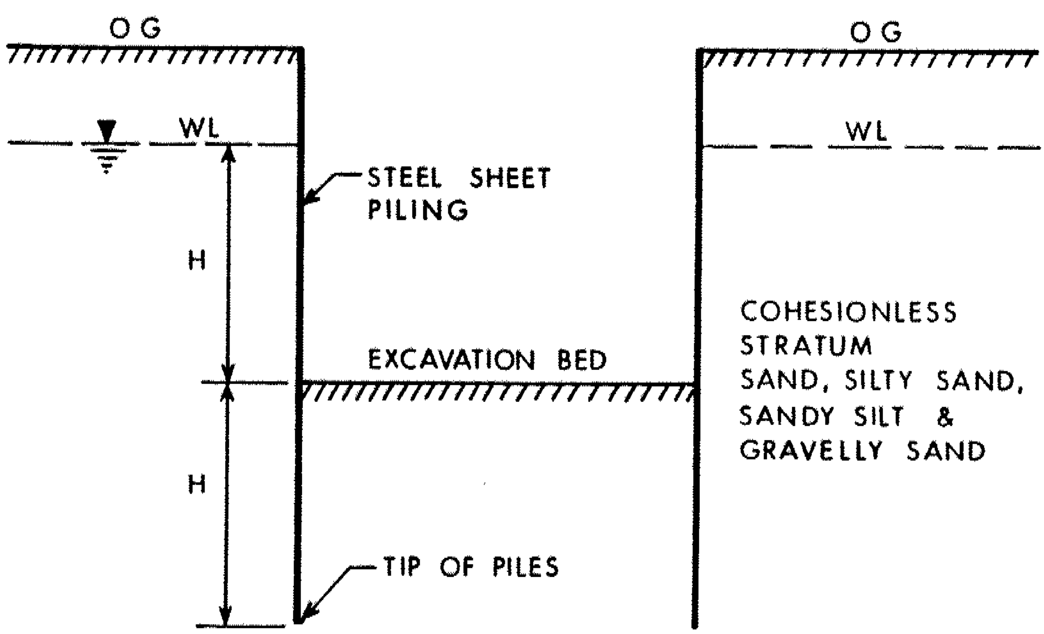
SECTION D-D (NTS)

Fig 15 WO 85-6-3003



OVERSIZE EXCAVATION WITH PERIMETER DRAINS

FIG No 16



STEEL SHEET PILING

FIG No 17

WO 85-6-3003

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3 m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY $= \frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX $= w_L - w_p$
I_L	1	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_u	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W O 85-6-3003 LOCATION Sta. 16 + 505.2; O/S 3.1 m Rt ℄ Hwy. 622 ORIGINATED BY LP

DIST 19 HWY 622 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY TCK

DATUM Geodetic DATE 86 11 11 & 12 CHECKED BY [illegible]

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
410.4	Ground Surface					
0.0	Sand and Gravel, Some Silt, Trace Clay (Fill)	1	SS	35		23 44 24 9
	Occ. to Numerous Cobbles and Boulders	2	SS	30		
		3	SS	44		43 42 11 4
		4	SS	13		
		5	SS	21		
	Gravel Content varies randomly throughout	6	SS	17		
		7	SS	11		
		8	SS	12		
	Compact to Dense	9	SS	18	Seal *	
400.6		10	SS	27	Seal	27 60 11 2
9.8	Silt, Some Sand, Trace Gravel and Clay, Dense	11	SS	41	Seal	5 12 74 9
398.8 / 11.6	Sand and Silt, Trace Gravel, Clay	12	SS	22	** Seal	4 50 39 7
	Compact to Very Dense	13	SS	83		9 43 44 4
395.5 / 14.9	Greywacke Bedrock, Unweathered	14	RC	REC 86%		RQD = 84%
394.0 / 16.4	End of Borehole					

Elevation scale: 410, 408, 406, 404, 402, 400, 398, 396

Dynamic Cone Penetration Resistance Plot: 20 40 60 80 100

Shear Strength: ○ Unconfined + Field Vane ● Quick Triaxial × Lab Vane

Plastic Limit W_p, Natural Moisture Content W, Liquid Limit W_L; Water Content (%) 10 20 30

Unit Weight γ

* Standpipe-bottom 350 mm slotted

** Piezometer installed at Elev. 398.4

GWL on 87 6 25

Standpipe at Elev. 406.9

Piezometer at Elev. 403.6

+3, ×5 : Numbers refer to Sensitivity

20 / 15 -◇- 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

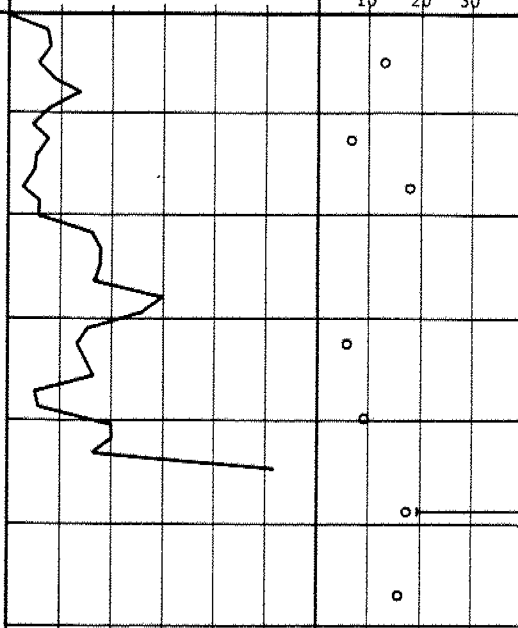
RECORD OF BOREHOLE No 2

METRIC

W O 85-6-3003	LOCATION Sta. 16 + 532.8; O/S 3.1 m Rt ℄ Hwy. 622	ORIGINATED BY VB
DIST 19 HWY 622	BOREHOLE TYPE Hollow Stem Auger and Cone Test	COMPILED BY TCK
DATUM Geodetic	DATE 86 11 11	CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
409.9	Ground Surface						
0.0	Fine Sand, Some Silt Trace Clay (Fill) Loose	1	SS	9			0 84 12 4
408.7 / 1.2	Sand Some/With Gravel, Trace Silt and Clay (Fill) Occ. Cobbles	2	SS	20		408	
		3	SS	9			20 68 10 2
		4	SS	5			18 69 10 3
		5	SS	5		406	
		6	SS	27			
		7	SS	41	▼	404	29 57 11 3
	Loose to Compact	8	SS	12		402	16 73 10 1
400.6 / 9.3	Silty Clay and Sand, Trace Gravel Very Stiff	9	SS	23	Seal, *	400	2 45 33 20
399.5 / 10.4	Fine to Med. Sand, Trace Gravel, Silt, Clay Compact	10	SS	16	Seal		4 88 7 1
397.9 / 12.0	End of Borehole					398	

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE



PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ

* Standpipe - bottom 350 mm slotted

GWL on 87 6 25

Standpipe at Elev. 403.7

+3, ×5 : Numbers refer to Sensitivity

15 ⟡ 5 (%) STRAIN AT FAILURE (20 above, 10 below)

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W O 85-6-3003
LOCATION Sta. 16 + 506.1; O/S 4.0 m Lt ℄ Hwy. 622
ORIGINATED BY LP

DIST 19 HWY 622
BOREHOLE TYPE Hollow Stem Auger
COMPILED BY TCK

DATUM Geodetic
DATE 86 11 11 & 12
CHECKED BY [signature]

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLES – NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%) (Wp – W – WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
410.8	Ground Surface								
0.0	Sand and Gravel, Some Silt, Trace Clay (Fill) Occ. to Numerous cobbles and boulders Compact to Dense					410			
						408			
		1	SS	25			o		42 34 20 4
		2	SS	40/8cm*					
		3	SS	17					
						406			
		4	SS	31					
						404			
					Seal	402			
401.4 / 9.4	Peat with Sand								
400.4 / 10.4	Sand with Gravel, Some Silt	5	SS	8	** Seal		o		27 62 10 1
	End of Borehole								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE

WATER CONTENT (%): 10 20 30

* Spoon Bouncing

** Piezometer installed at Elev. 400.6

GWL on 87 6 25 Piezometer at Elev. 401.8

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

15 ✧ 5 (%) STRAIN AT FAILURE (20 above, 10 below)

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 — METRIC

W O 85-6-3003 — LOCATION Sta. 17 + 374.1; O/S 2.8 m Rt ℄ Hwy. 622 — ORIGINATED BY VB

DIST 19 HWY 622 — BOREHOLE TYPE Hollow Stem Auger — COMPILED BY TCK

DATUM Geodetic — DATE 86 11 11 & 12 — CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	GR SA SI CL (%)
410.2	Ground Surface					410	
0.0	Sand with Gravel Trace Silt, Clay (Fill) Occ. Cobbles and Boulders Compact to Dense	1	SS	14			32 61 6 1
		2	SS	28			
		3	SS	42		408	
		4	SS	25	GWL		
405.6 / 4.6	Sand with Silt, Trace Gravel, Clay Compact	5	SS	*		406	
		6	SS	15		404	6 52 33 9
402.9 / 7.3	Silty Clay to Plastic Silt, Trace Sand Hard	7	SS	34		402	0 1 80 19
		8	SS	30			0 3 87 10
400.1 / 10.1	Sand with Gravel Some Silt, Trace Clay Very Dense	9	SS	84	Seal	400	30 47 19 4
		10	SS	50/12 cm	**	398	
397.6 / 12.6	End of Borehole						

* Sample may be disturbed due to hydraulic pressure imbalance

** Standpipe: bottom 350 mm slotted

GWL on 87 6 25 Standpipe at Elev. 406.3

Chart headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ; REMARKS & GRAIN SIZE DISTRIBUTION (%)

+3, x5 : Numbers refer to Sensitivity — 15 ⊕ 5 (20/10) (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 — METRIC

W O 85-6-3003 — LOCATION Sta. 17 + 296.9; O/S 3.3 m Lt ℄ Hwy. 622 — ORIGINATED BY VB

DIST 19 HWY 622 — BOREHOLE TYPE Hollow Stem Auger — COMPILED BY TCK

DATUM Geodetic — DATE 86 11 12 — CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH	WATER CONTENT (%) (Wp, W, WL; 10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
409.2	Ground Surface										
0.0	Sand and Gravel Some Silt, Trace Clay Occ. to Numerous Cobbles and Boulders Dense to Very Dense (Fill)		1	SS	58	*	408				
			2	SS	40				o		26 62 10 2
			3	SS	31				o		43 46 10 1
405.2			4	SS	21		406				
4.0	Sand, Some Gravel, Silt, Trace Clay Compact		5	SS	13				o		20 56 21 3
403.3							404				
5.9	End of Borehole Probable Bedrock * Water Level not established										

Shear strength legend: O UNCONFINED; ● QUICK TRIAXIAL; + FIELD VANE; × LAB VANE

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ⌖ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

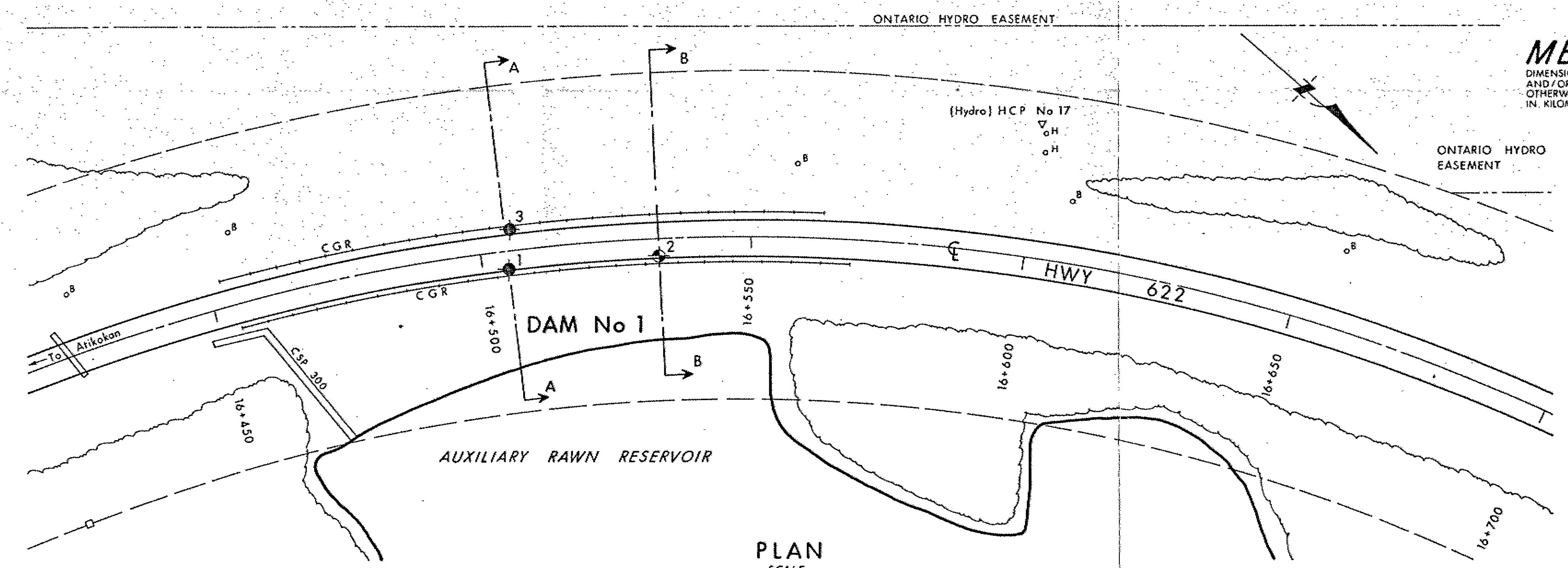
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

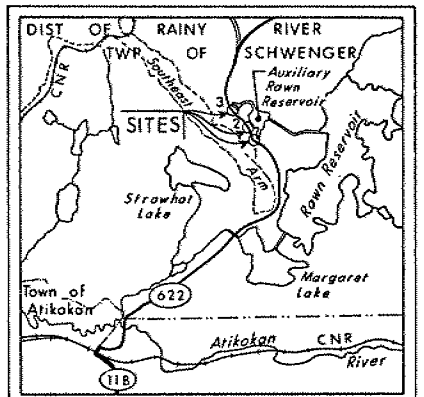
CONT No
W O No 85-6-3003

HWY 622 - DAM No 1
AUXILIARY RAWN RESERVOIR
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN
SCALE 10m 5 0 10m

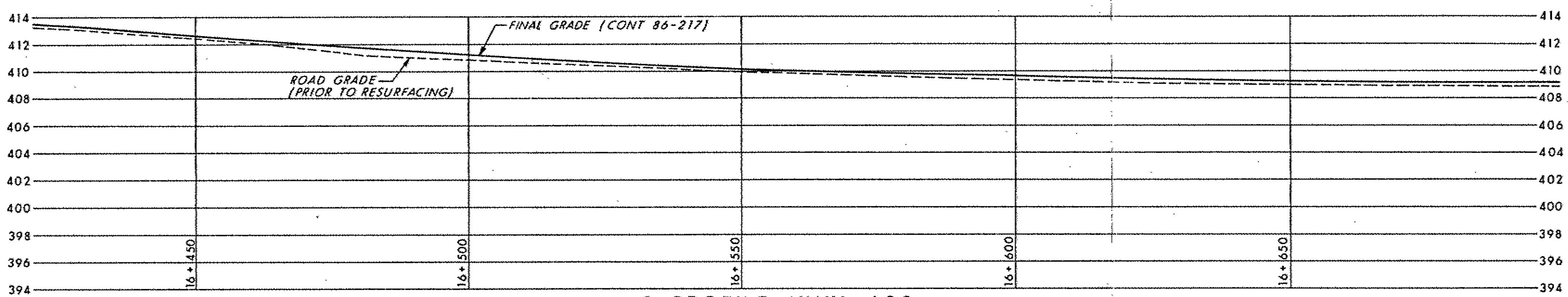


KEY PLAN
SCALE 1km 0 1 2 3 km

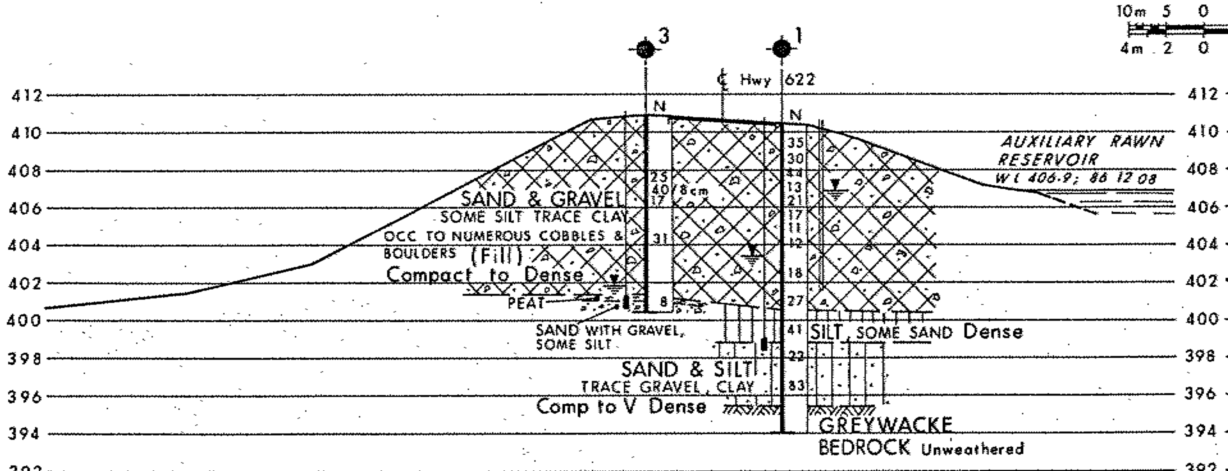
LEGEND

Symbol	Description
●	Bore Hole
⊕	Dynamic Cone Penetration Test (Cone)
◈	Bore Hole & Cone
N	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
▼	W L at time of investigation 1986 11
	Piezometer
	Standpipe

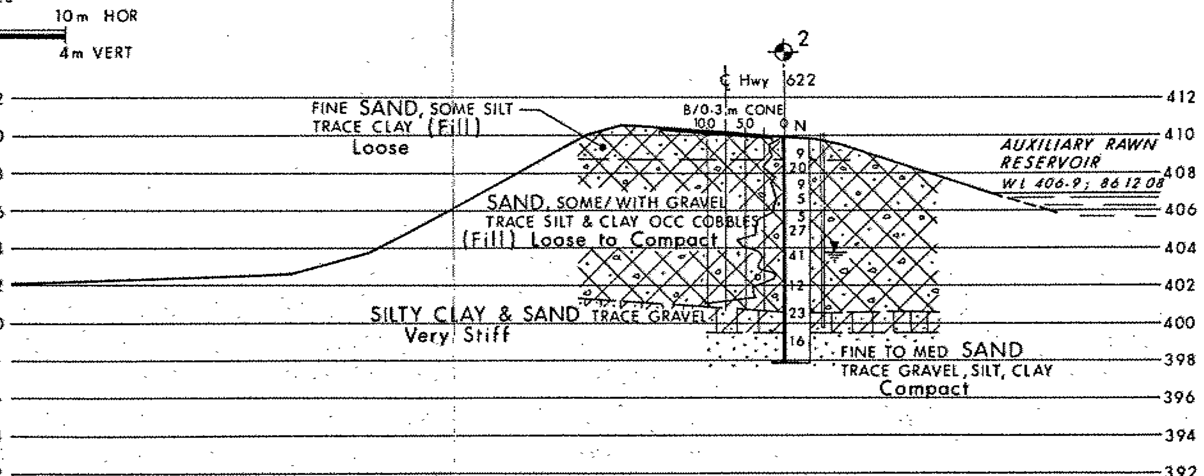
No	ELEVATION	STATION	OFFSET
1	410.4	16+505.2	3.1m Rt
2	409.9	16+532.8	3.1m Rt
3	410.8	16+506.1	4.0m Lt



℄ PROFILE HWY 622
SCALE 10m 5 0 10m HOR
4m 2 0 4m VERT



SECTION A-A STA 16+505.2 (DAM No 1)



SECTION B-B STA 16+532.8 (DAM No 1)

SCALE 4m 2 0 4m

=NOTE=
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION

Geocres No 528-10

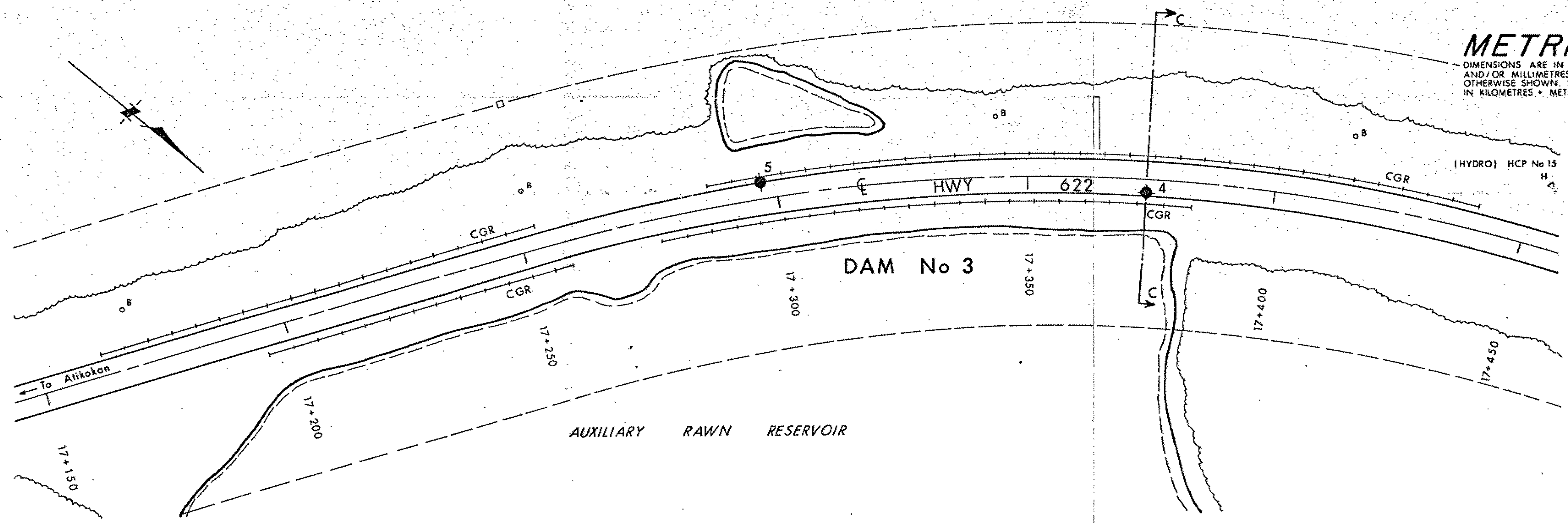
HWY No 622			DIST 19
SUBM'D T K	CHECKED	DATE 1987 09 01	SITE
DRAWN	CHECKED	APPROVED	DWG 8563003-A

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

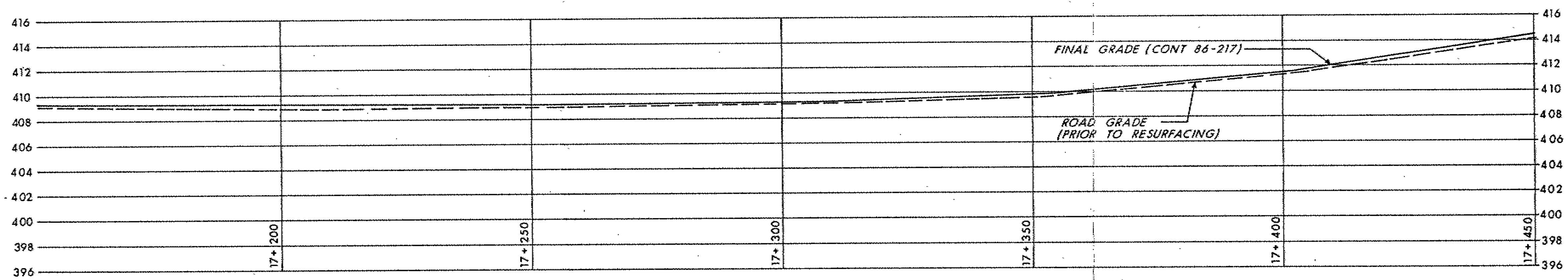
CONT No
W O No 85-6-3003

HWY 622 - DAM No 3
AUXILIARY RAWN RESERVOIR
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

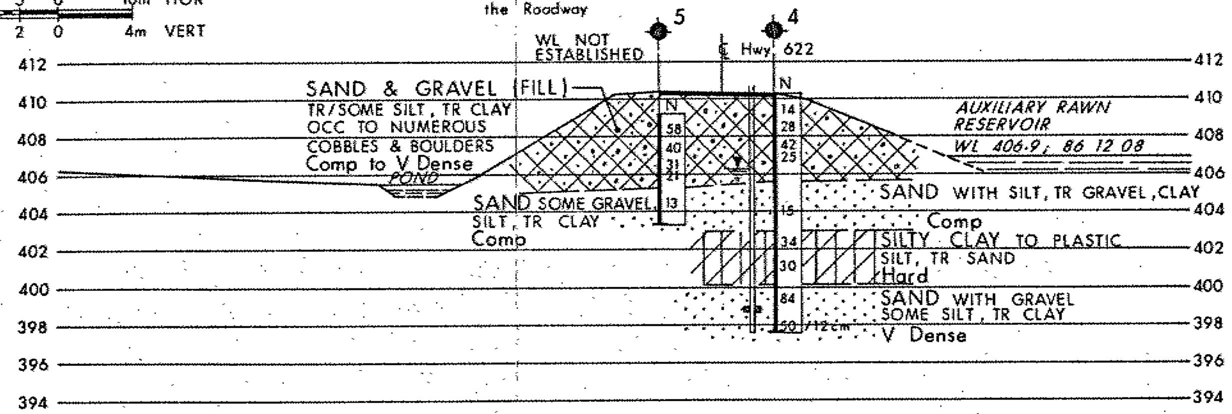


PLAN
SCALE
10m 5 0 10m



℄ PROFILE HWY 622
SCALE
10m 5 0 10m HOR
4m 2 0 4m VERT

NOTE: This Borehole Offset 77m Southerly along the Roadway



SECTION C-C STA 17+374.1 (DAM No 3)
SCALE
4m 2 0 4m

SEE DRAWING No 8563003-A

KEY PLAN
SCALE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 86 11
- Standpipe

No	ELEVATION	STATION	OFFSET
4	410.2	17+374.1	2.8m Rt
5	409.2	17+296.9	3.3m Lt

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION

Geocres No 52B-10

HWY No 622			DIST 19
SUBM'D TK	CHECKED	DATE 1987 09 03	SITE
DRAWN DT	CHECKED	APPROVED	DWG 8563003-B