

MEMORANDUM

To: Christopher Schueler, P.Eng.
AECOM

Date: April 15, 2016

From: Sydney Pang, P.Eng.
Alastair Gorman, P.Eng.
(Reviewed by P.K. Chatterji, P.Eng.)

File: 19-4406-20

DRAFT PRELIMINARY FOUNDATION ASSESSMENT OTONABEE RIVER BRIDGE (WBL) HIGHWAY 7 (SITE 26-061.2)

1 INTRODUCTION

This memorandum presents a brief summary of a geotechnical assessment of the Otonabee River Bridge (WBL) which carries the westbound lanes of Highway 7 over the Otonabee River in the County of Peterborough. It also contains preliminary geotechnical recommendations for use in the assessment of the existing foundations at this site. It is understood that the proposed rehabilitation includes concrete deck repairs, waterproofing and paving, replacement of expansion joint seals, repair or replacement of barrier walls, and all required substructure repairs (piers and abutments).

The recommendations provided in this memorandum are for planning, structure evaluation and preliminary design purposes only. Additional investigation and analyses may be required in any subsequent detail design phases of the project.

The following reference numbers apply to this site:

- Current W.P. 4007-13-01
- Site No. 26-061.2
- GEOCRETS No. 31D-280
- Historic W.P. 19-81-02

2 SITE DESCRIPTION

The site is located on Highway 7 at about 700 m west of Bensfort Road in the Geographic Township of Otonabee in the County of Peterborough. The WBL bridge carries the westbound lanes of Highway 7 (Peterborough Bypass) over the Otonabee River. This bridge is approximately 30 m north of another bridge which carries the eastbound lanes of the highway over the river.



Based on the description in Section 6.3.3 of the RFP, the existing bridge, constructed in 1983, is a 5 span (50 m + 55 m + 64 m + 55 m + 50 m) weathering steel box beam bridge. The overall deck width is 11 m, with an asphalt riding surface of 10 m carrying two lanes of traffic in the westbound direction of Highway 7. A historic General Arrangement (GA) drawing dated 1982 confirms the bridge approach span lengths quoted above. The structure has never been rehabilitated.

The natural terrain in the vicinity of the bridge is generally flat and is typical of a river floodplain. The historic data indicates that the original grade in the vicinity of the bridge was in the order of Elevations 190 to 191 m. The bridge approaches were constructed to approximate Elevations 196 to 196.5 m resulting in overall embankment heights in the order of 6 m. The historic GA drawing indicates that the approach fills were designed with forward slopes inclined at 2H : 1V,

The mapping in the Physiography of Southern Ontario by Chapman and Putnam shows that the site lies within the physiographic region known as the Peterborough Drumlin Field. This area is a heavily drumlinized till plain. The drumlins are composed of highly calcareous sandy and silty tills with varying quantities of limestone rubble and boulders. The overburden in this region is underlain by highly fossiliferous limestone bedrock.

3 SUBSURFACE CONDITIONS

A site investigation was completed by the Pavement & Foundation Design Section, Engineering Materials Office of the Ministry of Transportation and Communications (MTC) and reported in November 1981. A total of fourteen (14) boreholes were drilled and sampled at this site. Boreholes 5, 6 and 7 were located near the west abutment, Boreholes 8, 9 and 10 were located near Pier 1, Boreholes 1 and 2 were located near Pier 2, Boreholes 3 and 4 were located near Pier 3, Boreholes 11 and 12 were located near Pier 4, Boreholes 13 and 14 were located near the east abutment. Approximate locations of these boreholes are shown on the Bore Hole Locations and Soil Strata drawing attached as part of the report in Appendix A. These boreholes were advanced to depths of 6.6 to 18.0 m below the original ground surface.

Results of the boreholes indicated that the subsurface conditions at the west approach area (West Abutment and Pier 1) generally consisted of 3.4 to 6.5 m of silty sand to sandy silt overlying 2.3 to 3.1 m of silty clay and clay, which is underlain by silty clay till with cobbles and boulders throughout. The upper sand and silt deposit is absent at the east approach area (Pier 4 and East Abutment). In the river flow channel (Piers 2 and 3), both the sands and silts and the silty clay are absent, but instead a sand layer (possibly alluvium) is present at the Pier 3 area.

The upper sands and silts were in a loose to compact condition as indicated by SPT 'N' values ranging between 6 and 19 blows per 0.3 m penetration. Based on SPT 'N' values between 2 and 10 blows per 0.3 m penetration, field vane tests of greater than 50 kPa, unconfined compressive strengths of 22 to 75 kPa, and a quick triaxial test showing 41 kPa, the silty clay and clay is considered to have a typically firm to stiff consistency with occasional soft zones. The silty clay till was hard throughout as indicated by SPT 'N' values of typically greater than 100 blows for less than 0.3 m penetration. These higher blow counts also inferred the presence of cobbles and boulders.



Bedrock underlies the till and was cored in Boreholes 2, 3, 4, 6, 8, 11 and 14, and inferred by auger refusal in Boreholes 7, 9, 12 and 13. The remaining boreholes did not reach bedrock. The bedrock was described as shaley limestone, grey, fine grained, hard with occasional weathered shale partings. Core recovery was generally 100% except for an 85% value at one location, but no RQD values and fracture indices were reported. Bedrock elevations encountered in the boreholes are as follows:

Borehole	Location	Top of Rock Elevation (Depth)
5	West Abutment	borehole met probable refusal on boulder at 177.9 m
6	West Abutment	175.2 m (14.3 m) – proven
7	West Abutment	175.3 m (14.3 m) – inferred
8	Pier 1	176.2 m (12.2 m) – proven
9	Pier 1	176.1 m (12.3 m) – inferred
10	Pier 1	borehole did not reach bedrock
1	Pier 2	borehole did not reach bedrock
2	Pier 2	177.2 m (9.4 m) – proven
3	Pier 3	177.7 m (8.9 m) – proven
4	Pier 3	177.8 m (8.8 m) – proven
11	Pier 4	178.6 m (8.5 m) – proven
12	Pier 4	180.8 m (7.6 m) – inferred
13	East Abutment	178.8 m (10.2 m) – inferred
14	East Abutment	178.8 m (10.2 m) – proven

The short term groundwater levels observed in open boreholes at the time of the investigation ranged from Elevations 185.8 to 187.2 m on the west bank, and from Elevations 187.0 to 187.3m on the east bank. The Otonabee River water level was at Elevation 186.6 m at the time of the investigation.

The available GEOCRE information is attached in Appendix A.

4 SITE OBSERVATIONS

Foundation engineering staff from Thurber visited the site on January 14, 2016 to observe conditions related to the geotechnical performance. Construction supplies and equipment were observed to be present adjacent to the EBL structure at the time of the site visit.

There were no obvious signs of settlement or distress at the foundation elements. There were some transverse cracks on the pavement at the east abutment area.



The original design drawings indicated that the forward slopes and adjacent sideslopes were designed at an inclination of 2H : 1V. The approach embankments including the forward slope paving appeared to be stable, with no obvious signs of instability or bulging. Selected photographs of the structure and the approaches are attached in Appendix B.

5 EXISTING FOUNDATIONS

Based on a historic GA drawing for the structure (Drawing 1), a footing layout drawing (Drawing 4), and a Pier #2 & #3 – Footings drawing (Drawing 5), Contract 82-89, WP 19-81-02 dated February 1982 (Appendix C), both abutments and Piers 1 and 4 were designed to be supported by conventional HP 310 x 110 piles driven to the hard silty clay till with cobbles and boulders. Piers 2 and 3 located in the river were designed to be supported by spread footings resting on tremie concrete pads within sheetpile enclosures. The concrete was originally designed to be founded on bedrock. Subsequent MTC internal memoranda in 1983 and a revised Drawing 5 indicated that the foundation support at the sheetpile enclosed Pier 3 had been redesigned as a pile foundation where HP 310 x 110 piles were to be driven to bedrock and the space below the underside of the pile cap would be filled with tremie concrete. The Pier 2 foundation had also been redesigned such that the tremie concrete pad would be resting on the hard silty clay till (instead of bedrock).

There was no available construction records to indicate that the piles had indeed been driven to the design tip elevations. In view of the presence of boulders and cobbles, it is possible that some piles met practical refusal and were terminated at higher elevations within the till. According to the same drawings, the forward slopes and adjacent approach sideslopes were designed to have an inclination of 2H to 1V. The forward slopes were to be protected by a layer of concrete paving resting on slope surfaces. The design pile cap, pile tip and footing elevations, as well as the founding strata, are summarized in the following table:

Table 1 Design Founding Levels and Strata

Foundation Element	Reference Borehole	Design Underside Elevation of Footing (m)	Design Underside Elevation of Pile Cap (m)	Design Pile Tip Elevation (m)	Estimated Founding Stratum
West Abutment	5, 6, 7	-	190.75	177.55 to 178.05	Silty Clay Till (hard – 100-blows)
Pier 1	8, 9, 10	-	186.0	178.8 to 179.3	Silty Clay Till (hard – 100-blows)
Pier 2	1, 2	184.5 (footing) 181.5 (tremie concrete)	-	-	Tremie Concrete on Silty Clay Till (hard)
Pier 3	3, 4	-	184.5	177.0 to 177.5	Limestone Bedrock
Pier 4	11, 12	-	186.0	180.8	Silty Clay Till (hard – 100-blows)
East Abutment	13, 14	-	191.40	182.2 to 182.7	Silty Clay Till (hard – 100-blows)



The MTC report from GEOCRES recommended that the HP 310 x 110 piles be driven to refusal into the hard glacial till or to bedrock. Recommended minimum (highest) pile tip elevations are as follows:

Table 2 Recommended Founding Levels from GEOCRES Report

Foundation Element	Recommended Highest Pile Tip Elevation
West Abutment	178.5
Pier 1	179.5
Pier 3	178.0 or Bedrock
Pier 4	182.0
East Abutment	183.0

The GEOCRES report recommended that piles installed as shown above may be designed for a Factored Capacity at ULS of 1,600 kN and a Capacity at SLS Type II of 980 kN per pile. In addition, it was recommended that Pier 2 be designed to be founded in the glacial till deposit at or below Elevation 182 m. A Factored Capacity at ULS of 1,500 kPa and a Capacity at SLS Type II of 480 kPa were recommended for footing design. It was also recommended that a tremie mass concrete pad could be used to raise the footing elevation.

The table on Pile Data on the revised Drawing 5 indicated that driven HP 310 x 110 piles for both abutments, Piers 1 and 4 had been designed using a Factored Capacity at ULS of 1,600 kN and a Capacity at SLS Type II of 980 kN per pile, which are consistent with those recommended in the GEOCRES report. An ultimate capacity of 2,940 kN per pile was recommended for pile installation. This ultimate capacity is equal to 3 times the SLS value, which is consistent with the practice for pile installation at that time. Piles for Pier 3 were designed to be driven to bedrock using the same ULS and SLS design pile capacities.

6 ASSESSMENT OF EXISTING FOUNDATIONS

The archive information indicates that the existing bridge was designed to be founded on piles driven into hard till or to bedrock, and supported on footings (one pier) founded on tremie concrete/hard till. The foundations appear to be performing satisfactorily, and it can be assumed that the foundations will continue to perform satisfactorily in the future provided they are structurally sound.

The RFP document suggests that the anticipated rehabilitation works consist of concrete deck repairs, waterproofing and paving, replacement of expansion joint seals, repair or replacement of barrier walls, and all required substructure repairs at the piers and abutments. Accordingly, there should not be appreciable increase in the loading on the foundations. Provided there is no increase in the applied loads, it can be assumed that the bridge foundations will continue to perform satisfactorily.



However, if the bridge rehabilitation works result in an increase in loading greater than 10%, it will be necessary to carry out site investigation and field testing to support the preparation of foundation design recommendations.

7 EXCAVATION

It is anticipated that temporary excavations may be required at some locations to facilitate the rehabilitation works. All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purpose of OHSA, the pavement granulars and approach fills are classified as Type 3 soils. All excavations must be carried out in a manner that avoids undermining or destabilising the existing bridge foundations, existing approach slopes and the adjacent highway.

Where space permits, temporary excavations may be formed with sideslopes not steeper than 1H : 1V. Flatter slopes may be required at locations where the exposed soils are less competent than what is assumed during design or where water seepage affects surficial stability. Where space restriction and staged construction is anticipated, roadway protection will be required to support the ground adjacent to these temporary excavations (see Section 8 below).

8 ROADWAY PROTECTION

If the selected rehabilitation strategy requires excavation within roadway protection in the approach fills behind the abutments, it is recommended that site investigation and field testing be carried out in each approach fill in order to characterize the fill, and to select parameters for the design of roadway protection. One borehole within each approach fill and within the probable extent of excavation is considered to be appropriate. The boreholes should extend for the full depth of fill or to twice the depth of excavation, whichever is the greater.

The design of roadway protection should be the responsibility of the Contractor. All shoring systems must be designed by a Professional Engineer experienced in such designs.

9 CLOSURE

The factual subsurface information used for foundation review and assessment of the existing foundation conditions was taken from the MTC report titled "Foundation Investigation Report for Otonabee River Bridge (W.B.L.) on Peterborough Bypass", W.P. 19-81-02, Site 26-61, Highway 7, District 7, Port Hope, dated November 4, 1981.



This memorandum was prepared by Dr. Sydney Pang, P.Eng., and was reviewed by Mr. Alastair Gorman, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

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Attachments

Client: AECOM

File No.: 19-4406-20

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Appendix A
GEOCRES Information

CONT 82-89



Ontario

Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 19-81-02 DIST 7
HWY 7 STR SITE 26-458-61

OTONABEE RIVER BRIDGE (W. B. L.)
on Peterborough Bypass

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FOUNDATION INVESTIGATION REPORT
For
OTONABEE RIVER BRIDGE (W. B. L.)
on Peterborough Bypass
W. P. 19-81-02, Site 26-61
Highway 7, District 7, Port Hope

INTRODUCTION

This Report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural location and provides detailed recommendations pertaining to the structure foundations and related earthworks. The fieldwork was carried out in two stages; the initial stage between 81 07 09 and 81 07 20 consisted of advancing four boreholes to bedrock and coring two of these using a raft mounted diamond drill for pier locations in the Otonabee River. The second stage, between 81 07 29 and 81 08 10, consisted of ten sampled boreholes advanced to bedrock utilizing continuous flight augers with four of the holes having bedrock cored. These boreholes extended for depths ranging from 6.6 to 18.0 metres with bedrock being cored for depths ranging from 2.3 to 3.7 metres.

SITE DESCRIPTION AND GEOLOGY

The site is located some 2.0 kilometres east of the Highway 115 and Highway 7 intersection, 30 metres north (upstream) of the existing Highway 7 Otonabee River Bridge, in the City of Peterborough, County of Peterborough.

The existing bridge is a 300 metre long 11 span steel girder structure constructed in 1959. The two river piers for the three main spans (46 m - 64 m - 46 m) are supported on concrete spread footings founded on 4.3x22.3 metre tremie concrete foundations taken to bedrock. The other eight piers are founded on 310HP79 steel 'H' section piles driven to end-bearing. The two abutments are perched within the approach fills and

supported on 250 HP 62 endbearing steel 'H' piles. The existing structure and earthworks exhibit no apparent signs of foundation distress.

The topography of the immediate site is generally flat, typical of a river flood plain. River valley slopes are very shallow at the crossing location with river water levels controlled by upstream dams and locks of the Trent Canal System. Land use is classified as rural-urban fringe with residential to the north and farming to the south.

Physiographically, the site is part of the Peterborough Drumlin Field Region which is described as a heavily drumlinized till plain. The drumlins are composed of highly calcareous sandy tills with varying quantities of angular limestone rubble and Precambrian boulders. In general, shallow overburden in this region is underlain by limestone bedrock of the Trenton Formation, which is highly fossiliferous and disintegrates readily upon weathering.

SUBSURFACE CONDITIONS

In general, moderately uniform subsurface conditions were encountered across the site. The predominate deposit encountered beneath varying surficial deposits and underlain by competent limestone bedrock is a coarse grained silty clay glacial till. The varying surficial strata consisted of a silty sand to sandy silt underlain by a shallow deposit of alternating layers of silty clay and clay on the west river bank; the east bank was overlain by a silty clay interbedded with silty sand layers overlying till; whereas at the river pier locations the till was exposed at one pier and covered with a shallow mantle of sand at the other river pier location.

The boundaries between the various soil types, insitu and laboratory test results, as well as ground water levels, are shown on the attached Record of Borehole Sheets.

The various subsoil types encountered across the site are briefly described in the following paragraphs.

Silty Sand to Sandy Silt

The surficial flood plain deposit on the west river bank, as encountered in borings for the west abutment and pier 1, is described as a fine grained alluvium consisting of a uniformly graded silty sand to sandy silt with a trace of clay. Grain size distribution curves for this deposit, plotted in envelope form, are shown on Figure No. 1. Explored depths for this alluvium ranged from 3.9 to 6.5 metres, generally becoming shallower as we approached the river.

Based on Standard Penetration Test 'N' values ranging from 6 to 19 blows per 0.3 metres but averaging 10, the denseness for this deposit is described as loose to compact.

Silty Clay and Clay

Underlying the granular alluvium on the west bank and encountered for thicknesses ranging from 2.4 to 3.1 metres is a stratified cohesive stratum consisting of alternating thin layers of silty clay and clay. Visual observations indicate this layered deposit to be fissured, exhibiting a brittle behaviour.

As a result of the stratified structure of this deposit, Atterberg Limit testing resulted in lower plasticity values than anticipated.

Undrained shear strength measurements performed on representative samples of this deposit gave the following results:

	<u>Range</u>	<u>Average</u>
Insitu Field Vane (kPa)	> 50	> 50
Unconfined Compression (kPa)	22-75	42
Quick Triaxial (kPa)	(One Test)	41
Lab Vane (kPa)	(One Test)	75

Based on these results, the consistency of this layered clay stratum is assessed as generally stiff throughout.

Sand

The river bed deposit, as encountered at the Pier 3 location, consists of 2.3 to 4.1 metres of sand with a trace of silt and gravel. Occasional thin layers of firm silty clay were encountered in one of the borings at this location. Grain size distribution curves for two representative samples are plotted on figure 3. The denseness of this recent fluvial deposit, as based on interpretation of 'N' values and wash-boring operations, ranges from very loose to compact, but can be assumed to be very loose throughout.

Silty Clay

The surficial deposit on the east bank as encountered in borings for the east abutment and pier 4 consists of a silty clay interbedded with layers of silty sand. Occasional surficial boulders and cobbles, as well as a trace of organics and isolated gravel layers, were found within this deposit. Depths for this stratum ranged from 3.0 to 3.7 metres across the east bank.

The consistency of this deposit is interpreted as ranging from soft to firm, as based on interpretation of 'N' values and augering operations.

Silty Clay, sand with gravel, cobbles and boulders throughout (Glacial Till)

The predominate stratum underlying the varying surficial deposits and immediately below river bottom at pier 2 is described as a coarse grained glacial till consisting of a silty clay and sand matrix with varying amounts of gravel, cobbles and boulder-size fragments throughout. The larger sized particles were characterized by boulders, and detached fragments and slabs of limestone bedrock, generally becoming more frequent in occurrence towards the base of this deposit but present throughout. Grain size distribution curves for the less coarse fraction of this till deposit are plotted in envelope form on Figure 4.

The consistency of this glacial till deposit is assessed as hard, based on S. P. T. 'N' values in excess of 100 and the difficulties encountered in trying to advance borings through this stratum.

Bedrock

Bedrock was proven by utilizing coring techniques to obtain BXL size core in seven of the boreholes for penetrations ranging from 2.3 to 3.7 metres. In addition, 3 borings were advanced to practical refusal on probable bedrock to better ascertain bedrock surface contours at the individual structure foundation locations.

In summary, competent bedrock was found to slope uniformly in a westerly direction at a shallow angle across the site. Depths to bedrock ranged from 14.3 metres (elevation 175.2) at the west abutment to 10.2 metres

(elevation 178.8) at the east abutment.

Based on visual examination of the rock core and consistent rock core recovery rates of 100%, bedrock is described as a hard, grey, fine grained, shaly limestone with occasional weathered shale partings.

Groundwater

Groundwater levels as established, based on overnight stabilized borehole water levels, ranged from elevation 185.8 to 187.2 on the west bank and from elevations 187.0 to 187.3 on the east bank. These levels can generally be assumed to reflect Otonabee River water level (elevation 186.6 at the time of investigation) and are expected to fluctuate accordingly.

DISCUSSION AND RECOMMENDATIONS

In order to accommodate the four laning of the Peterborough Bypass, it is proposed to twin the existing Otonabee River Bridge. The new W. B. L. structure will be located immediately upstream of the present and consist of a 5 span (50 m - 55 m - 64 m - 55 m - 50 m) bridge based on a steel box girder design. Top of finished pavement profile will vary from elevation 195.9 to 197.2, necessitating maximum approach fill heights in the order of 7.5 metres above river banks.

In view of the variable surficial deposits overlying competent till and bedrock across the site, recommendations pertaining to the structure foundations and related earthworks are as follows:

Structure Foundations

In consideration of the poor strength/deformation characteristics of the varying surficial soils, it is recommended that all abutment and pier elements, except pier 2 (west river pier), be supported on deep foundations located in the coarse till deposit or on competent bedrock. Perched-type abutment foundations and pier foundations (excepting pier 2) can be founded on heavy section steel 'H' section piles equipped with standard M. T. C. reinforced flange plates or commercially produced pile shoes, to facilitate penetration through the cobbles and boulders, driven to refusal into the hard glacial till or to bedrock.

A 310HP110 pile equipped with reinforced tips should be driven to a minimum set of 15 blows/25 mm for the last 75 mm with a hammer capable of delivering a minimum energy of 48,000 joules/blow. In addition to the preceeding driving criteria, piles should penetrate to the following minimum tip elevations:

	<u>Elevation</u>
West Abutment	178.5
Pier 1	179.5
✓ Pier 3	178.0 or Bedrock
Pier 4	182.0
✓ East Abutment	183.0

For 310HP110 steel 'H' piles equipped and driven as specified, the following foundation design parameters are recommended:

Factored Capacity at U. L. S.	1600 kN
Capacity at S. L. S. Type II	980 kN

For Pier 2 (west river pier), considering the proximity of the hard till deposit to river bottom and the anticipated lack of sufficient penetration of piles to resist lateral loads, it is recommended that this pier be supported on spread footings founded in the glacial till deposit. Footings founded at or below elevation 182 can be designed with the following parameters:

Factored Capacity at U. L. S.	1500 kPa
Capacity at S. L. S. Type II	480 kPa

Final footing elevations should be decided based on hydrological requirements for scour protection.

A tremie mass concrete pad can be used to raise the footing elevation to a more structurally economic level.

Alternatively the Pier 2 footing can be founded on limestone bedrock at an approximate elevation of 177, and designed based on the following parameters:

Factored Capacity at U. L. S.	2500 kPa	3000
Capacity at S. L. S. Type II	1000 kPa	1500

The exposed bedrock surface should be cleaned of all rubble and debris, and then covered immediately with a thin working pad of lean concrete to prevent any weathering of the shaly partings within the limestone.

In order to prevent possible construction problems and delays associated with cofferdams and footings constructed in river beds with a high water head, serious consideration should be given to supporting all pier elements, particularly Pier 2, on concrete caissons socketed into bedrock. A 900 mm diameter concrete caisson advanced through the till deposit and socketed a minimum 150 mm into competent bedrock using churn-drilling techniques can easily support the following loadings:

Factored Capacity at U. L. S.	3800 kPa
Capacity at S. L. S. Type II	2400 kPa

This technique would ensure uniform foundation loadings at the pier locations and expediate foundation construction operations.

The underside of all pile caps and the spread footing should be provided with a minimum 1.25 m of earth cover for frost protection purposes.

Other Considerations

Due to the presence of cobbles, boulders, and detached rock fragments throughout the till deposit, advancement of sheet pile for cofferdam schemes will be difficult at the Pier 2 location. 'Neat' excavations in advance of the sheeting in conjunction with progressive driving of the sheeting will be

required to reach and seal off the footing level.

In consideration of the coarse gradation of the till deposit, a properly designed dewatering scheme will be required to place the Pier 2 footing in the dry.

In addition, excavations for pier caps carried down below prevailing ground water levels will also require an appropriately designed dewatering scheme.

All pier locations should be protected from river scour action by an effective rip-rap scheme utilizing heavy duty armour stone.

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the O. H. B. D. C.

Approach Embankments

Anticipated fill heights in the order of 7.5 metres can be safely constructed with standard 2:1 slopes. All organic or softened material should be subexcavated for their full depth and replaced with well compacted earthfill for a minimum 30 m behind the abutments within the planned limits of the embankment prior to embankment construction.

MISCELLANEOUS

The fieldwork for this investigation was performed under the supervision of Mr. Z. Mabraïdopoulos, Student Technician, utilizing equipment owned and operated by both Atcost Soil Drilling and Site Investigation Services. This Report was written by Mr. T. J. Kazmierowski, Foundations Engineer, and reviewed by Mr. M. Devata, Senior Foundations Engineer.



T. J. Kazmierowski

T. J. Kazmierowski, P. Eng.,
Foundations Engineer

M. Devata

M. Devata, P. Eng.,
Senior Foundations Engineer

APPENDIX



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 19-81-02 LOCATION Sta. 5+499.0; o/s 2.2 m Lt. Highway 7 WBL ORIGINATED BY Z. H.
DIST 7 HWY 7 BOREHOLE TYPE Diamond Drill COMPILED BY T. K.
DATUM Geodetic DATE 81 07 09 - 81 07 11 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
186.6	River Level												
0.0	Water						186						
183.3	River Bottom						184						
3.3	Grey (Till)		1	SS	57	18 cm							16 40 31 13
	Silty clay, sand some gravel		2	SS	100	10 cm	182						
	Hard		3	SS	100	13 cm	180						
	Cobbles and boulders throughout		4	SS	100	5 cm	178						
177.2													
9.4	End of Borehole Note: Borehole terminated due to damaged casing as a result of heavy driving												

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

W P 19-81-02 LOCATION Sta. 5+493.3; o/s 5.7 m Rt. of Highway 7 WBL ORIGINATED BY Z. M.
 DIST 7 HWY 7 BOREHOLE TYPE Diamond Drill COMPILED BY T. K.
 DATUM Geodetic DATE 81 07 14 - 81 07 15 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80
186.6	River Level															GR SA SI CL
0.0	Water						186									
183.5	River Bottom						184									
3.1	Grey (Till) Silty clay, sand with varying amounts of gravel		1	SS	100	10 cm	182									22 34 33 11
	Hard		2	SS	100	8 cm	180									30 28 35 7
	Cobbles and boulders throughout		3	SS	107		178									
	Boulder		4	SS	107	18 cm	176									
177.2	Bedrock, competent		5	RC	REC	100%										
9.4	Grey Shaly limestone		6	BXL RC	REC 85%											
	Fine grained		7	BXL RC	REC 100%											
174.1	Fossiliferous															
12.5	Hard															
	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 19-81-02 LOCATION Sta. 5+558.0; o/s 5.2 m Rt. Q Highway 7 WBL ORIGINATED BY Z. M.
 DIST 7 HWY 7 BOREHOLE TYPE Diamond Drill COMPILED BY T. K.
 DATUM Geodetic DATE 81 07 15 - 81 07 16 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
186.6	River Level													
0.0	Water						186							
184.3	River Bottom													
2.3	Sand, trace silt and gravel Very loose Occasional layers of firm silty clay		1	SS	4		184							
182.0			2	SS	5		182							
4.6	(T111) Silty clay sand and gravel Hard cobble and boulders		3	SS	66		180							47 32 15 6
			4	SS	87		178							
177.7			5	SS	115		176							43 47 (10)
8.9	Bedrock, competent Grey Shaly limestone Fine grained Hard		6	BXL RC	REC 100%									
174.8			7	BXL RC	REC 100%									
11.8	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION



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RECORD OF BOREHOLE No 4

METRIC

W P 19-81-02 LOCATION Sta. 5+563.6; o/s 3.2 m Lt Highway 7 WBL ORIGINATED BY Z. M.
DIST 7 HWY 7 BOREHOLE TYPE Diamond Drill COMPILED BY T. K.
DATUM Geodetic DATE 81 07 17 - 81 07 20 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
186.6	River Level																
0.0	Water						186										
184.7	River Bottom																
1.9	Sand						184										
	Trace of silt and gravel		1	SS	2												5 90 (5)
	Very loose to compact		2	SS	14		182										15 72 (13)
180.6	(T411)						180										
6.0	silty Cobbles and clay, Boulders sand and sand and gravel Hard		3	SS	100/15 cm												51 39 (10)
177.8	Bedrock, competent Grey Shaly Limestone Fine grained		4	BXL RC	REC 100%		178										
8.8	Hard		5	BXL RC	REC 100%		176										
174.8																	
11.8	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10

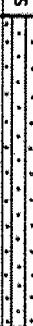


5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 19-81-02 LOCATION Sta. 5+390.5; o/s 6.8 m Lt. Q Highway 7 WBL ORIGINATED BY Z. M.
 DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. K.
 DATUM Geodetic DATE 81 08 05 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
189.5	Ground Surface							20	40	60	80	100					GR SA SI CL	
0.0	Grey Silty sand to sandy silt						188											
	Loose to compact		1	SS	7		186										0 16 78 6	
			2	SS	14		184											
183.1			3	SS	12		182										0 16 76 8	
6.4	Layered silty clay and clay		4	SS	8		180									19.0		
	Brittle and fissured Stiff		5	TW	PH		178										18.5	0 0 65 35
180.7			6	TW	PH		176									20.0	2 11 42 45	
8.8	Grey (Till) Silty clay, sand		7	SS	163	28 cm	174										12 41 33 14	
	some cobbles		8	SS	100	13 cm	172											
	gravel and boulders																	
177.9	Hard						170											
11.6	End of Borehole																	
	Refusal to augering probable boulder																	
	Augers tilted easterly on sloping boulder surface																	

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6 (A1,A2,A3)

METRIC

W P 19-81-02 LOCATION Sta. 5+391.0: o/s 4.5 m Lt Highway 7 WBL ORIGINATED BY Z. M.
 DIST 7 HWY 7 BOREHOLE TYPE Flight Augers, Tricone and washboring COMPILED BY T. K.
 DATUM Geodetic DATE 81 08 05 - 81 08 06 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
189.5	Ground Surface																
0.0	Silty Sand to Sandy Brown Silt Grey Trace of clay		1	SS	10		188										
			2	SS	6												
			3	SS	10												
			4	SS	9		186										
			5	SS	10												
	Loose to compact		6	SS	10												
			7	SS	12		184										
183.0			8	SS	10												
			9	SS	1												
6.5	Alternating layers of silty clay and clay Brittle, fissured		10	TW	FR		182									16.5	0 2 42 56
179.9	Stiff		11	SS	5		180										
9.6	Gray (Till) Silty clay, sand some gravel Cobbles and boulders throughout		12	SS	100/10 cm												13 34 38 15
			13	SS	100/5 cm		178										12 48 (40)
	Hard						176										
175.2																	
14.3	Bedrock, competent Gray Shaly limestone Fine grained Fossiliferous		14	BXL RC	REC 100%		174										
			15	BXL RC	REC 100%												
171.5	Hard						172										
18.0	End of Borehole *Water level not established at time of investigation. Borehole 6 is a combination of 3 boreholes: BHA1 was abandoned at depth of 7.9m due to loss of T. W. sampler in hole. BHA2 was abandoned at 12.6 metres due to augers tilting easterly on boulders. BHA3 was completed to a depth of 18 metres.																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 7

METRIC

W P 19-81-02 LOCATION Sta. 5+391.5; o/s 5.0 m Rt 7 Highway 7 WBL ORIGINATED BY Z. M.
DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. K.
DATUM Geodetic DATE 81 07 31 - 81 08 02 CHECKED BY CF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
189.6	Ground Surface															
0.0	Silty sand to sandy silt trace of clay compact to loose		1	SS	19		188									0 74 20 6
			2	SS	12											0 89 8 3
			3	SS	7											0 10 82 8
			4	SS	7											0 15 79 6
			5	SS	10											
			6	SS	10											
183.8	Alternating layers of silty clay and clay Brittle and fissured Stiff		7	SS	9		184									
5.8			8	SS	3											
			9	SS	5											
			10	SS	4		182									
180.9	Gray (Till) Silty clay, sand Some gravel Hard Cobbles and Boulders		11	SS	10											
8.7			12	SS	17		180									4 40 39 17
			13	SS	110/13 cm											12 47 31 10
			14	SS	100/10 cm											
			15	SS	100/18 cm		178									
175.3	End of Borehole Refusal to augering probable bedrock						176									
14.3																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8

METRIC

W P 19-81-02 LOCATION Sta. 5+441.6; o/s 3.5 m Lt C Highway 7 WBL ORIGINATED BY Z. M.
 DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers - BX Casing COMPILED BY T. K.
 DATUM Geodetic DATE 81 07 29 - 81 07 30 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
188.4	Ground Surface															
0.0	Silty sand to sandy silt Trace clay		1	SS	7	*	188									
	Brown		2	SS	10											0 86 11 3
	Gray		3	SS	10		186									0 10 86 4
	Loose to compact		4	SS	11											
184.1			5	SS	13		184									
4.3	Alternating layers of silty clay and clay		6	SS	4											0 2 73 25
	Brittle, fissured		7	SS	3											
	Stiff		8	SS	3		182									
181.4			9	SS	45											
7.0	Gray (Till) Silty clay, sand some gravel		10	SS	70/10 cm		180									
	Cobbles and boulders throughout		11	SS	60/8 cm											12 38 31 19
	Hard		12	SS	60/5 cm		178									
	Boulder		13	SS	100/10 cm											
176.2			14	RC	REC 100%		176									
12.2	Bedrock Gray shaly limestone fine grained Hard		15	RC	100%		174									
173.7																
14.7	End of Borehole *Water level not established															

+3, x⁵ : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 9

METRIC

W P 19-81-02 LOCATION Sta. 5+445.1; o/s 4.6 m Rt Highway 7 WBL ORIGINATED BY Z. M.
DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. K.
DATUM Geodetic DATE 81 07 30 - 81 07 31 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH						WATER CONTENT (%)
188.4	Ground Surface							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						GR SA SI CL	
0.0	Silty sand to sandy silt Trace of clay Loose to compact		1	SS	14	↓	188							D _m =0.8% 1 69 26 4	
			2	SS	10		186								
			3	SS	10										
184.5			4	SS	8										
3.9			5	SS	4										
	Alternating layers of silty clay and clay, fissured brittle, stiff		6	SS	5		184								
			7	SS	5										
182.2			8	SS	45										
6.2			9	SS	100/10 cm		182								
	Grey (Till) Silty clay, sand with varying amounts of gravel		10	SS	100/13 cm										
			11	SS	100/15 cm		180								
	Cobbles and boulders throughout		12	SS	100/15 cm										
			13	SS	120/18 cm		178								
	Hard		14	SS	100/10 cm										
176.1															
12.3	End of Borehole Refusal to augering probable bedrock														

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 10

METRIC

W P 19-81-02 LOCATION Sta. 5+444.6; Highway 7 WBL ORIGINATED BY Z. M.
DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Flight Augers COMPILED BY T. K.
DATUM Geodetic DATE 81 08 06 CHECKED BY CF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
188.4	Ground Surface																
0.0						*	188										
	Advance augers to 3.9 metres Probable silty sand to sandy silt						186										
184.5																	
3.9	Alternating layers of silty clay and clay Brittle & fissured		1	SS	3		184										
			2	TH	PH												
181.8	(Till) Hard		3	SS	100/13 cm		182										
6.6	End of Borehole *Water level not established																

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



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RECORD OF BOREHOLE No 11

METRIC

W P 19-81-02 LOCATION Sta. 5+614.6; o/s 3.0m Lt & Highway 7 WBL ORIGINATED BY Z. M.
DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers - BX Casing COMPILED BY T. K.
DATUM Geodetic DATE 81 08 10 CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							
187.1	Ground Surface														GR SA SI CL
0.0	Boulder Silty clay with silty sand layers Varying amounts of gravel Firm		1	SS	PM	*	186								
183.7	gravel some sand		2	SS	105		184								51 39 7 3
3.4	Grey (Till) Silty clay, sand Varying amounts of gravel Cobbles and boulders throughout		3	SS	100	10 cm	182								37 40 18 5
	gravel some sand		4	SS	63		180								62 32 (6)
	boulders		5	RC	100%	REC	178								55 32 (13)
	Hard		6	SS	100	10 cm	176								
178.6															
8.5	Bedrock, competent Grey shaly limestone Fine grained Hard		7	BXL RC	REC 100%		178								
175.5							176								
11.6	End of Borehole *Water level not established														

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 12

METRIC

W P 19-81-02 LOCATION Sta. 5+618.6; o/s 2.0 m Rt & Highway 7 WBL ORIGINATED BY Z. M.
DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. K.
DATUM Geodetic DATE 81 08 07 CHECKED BY ef

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
188.4	Ground Surface																GR SA SI CL
0.0	Boulders						188										
	Silty clay with silty sand layers and organics		1	SS	6												
	Firm		2	SS	PM		186										W=65% 25 41 31 3 Om=7.3%
184.7			3	SS	8												
3.7	Gray (Till)		4	SS	123												40 40 16 4
	Silty clay, sand, varying amounts of gravel		5	SS	100/15 cm		184										
	gravel and cobbles		6	SS	90/15 cm												44 40 (16)
	Cobbles and boulders throughout		7	SS	130/23 cm		182										
180.8	Hard																
	gravel some sand		8	SS	100/13 cm												25 59 (16)
7.6	End of Borehole																
	Refusal to augering probable boulder																

+3, x5 Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 13

METRIC

W P 19-81-02 LOCATION Sta. 5+666.6; o/s 5.0 m Lt Q Highway 7 WBL ORIGINATED BY Z. M.
 DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T. K.
 DATUM Geodetic DATE 81 08 10 CHECKED BY ef

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
189.0	Ground Surface																
0.0	Brown, silty clay varying amounts of sand.		1	SS	10		188										
			2	SS	3												
			3	SS	3												
185.6	Firm		4	SS	10		186										0 2 (98)
3.4	Grey (Till) Silty clay, sand varying amounts of gravel		5	SS	128/28 cm												8 50 33 9
			6	SS	138		184										
	cobbles and gravel		7	SS	100/10 cm		182										20 42 26 12
	Cobbles and boulders throughout		8	SS	133												
	sand some silt		9	SS	100/15 cm		180										6 76 (18)
178.8	Hard																
10.2	End of Borehole Refusal to augering probable bedrock																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 14

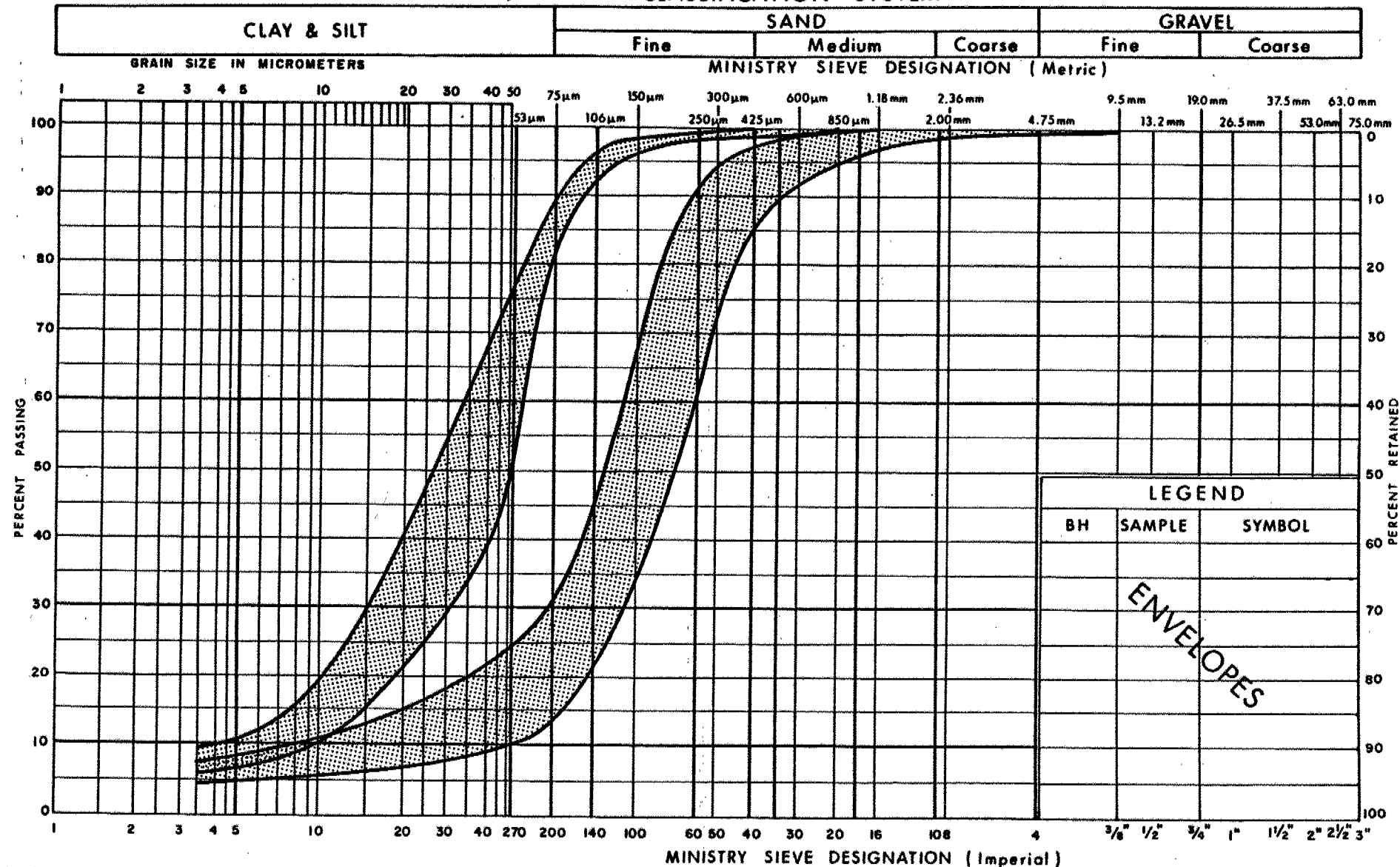
METRIC

W P 19-81-02 LOCATION Sta. 5+666.6; o/s 5.0m Rt C Highway 7 WBL ORIGINATED BY Z. H.
DIST 7 HWY 7 BOREHOLE TYPE Hollow Stem Augers - NQ casing COMPILED BY T. K.
DATUM Geodetic DATE 81 08 10 CHECKED BY CF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
189.0	Ground Level																GR SA SI CL
0.0	Brown, silty clay with silty sand layers Firm		1	SS	4		188										0 1 (99)
186.0			2	SS	4		186										32 36 25 7
3.0	Grey (Till) silty clay, sand cobble and varying boulder amounts of gravel Cobbles and boulders throughout Hard boulder boulder		3	SS	15		184										
			4	SS	114		182										
			5	SS	807 8 cm		180										
			6	SS	1007 15 cm		178										
178.8																	
10.2	Grey, shaly limestone Bedrock weathered shale partings, fine grained Hard		7	NQ RC	REC 100Z		178										
176.5																	
12.5	End of Borehole *Water level not established																

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

UNIFIED SOIL CLASSIFICATION SYSTEM



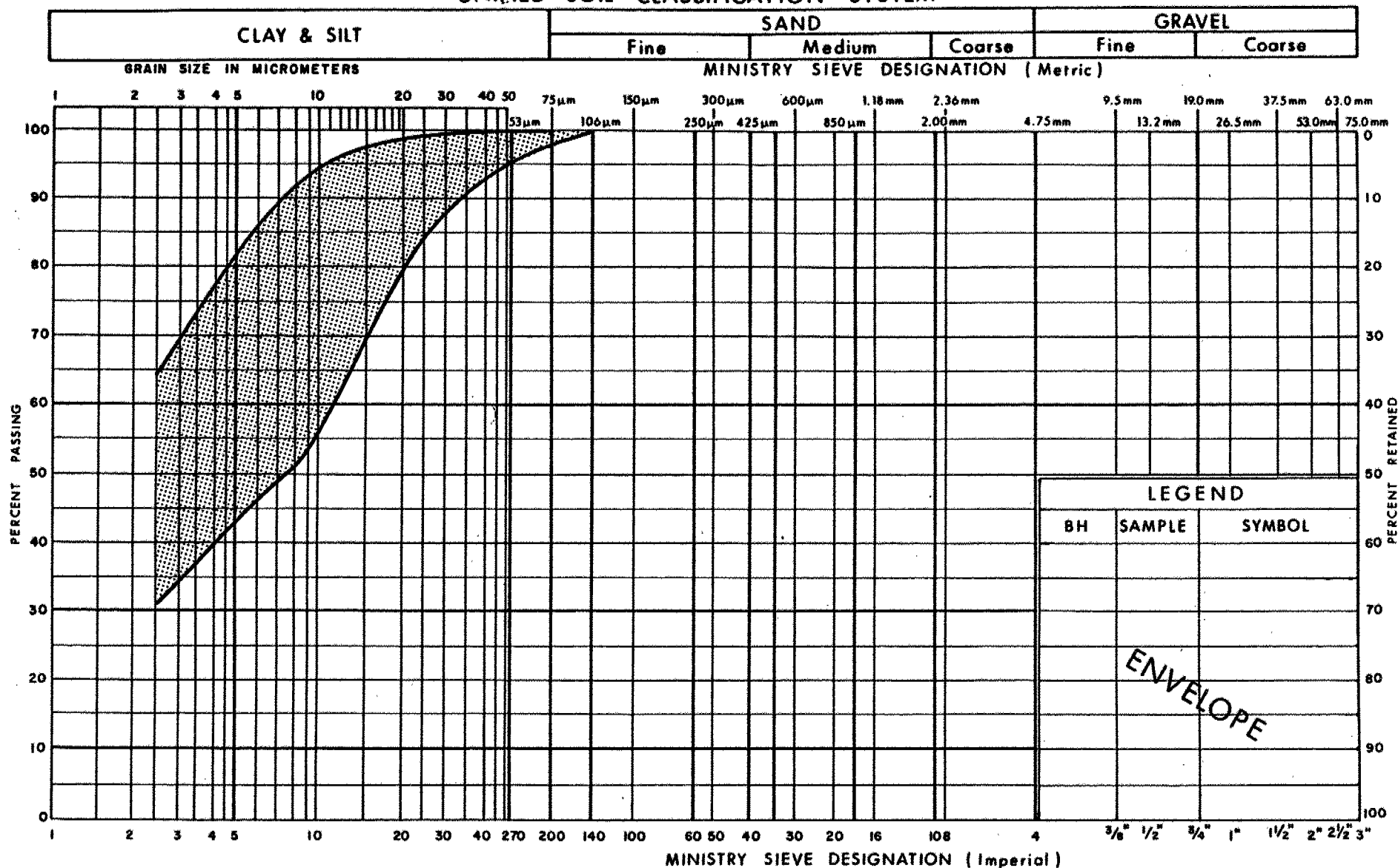
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GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT, TRACE OF CLAY

FIG No 1

W P 19-81-02

UNIFIED SOIL CLASSIFICATION SYSTEM



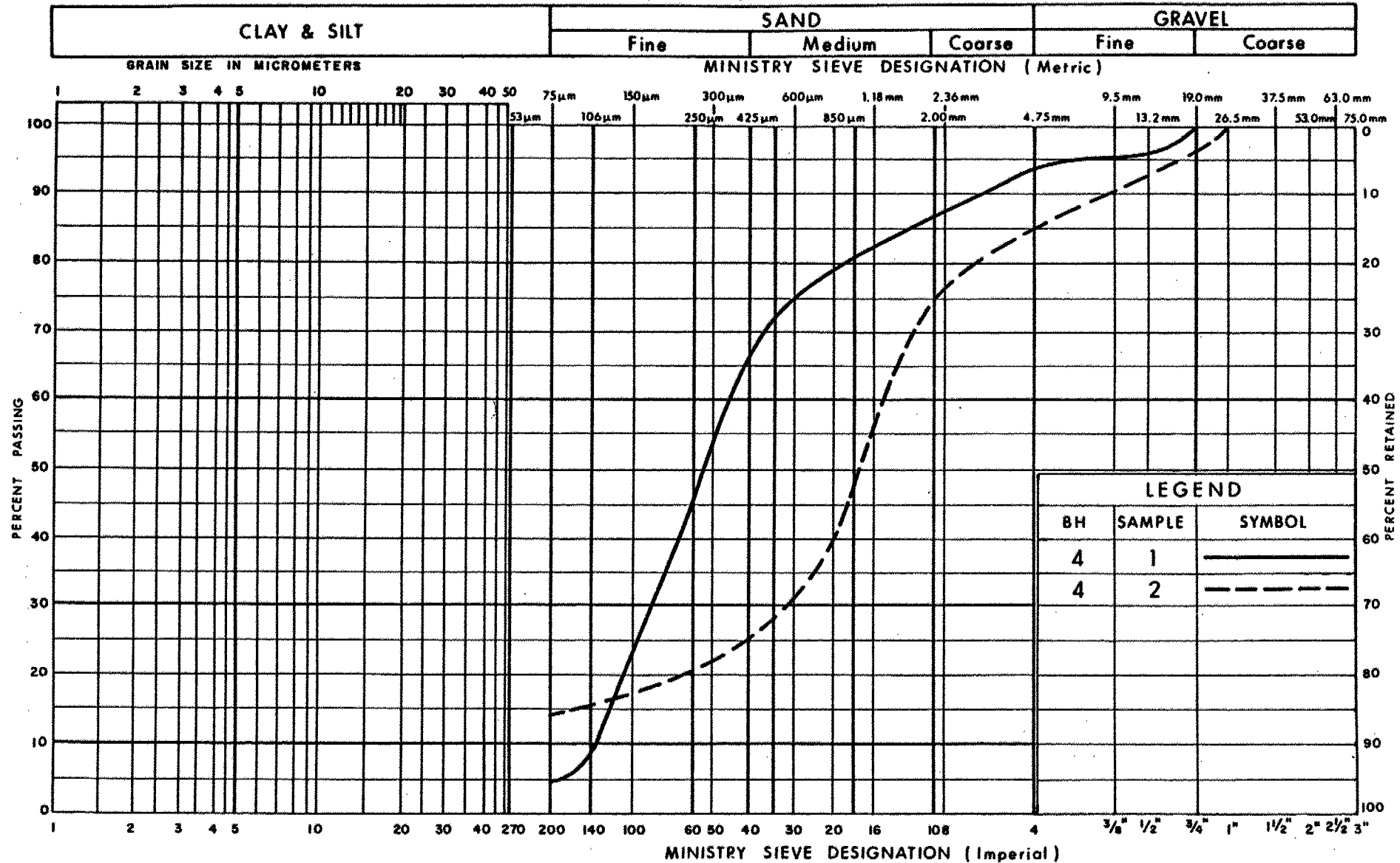
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GRAIN SIZE DISTRIBUTION SILTY CLAY AND CLAY

FIG No 2

W P 19-81-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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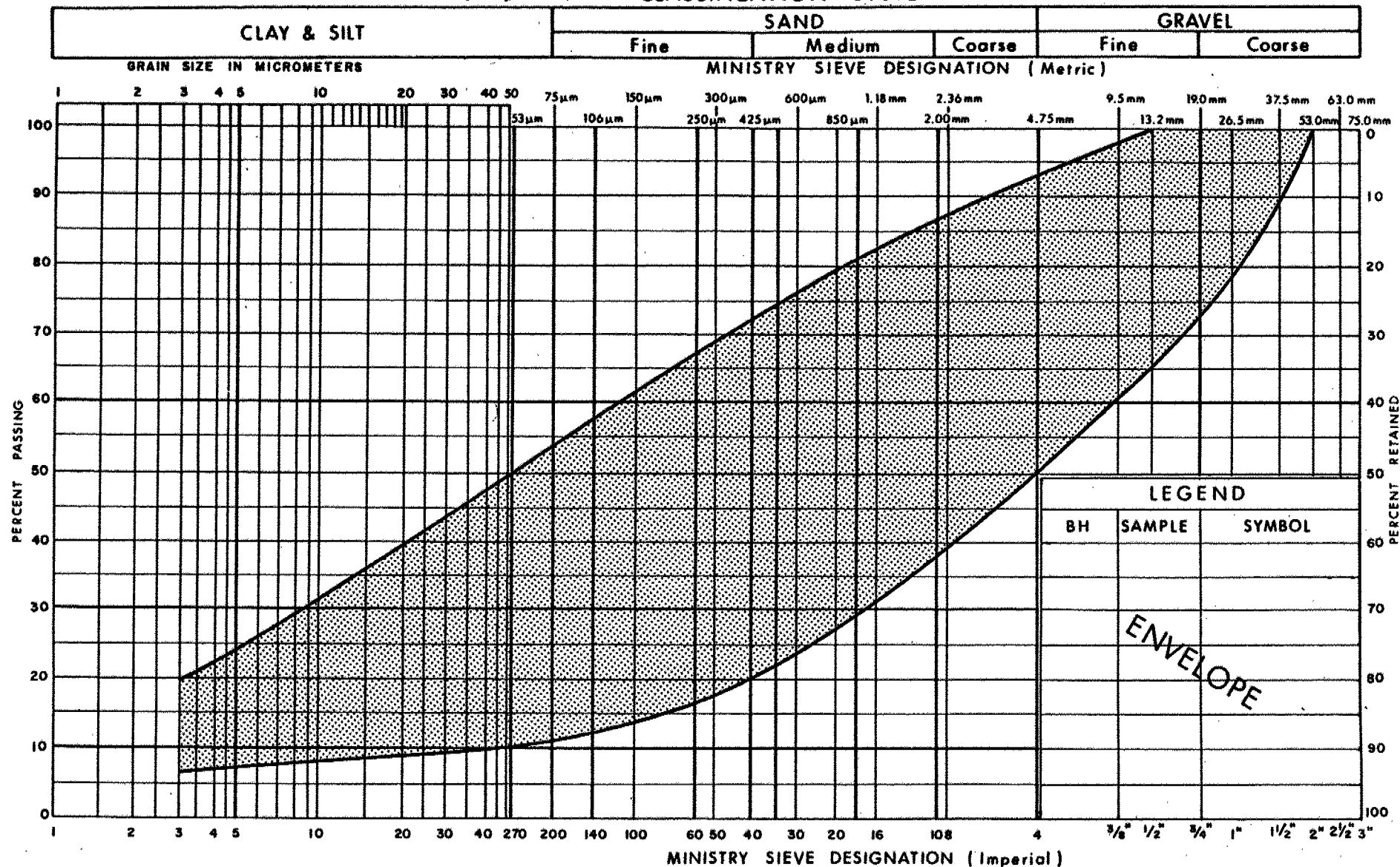
GRAIN SIZE DISTRIBUTION

SAND, TRACE OF SILT AND GRAVEL

FIG No 3

W P 19-81-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SILTY CLAY, SAND
 WITH VARYING AMOUNTS OF GRAVEL (Glacial Till)

FIG No 4

W P 19-81-02

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/0.3m)	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 (RQD), 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	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

METRIC

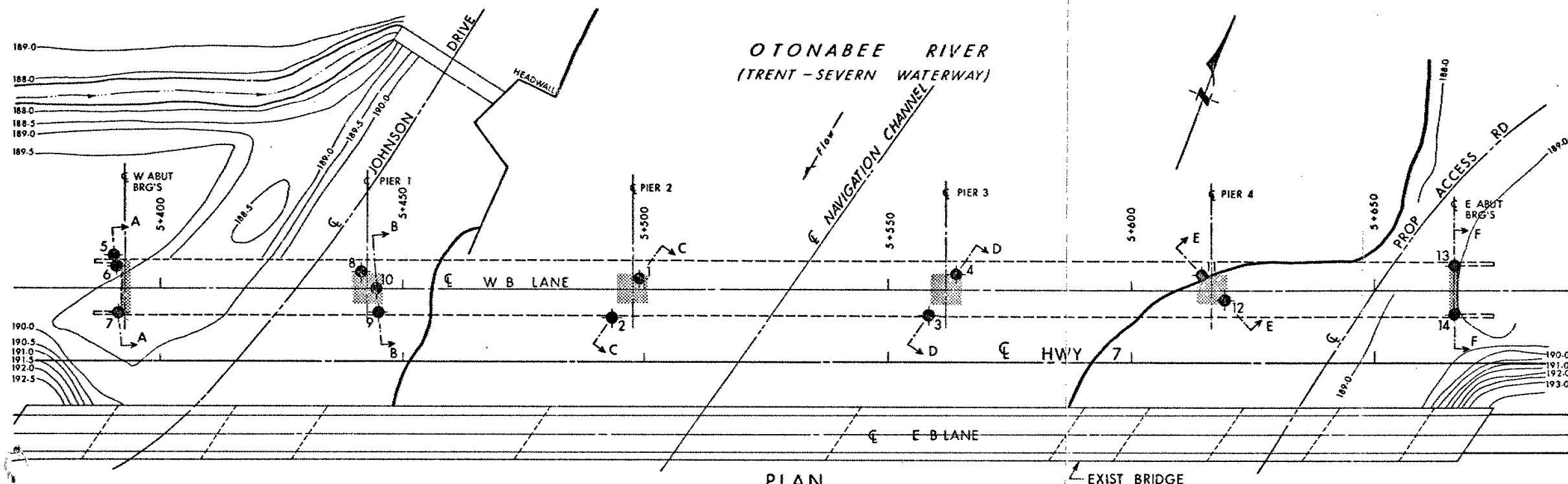
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN.
STATIONS ARE IN
KILOMETRES + METRES.

CONT No
WP No 19-81-02

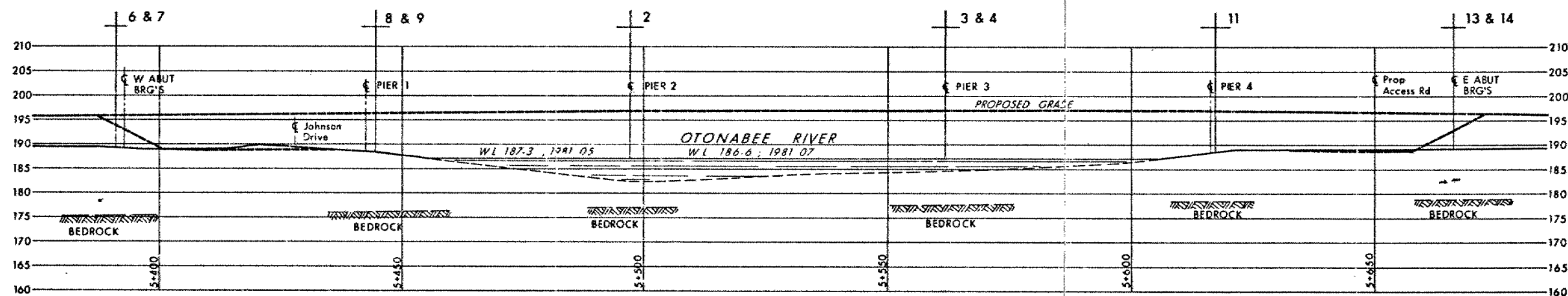
OTONABEE RIVER BRIDGE
(WEST BOUND LANE)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



PLAN
SCALE
10m 5 0 10m



PROFILE HWY 7 W B L

SCALE
10m 5 0 10m

NOTE

For Sections and Soil Strata
Refer to Dwg No 198102-B

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)
- W L at time of investigation 1981 07

No	ELEVATION	STATION	OFFSET W B L
1	186.6	5+499.0	2.2m Lt
2	186.6	5+493.3	5.7m Rt
3	186.6	5+558.0	5.2m Rt
4	186.6	5+563.6	3.2m Lt
5	189.5	5+390.5	6.8m Lt
6	189.5	5+391.0	4.5m Lt
7	189.6	5+391.5	5.0m Rt
8	188.4	5+441.6	3.5m Lt
9	188.4	5+445.1	4.6m Rt
10	188.4	5+444.6	⊕
11	187.1	5+614.6	3.0m Lt
12	188.4	5+618.6	2.0m Rt
13	189.0	5+666.6	5.0m Lt
14	189.0	5+666.6	5.0m Rt

NOTE

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

DATE	BY	DESCRIPTION

Geocres No 310-280

HWY No 7	DIST 7
SUBMITTAL CHECKED DATE 1981 10 08	SITE 26-458-61
DRAWN BY CHECKED	APPROVED
	DWG 198102-A

REF STRUCT DWG P1 ; 8108 28



HWY No 7	DIST 7
SUBMITTAL CHECKED <input checked="" type="checkbox"/> DATE 1981 10 15	SITE 25-458-01
DRAWN BY CHECKED <input checked="" type="checkbox"/> APPROVED	DWG 104102-8

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 19-81-02

SHEET

OTONABEE RIVER
BRIDGE (U.S.L.)
GENERAL ARRANGEMENT

NOTES

REINFORCING STEEL
REINFORCING STEEL SHALL BE GRAD 400
UNLESS OTHERWISE SPECIFIED. BARS CURVED
WITH THE SUFFIX C SHALL BE COATED
BARS.

CLASS OF CONCRETE
DECK, BARRIER WALLS, ABUTMENTS,
PIERS, PIER FOOTINGS AND
REMAINDER 30 MPa
REMAINDER 20 MPa

SLAB COVER TO REINFORCING STEEL
FOOTINGS 100 ± 25 mm
ABUTMENTS & WINGWALLS 100 ± 25 mm
PIERS 100 ± 25 mm
DECK TOP 100 ± 25 mm
DECK BOTTOM 100 ± 25 mm
BARRIER WALLS 100 ± 25 mm
APPROACH SLABS 100 ± 25 mm
UNLESS OTHERWISE NOTED ON DRAWINGS.

CONSTRUCTION NOTES
THE CONTRACTOR SHALL ENSURE THE
BRIDGING SEATS ARE LEVEL TO THE
SPECIFIED ELEVATIONS TO A TOLERANCE
OF ± 3 mm.

LIST OF DRAWINGS

- 26-458-61-
- 1 GENERAL ARRANGEMENT
- 2 BORE HOLE LOCATIONS & SOIL STRATA
- 3 SECTIONS & SOIL STRATA
- 4 FOOTING LAYOUT
- 5 PIER #2 & #3 FOOTINGS
- 6 WEST ABUTMENT
- 7 EAST ABUTMENT
- 8 PIER #1
- 9 PIERS #2, #3 & #4
- 10 BEARINGS
- 11 STRUCTURAL STEEL I
- 12 STRUCTURAL STEEL II
- 13 STRUCTURAL STEEL III
- 14 DECK
- 15 DECK SCREED ELEVATIONS
- 16 WEST ABUTMENT EXPANSION JOINT
- 17 BARRIER WALL
- 18 6000mm APPROACH SLAB
- 19 PILE DRIVING - STEAM & DIESEL HAMMERS
- 20 BRIDGE DATA & SITE NUMBER DATA
- 21 AS CONSTRUCTED ELEV. & DIM.
- 22 STANDARD DETAILS
- 23 DETAILS OF CONC. SLOPE PAVING
- 24 ELECTRICAL EMBEDDED WORK

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED
BELOW FOR THE APPROPRIATE CONCRETE
LUMP SUM TENDER ITEMS:

CONCRETE IN PIERS, ABUTMENTS & WINGWALLS 348 m³
CONCRETE IN DECK 737 m³
CONCRETE IN BARRIER WALLS 172 m³
CONCRETE IN APPROACH SLABS 32 m³
CONCRETE IN SLOPE PAVING 9 m³

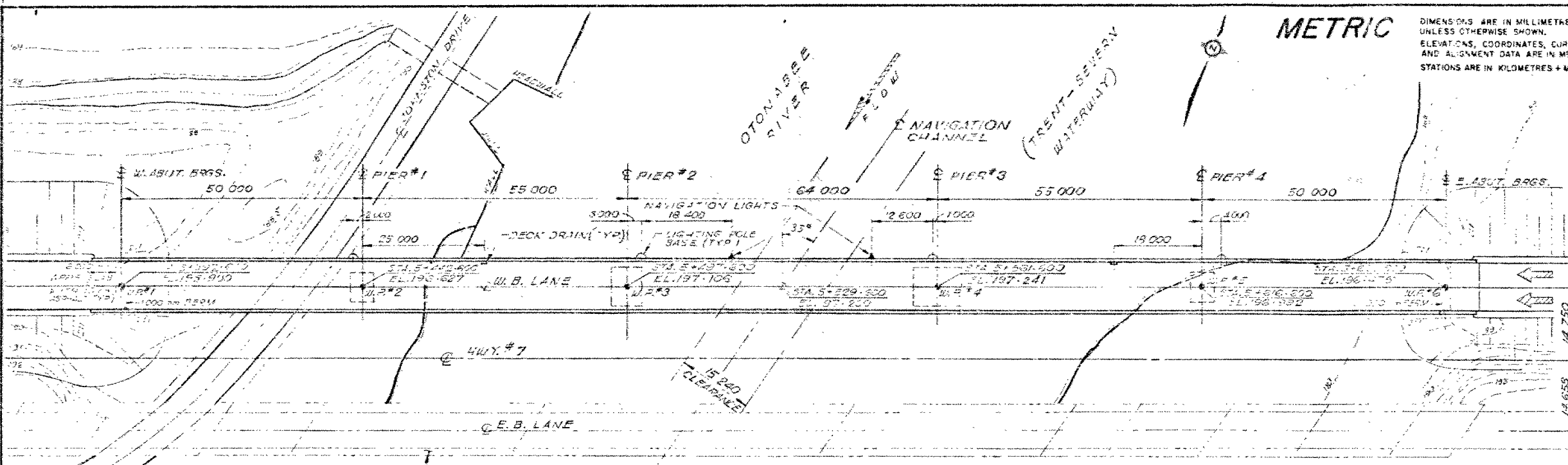
STRUCTURAL STEEL QUANTITY

585 TONNE

B.M. M.T.C. 75-171 (ON BRIDGE)

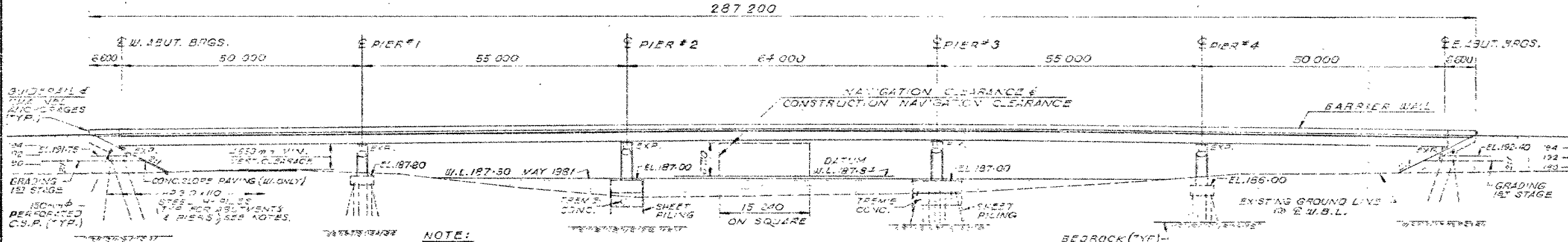
EL. 195.213

TABLET IS SET 1.00 M CONTINALLY IN THE
NORTH FACE OF THE WEST ABUTMENT
OF THE EXISTING OTONABEE RIVER
BRIDGE, BEING 1.00 M WEST OF THE
NORTH EAST CORNER AND 21 CM BELOW
THE TOP OF CURBING.



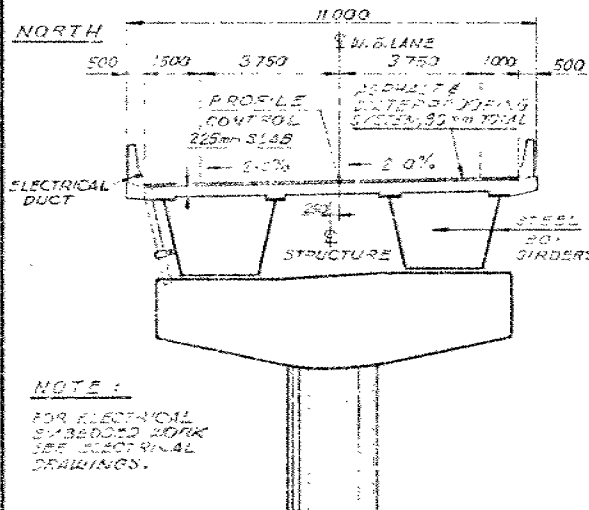
PLAN
1:500

NOTE:
FOR PROFILE & ALIGNMENT
OF JOHNSON DRIVE, SEE
GRADING DRAWINGS.



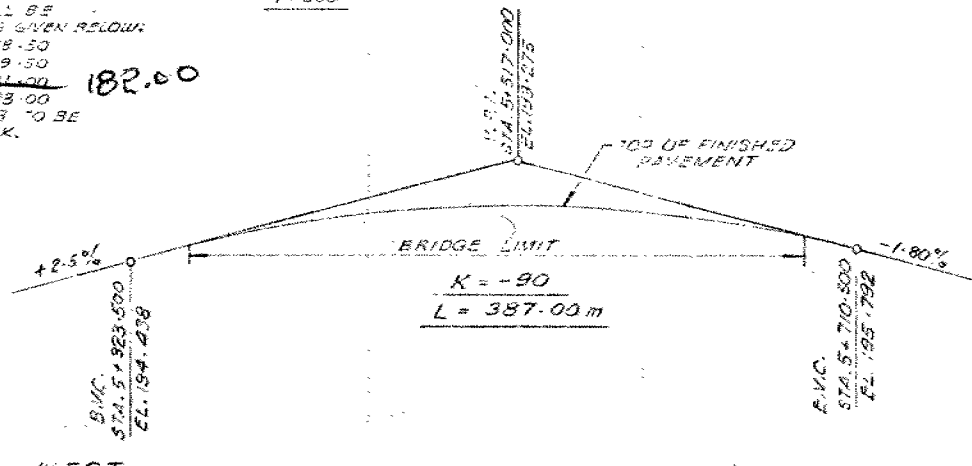
ELEVATION
1:500

NOTE:
ALL PILES EXCEPT FOR
PIER #3 TO BE DRIVEN IN
ACCORDANCE WITH STANDARD
SS 103-11 USING AN ULTIMATE
CAPACITY OF 2,940 kN
PER PILE BUT SHALL BE
DRIVEN TO ELEVATIONS GIVEN BELOW:
W. ABUTMENT 178.50
PIER #1 179.50
PIER #4 181.00
E. ABUTMENT 183.00
PILES FOR PIER #3 TO BE
DRIVEN TO BEDROCK.

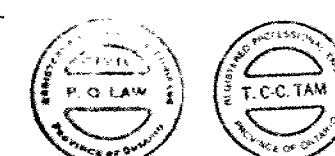


TYP. DECK SECTION
1:100

NOTE:
FOR ELECTRICAL
EMBEDDED WORK
SEE ELECTRICAL
DRAWINGS.



PROFILE OF W.B. LANE
N.T.S.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CHECK	LOAD NO.	DATE
DRAWING	CHECK	SITE NO.	DRG

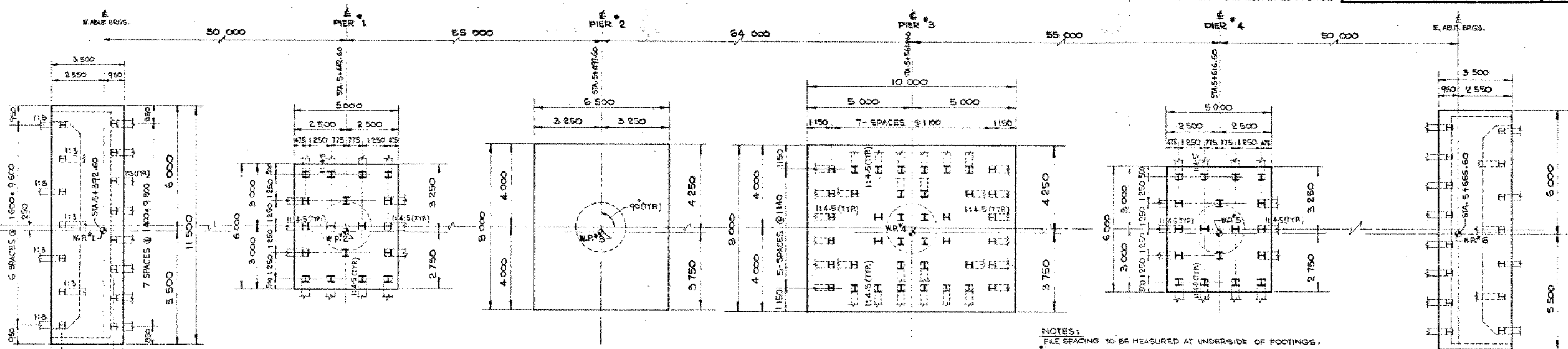
DIST. 7
CONT No
WP No 19-81-02

OTONABEE RIVER BRIDGE
W.B.L.
FOOTING LAYOUT

SHEET

METRIC

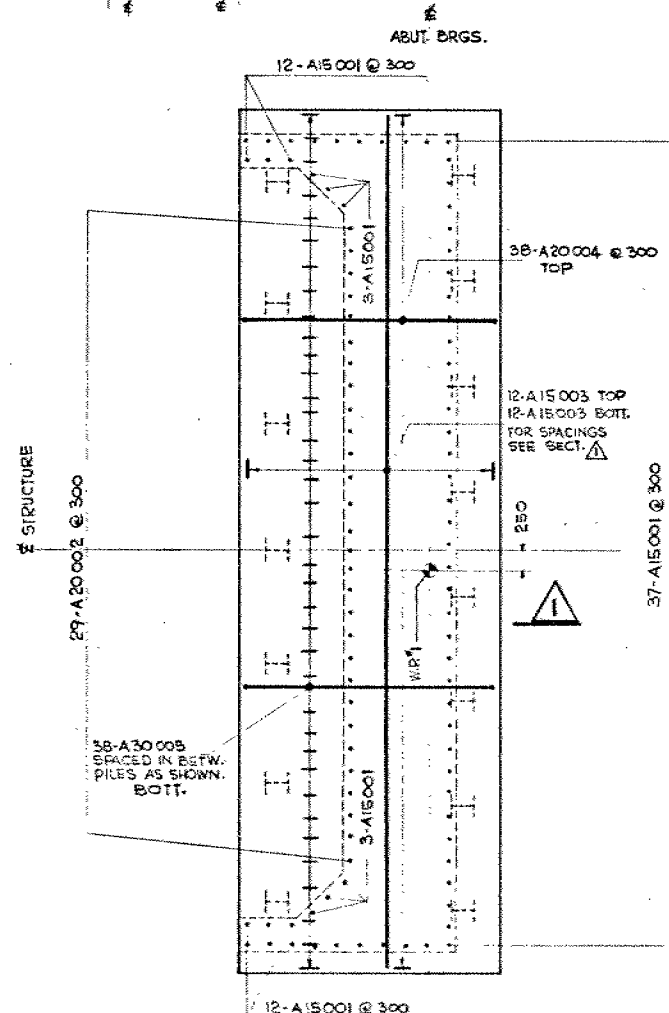
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.



FOOTING LAYOUT
1:100

- NOTES:
- FILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
 - SHEET PILES ARE NOT DESIGNED TO PENETRATE THE COBBLES, BOULDERS OR ROCK FRAGMENTS. REMOVAL OF COBBLES, BOULDERS AND ROCK FRAGMENTS MIGHT BE NECESSARY TO INSTALL SHEET PILES TO REQUIRED ELEVATION, PARTICULARLY FOR PIER #2.

SIMILAR TO W. ABUTMENT



PLAN OF ABUTMENT
FOOTING
1:50

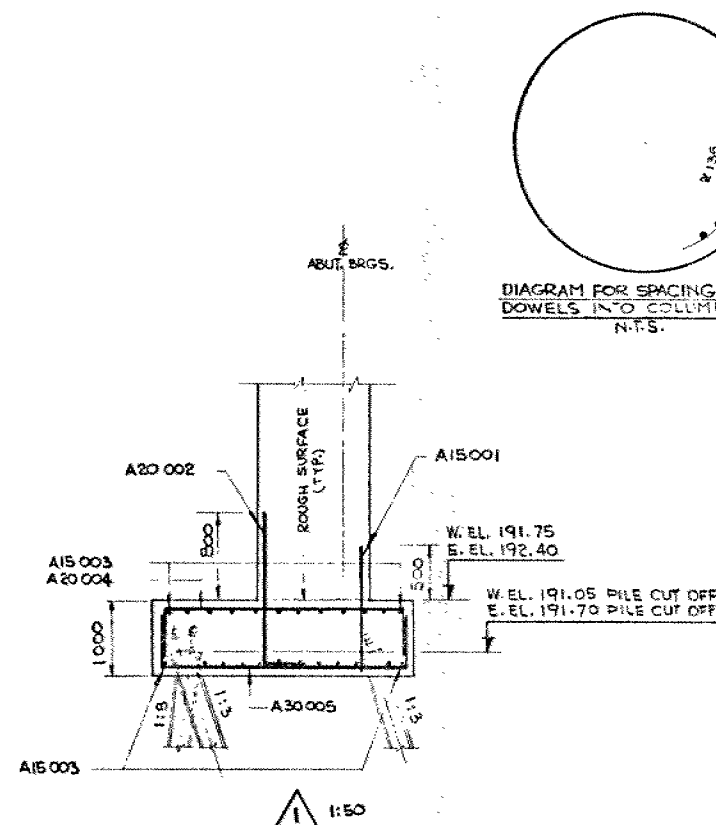
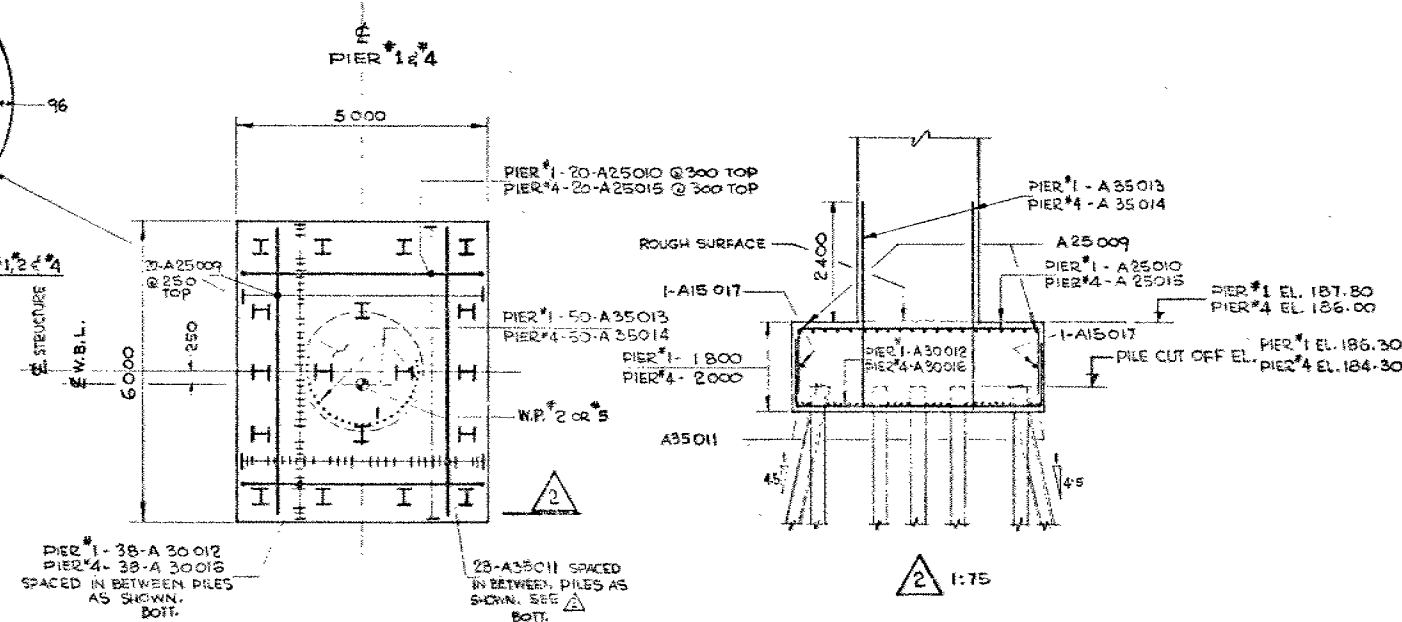


DIAGRAM FOR SPACING OF
DOWELS IN COLUMNS #1, 2, 4
N.T.S.



PLAN
1:75

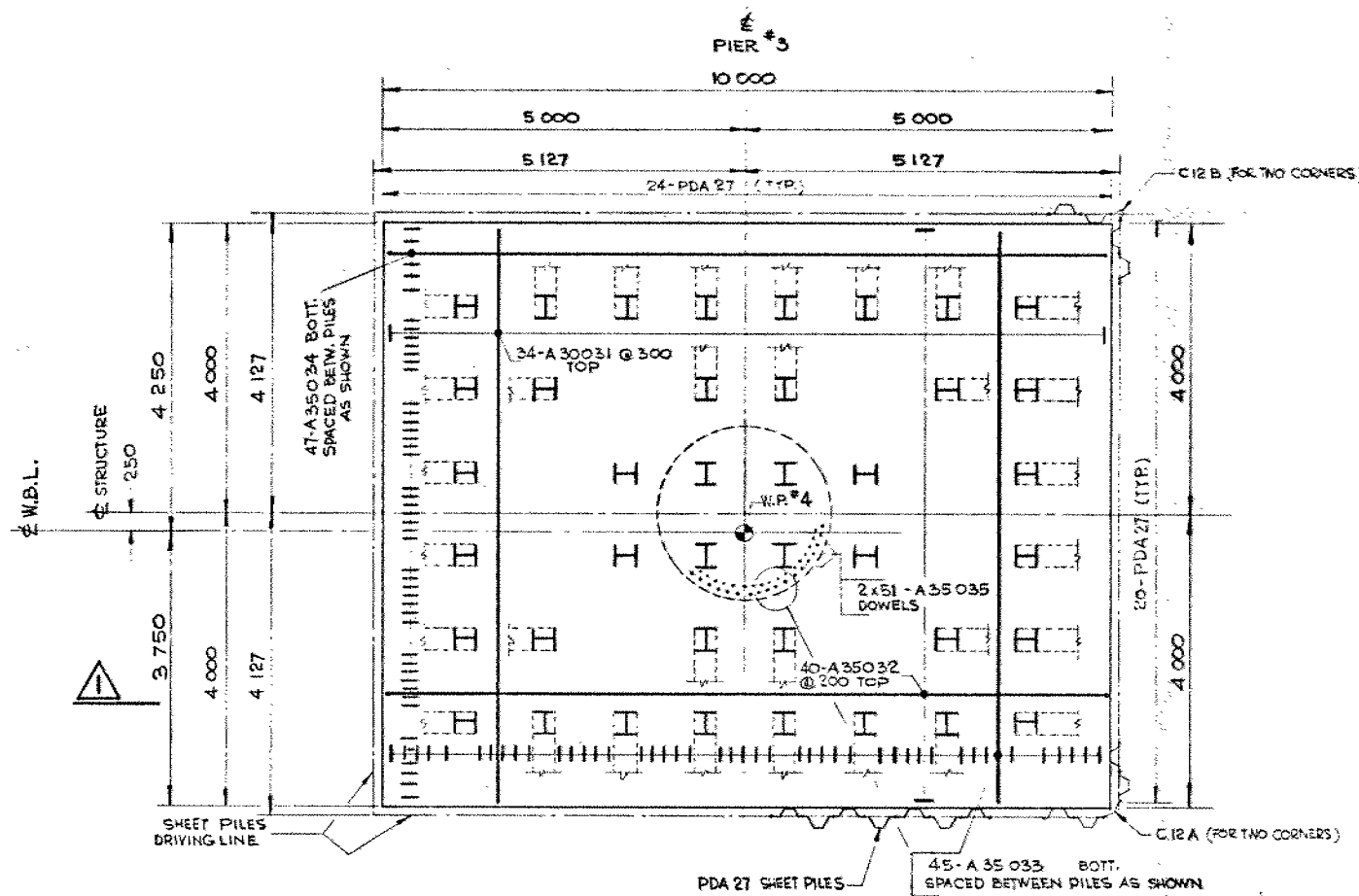


DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

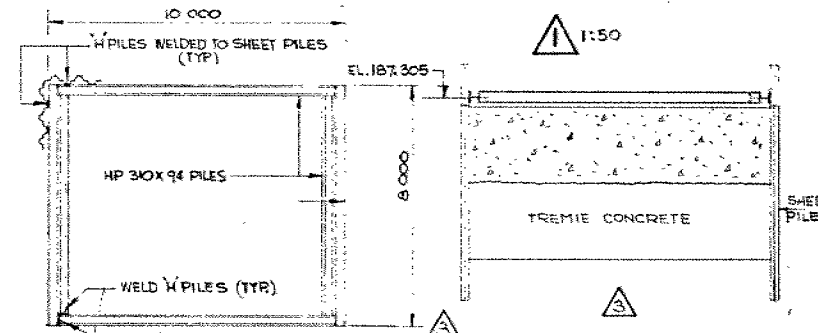
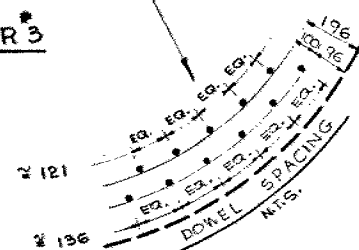
REVISIONS	DATE	BY	DESCRIPTION
DESIGN		CHECK	LOADING 2-3-81 DATE FEB 82
DRAWING		CHECK	SITE 2-3-81 DWS

METRIC

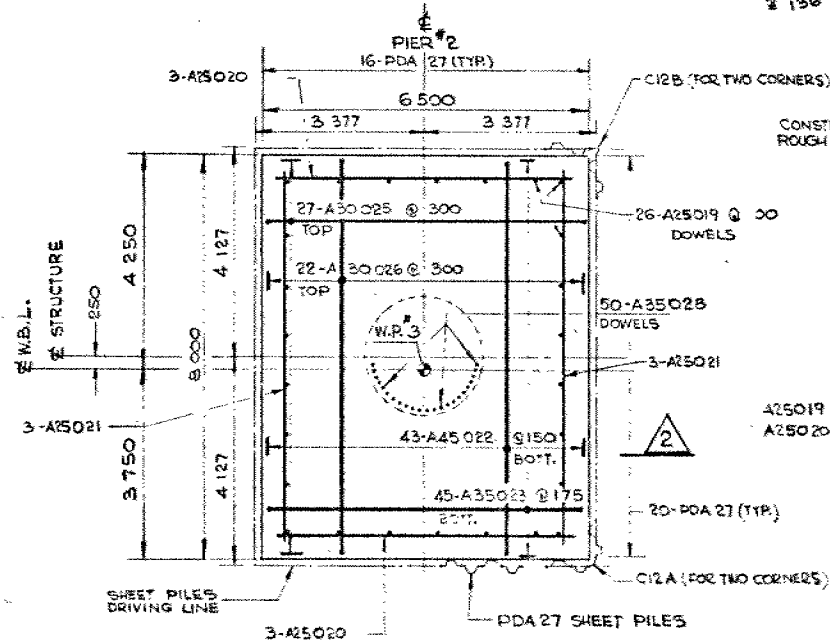
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
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AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.



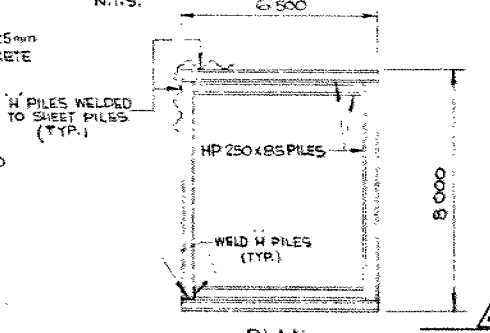
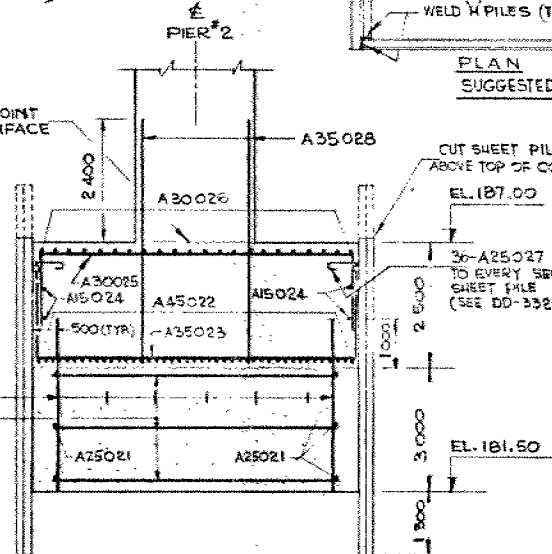
PLAN-PIER #3
1:50



PLAN SUGGESTED SHEET PILE BRACING SCHEME FOR PIER #3
N.T.S.



PLAN-PIER #2
1:75



SUGGESTED SHEET PILE BRACING SCHEME FOR PIER #2
N.T.S.

PILE DATA									
LOCATION	Nº	BATTER	LENGTH (mm)	CUT OFF ELEVATION	TYPE	PILE DESIGN DATA LOAD @ 5% S TYPE II	FACTORED CAPACITY @ 5% S	PILE CONST. DATA ULTIMATE CAPACITY	REMARKS
W. ABUT.	4	1:8	13,000	191.05	HP30x110	980 KN/PILE	1600 KN/PILE	2940 KN/PILE	WITH DRIVING SHOES
	11	1:3	13,500						
PIER #1	4	STR.	7,200	186.30	HP30x110	DO	DO	DO	DO
	14	1:4.5	7,500						
PIER #3	8	STR.	8,000	185.50	HP30x110	DO	DO	DO	DRIVEN TO BEDROCK
	22	1:4.5	8,800						
PIER #4	4	STR.	3,800	184.30	HP30x110	DO	DO	2940 KN/PILE	DO
	14	1:4.5	3,500						
E. ABUT.	4	1:8	9,000	191.70	HP30x110	DO	DO	DO	DO
	11	1:3	9,500						

NOTE: PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW CUT-OFF ELEVATION.

SHEET PILE DATA			
LOCATION	TYPE	Nº	LENGTH
PIER #2	PDA 27	72	7 000
	C12 A	2	
	C12 B	2	
PIER #3	PDA 27	88	6 500
	C12 A	2	
	C12 B	2	



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION



Ontario

Ministry of
Transportation and
Communications

Central Region
Construction Office
5000 Yonge Street
Willowdale, Ontario
M2N 6E9

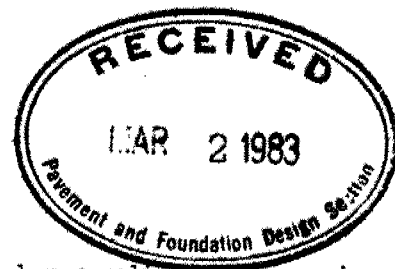
March 1, 1983

Robert McAlpine Ltd.
185 Bethridge Road
Rexdale, Ontario
M9W 1N5

Attention: Mr. A. Saunders, P.Eng.

Dear Sir:

RE: Contract 82-89
Otonabee River Bridge
Highway 7



I wish to confirm recent decisions reached regarding changes in the footing designs on Piers #2 and #3 at the Otonabee River Bridge.

Revisions to the original designs were requested by McAlpine Ltd. because of difficulties experienced in excavating the hard glacial till to bedrock. The soil conditions shown in the Foundation Report for Pier #3 are substantially correct (excavation of till at Pier #2 has not begun yet).

It is the understanding that the cost of the revised footing construction will be paid at tender unit prices (rock anchors by Quotation Request) but the cost to the Ministry is not to exceed the original tender cost for this work which includes structure excavation, tremie and concrete in footings. The fee for the revised footing designs will be considered in the cost computation.

A contract special provision stipulates that work in the river is to be suspended from March 1 to May 31. Permission has been obtained, with qualifications, to continue beyond February 28, 1983.

Piers #3, #2

- Driving piles (sheet and "H") to March 15, 1983

Fish activity may necessitate stopping this work before March 15, 1983. The Ministry of Natural Resources will monitor conditions and advise this Ministry if an earlier shut-down date is warranted.

Work on the following operations may continue after February 28, 1983:

(i) Earth Excavation for Structures

Providing this work is carried out in the "dry" and no material is deposited in the river while moving earth from the caissons to the shore.

(ii) Unwatering

If water is clear, it may be acceptable to discharge it into the river. However, if it is sediment laden, it will be necessary to direct the water to a settling tank before it enters the river. The decision on the method to be used will be made before unwatering begins.

Any disruption to construction operations as a result of "uplift" in the caissons at Piers #2 and #3 is the responsibility of the Contractor.

(iii) Concrete in Footings, Unwatering, Pier Shaft and Caps

The presence of the two trestles in the river at the same time, however, was the subject of discussion earlier. The Conservation Authority and the Trent-Severn Waterway Authority will be consulted. The outcome may have a bearing on the extent of work that may be carried out in the shut down period.

Please let me know if you are in disagreement with any of the points noted.

Yours truly,



J. P. Cullen
Area Construction Engineer

for:

J. Smrcka
Manager
Construction Office

JPC:ek

memorandum

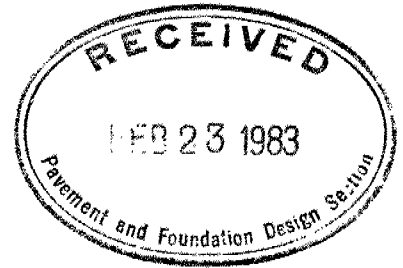
M3K 1N6



To: Mr. J. P. Cullen
Area Construction Engineer
Central Region

Date: 83 02 22

Re: Contract 82-89
Otonabee R. Bridge, Site 26-458-61
Highway #7, District #7



Attached are six prints of the pile foundation layout for Pier #3 in lieu of placing footings on bedrock.

In addition, the Contractor should adhere to the following points and conditions:

1. The 310 HP 110 piles shall be provided with either pruy points or driving shoes as per MTC Std. DD-3301.

Piles shall be driven to bedrock. A minimum set of 15 blows per 25 mm for the last 75 mm of driving shall be obtained with a hammer capable of delivering minimum energy of 48,000 joules per blow.

In case of difficulty encountered in driving piles to bedrock due to presence of boulders and cobbles, it may be necessary to employ preaugering technique.

In lieu of preaugering, additional piles may be driven in the close proximity of the not fully penetrated pile.

2. Rock anchors shall be installed to develop the required resistance and shall be installed in accordance with the Manufacturers recommendation with a minimum embedment into bedrock of not less than 2 meters.
3. The minimum depth of tremie concrete shall be one meter.

A resistance of 48 KPa/m^2 due to soil friction for the embedded length of piles may be assumed in computing the resistance against up-lift of the tremie concrete during unwatering operation.

.... /2

The installation procedure and the design parameters have been discussed with M. Devata, Senior Foundation Engineer.

A. Radkowski
A. Radkowski,
Design Engineer,
Northern and North-
western Region

AR:vs

attach.

c.c. H. Jagasia
K. Bassi
K. Luczka
M. Devata✓

memorandum



To: Mr. K.G. Bassi
Head
Operating Section
Structural Office

Date: 82 06 23

From: Pavement & Foundation Design
Room 315, Central Building
Downsview, Ontario

Re: Otonabee River Bridge (W.B.L.)
W.P. 19-81-02, Site: 26-458-61
Hwy. 7, District 7

We have reviewed the revised drawings #1, #4, #5, and #9 for the above-mentioned site and note the most of the comments from our letter dated 82 04 14 and our subsequent meeting have been incorporated into design. Excavations for Pier #4 pile cap will require an unwatering scheme, if carried down below prevailing river water level due to the presence of granular layers within the silty clay stratum.

On drawing #5, bedrock should be shown with cross-hatched symbols on the sheet pile sections.

A handwritten signature in black ink, appearing to read "Tom Kazmierowski".

Tom Kazmierowski, P. Eng.
Foundations Engineer

TK/jb

memorandum



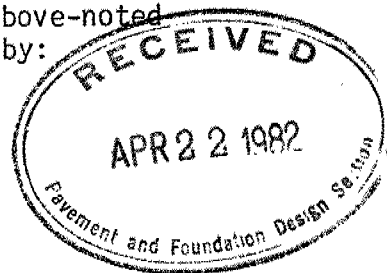
To: F I L E

Date: 82-04-16

Subject: Foundations for Piers #2 and #3
Otonabee River Bridge W.B.L.
W.P. 19-81-02, Site 26-458-61
Hwy. #7, Dist. #7

A meeting to discuss the foundations for the above-noted bridge was held on 82-04-15. It was attended by:

K. Bassi
G. Burkhardt
H. Jagasia
P. Law
W. Lin
A. Radkowski



The tops of Piers #2 and #3 footings were shown to be at about the river bed level on the Preliminary General Arrangement Plan but were subsequently raised to within 0.30 m from the water surface. The raise in the top of footing elevations was unacceptable to the Region because:

- (a) it would raise the flood level by 9" to 12";
- (b) the footings would pose a hazard to watercraft. The footings at the higher elevations would also be affected by ice.

It was agreed that top of footings for Piers #2 and #3 would be lowered so as to be approximately level with the river bed. The concerns expressed by the Pavement and Foundation Design Section concerning all pier foundations will also be reviewed.

The Regional Technical Review meeting for this project will take place on 82-06-16 but the mini-review is scheduled for 82-05-19. The mini-review meeting will review the plans as submitted on 820414 but will be advised by the Regional Structural Section that the Pier Footings are being revised. The Revised Plans and revisions to the D4 must be submitted to the Region by 82-06-01.

K. G. Bassi,
Head, Operating Section

KGB:vs

c.c. R.A. Dorton
G. Burkhardt
H. Jagasia
P. Law
W. Lin
A. Radkowski
M. Devata
W. McFarlane

memorandum



To: Mr. K.G. Bassi
Structural Office
2nd Floor, West Building

Date: 82 04 14

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Otonabee River Bridge (W.B.L.)
W.P. 19-81-02, Site 26-458-61
Hwy. 7, District 7

We have reviewed the final bridge plan drawings No. 1, 4, & 5 for the above-mentioned structural site, and provide the following comments:

- 1) Approach fills placed in the area of the abutments should be restricted in gradation to a maximum size of 75 mm, to facilitate pile penetration.
- 2) An appropriately designed unwatering scheme is necessary at Pier #1 to prevent 'boiling' of the foundation material since excavations are being carried out below river water level in the granular subsoil.
- 3) Sheet piling for Pier #2 will not penetrate the hard till structure to elevation 180.2. Excavation in advance of sheeting will be required even to reach the tremie concrete base i.e. elev. 181.5.
- 4) Excavations for Pier #4 will require an unwatering scheme due to the presence of granular layers within the silty clay which are assumed to be in direct communication with river water levels.
- 5) Pile tip elevations for Pier #4 should be modified to elevation 182.0 and the elevation schematic on Drawing #1 should not show piles driven to bedrock.
- 6) In addition, due to the depth of excavation for Pier #4 pile cap, we feel the pier can be supported on spread footings at or below elevation 184. Provided spread footings are adopted, this section will provide further detailed design parameters as required.

A handwritten signature in dark ink, appearing to read "Tom Kazmierowski".

T. Kazmierowski, P. Eng.
Foundations Engineer

TK/syc

cc: C.S. Grebski



Appendix B

Site Photographs



Photo 1 Looking West at WBL West Abutment



Photo 2 Looking East at WBL East Abutment



Photo 3 **Looking West at WBL Piers and River**



Photo 4 **Looking Northwest at WBL Approach**

Appendix C
Archived Drawings

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 19-81-02

SHEET

OTONABEE RIVER
BRIDGE (U.S.L.)
GENERAL ARRANGEMENT

NOTES

REINFORCING STEEL
REINFORCING STEEL SHALL BE GRAD 400
UNLESS OTHERWISE SPECIFIED. BARS CURVED
WITH THE SUFFIX C SHALL BE COATED
BARS.

CLASS OF CONCRETE
DECK, BARRIER WALLS, ABUTMENTS,
PIERS, PIER FOOTINGS AND
REMAINDER 30 MPa
REMAINDER 20 MPa

SLAB COVER TO REINFORCING STEEL
FOOTINGS 100 ± 25 mm
ABUTMENTS & WINGWALLS 100 ± 25 mm
PIERS 100 ± 25 mm
DECK TOP 100 ± 25 mm
DECK BOTTOM 100 ± 25 mm
BARRIER WALLS 100 ± 25 mm
APPROACH SLABS 100 ± 25 mm
UNLESS OTHERWISE NOTED ON DRAWINGS.

CONSTRUCTION NOTES
THE CONTRACTOR SHALL ENSURE THE
BEDROCK SEATS ARE LEVEL TO THE
SPECIFIED ELEVATIONS TO A TOLERANCE
OF ± 3 mm.

LIST OF DRAWINGS

- 26-459-61-
- GENERAL ARRANGEMENT
- 2 BORE HOLE LOCATIONS & SOIL STRATA
- 3 SECTIONS & SOIL STRATA
- 4 FOOTING LAYOUT
- 5 PIER #2 & #3 FOOTINGS
- 6 WEST ABUTMENT
- 7 EAST ABUTMENT
- 8 PIER #1
- 9 PIERS #2, #3 & #4
- 10 BEARINGS
- 11 STRUCTURAL STEEL I
- 12 STRUCTURAL STEEL II
- 13 STRUCTURAL STEEL III
- 14 DECK
- 15 DECK SCREED ELEVATIONS
- 16 WEST ABUTMENT EXPANSION JOINT
- 17 BARRIER WALL
- 18 6000mm APPROACH SLAB
- 19 PILE DRIVING - STEAM & DIESEL HAMMERS
- 20 BRIDGE DATA & SITE NUMBER DATA
- 21 AS CONSTRUCTED ELEV. & DIM.
- 22 STANDARD DETAILS
- 23 DETAILS OF CONC. SLOPE PAVING
- 24 ELECTRICAL EMBEDDED WORK

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED
BELOW FOR THE APPROXIMATE CONCRETE
LUMP SUM TENDER ITEMS:

CONCRETE IN PIERS, ABUTMENTS & WINGWALLS 348 m³
CONCRETE IN DECK 737 m³
CONCRETE IN BARRIER WALLS 172 m³
CONCRETE IN APPROACH SLABS 32 m³
CONCRETE IN SLOPE PAVING 9 m³

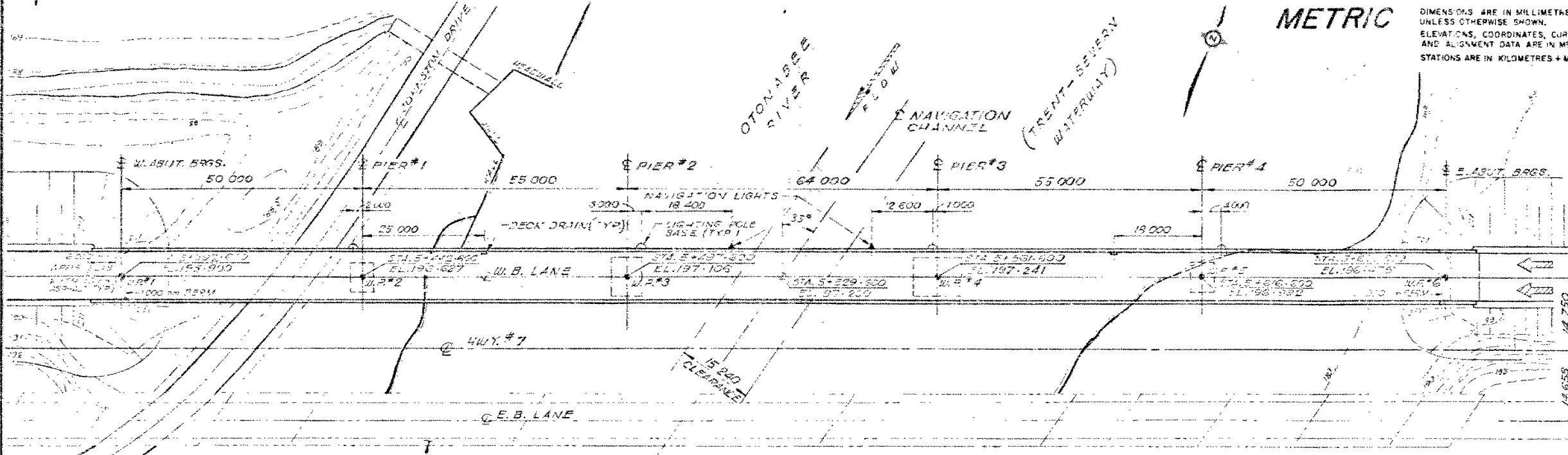
STRUCTURAL STEEL QUANTITY

585 TONNE

B.M. M.T.C. 75-171 (ON BRIDGE)

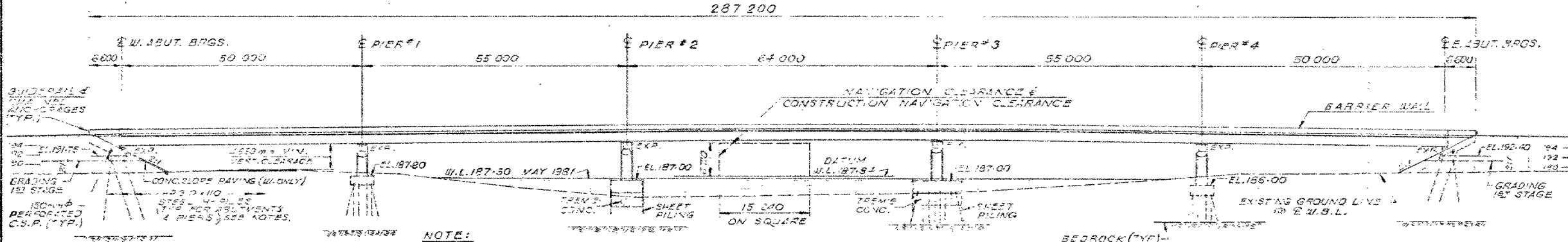
EL. 195.213

TABLET IS SET 1.00 M CONTINALLY IN THE
NORTH FACE OF THE WEST ABUTMENT
OF THE EXISTING OTONABEE RIVER
BRIDGE, BEING 1.00 M WEST OF THE
NORTH EAST CORNER AND 21 CM BELOW
THE TOP OF CURBING.

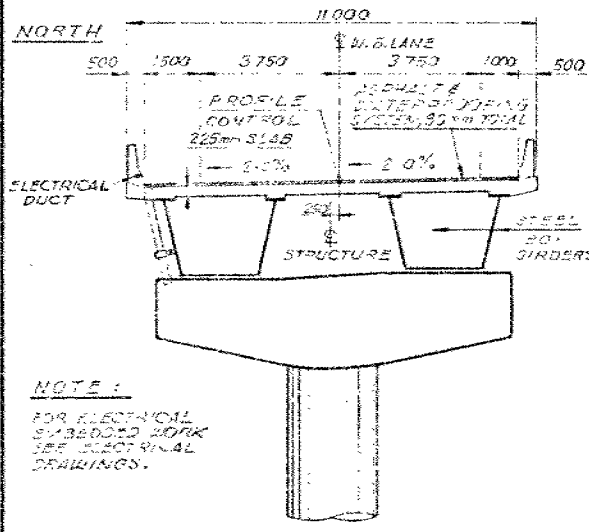


NOTE:
FOR PROFILE & ALIGNMENT
OF JOHNSON DRIVE SEE
GRADING DRAWINGS.

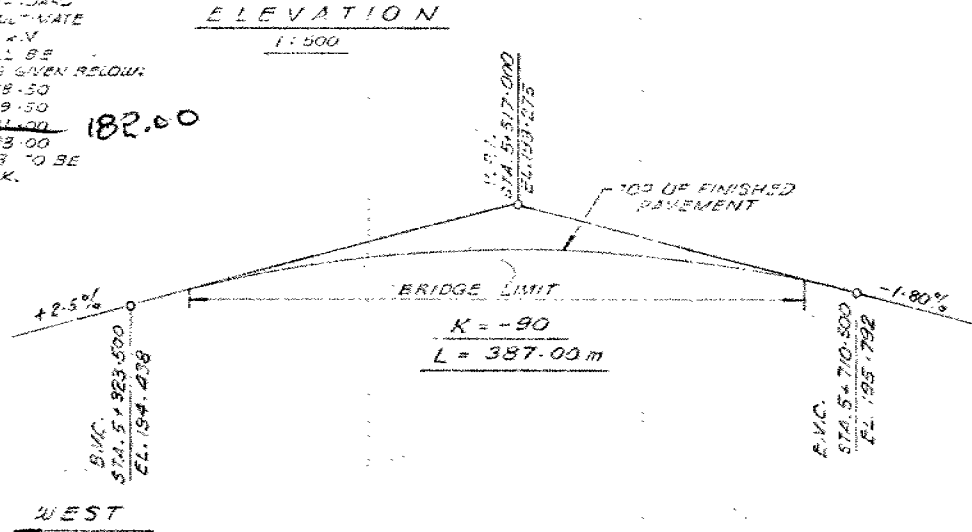
APPROACH SLABS, ASPHALT & WATERPROOFING
NOT PART OF THIS CONTRACT



NOTE:
ALL PILES EXCEPT FOR
PIER #3 TO BE DRIVEN IN
ACCORDANCE WITH STANDARD
SS 103-11 USING AN ULTIMATE
CAPACITY OF 2 940 kN
PER PILE BUT SHALL BE
DRIVEN TO ELEVATIONS GIVEN BELOW:
W. ABUTMENT 178.50
PIER #1 179.50
PIER #4 181.00
E. ABUTMENT 183.00
PILES FOR PIER #3 TO BE
DRIVEN TO BEDROCK.



NOTE:
FOR ELECTRICAL
EMBEDDED WORK
SEE ELECTRICAL
DRAWINGS.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CHECK	LOAD NO	DATE
DRAWING	CHECK	SITE NO	DRG

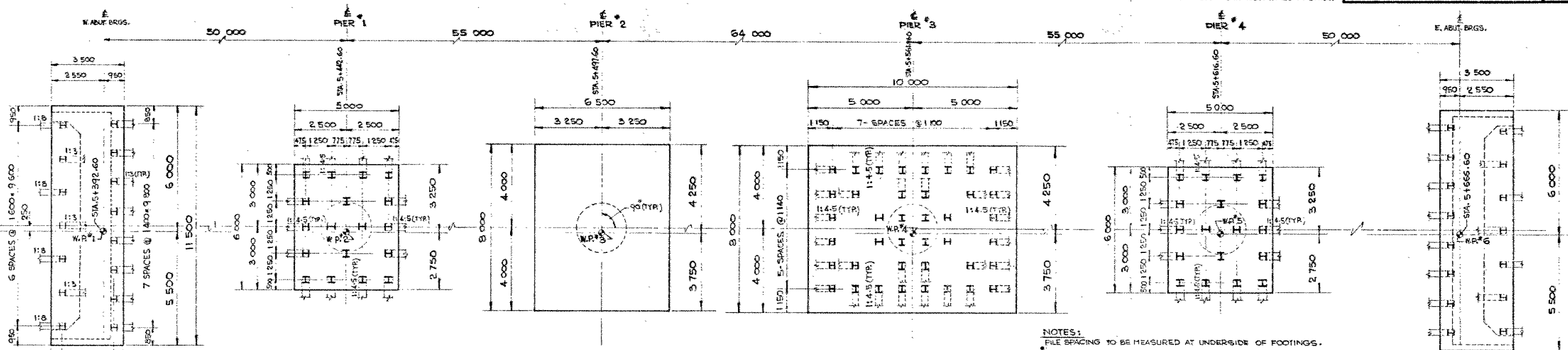
DIST. 7
CONT No
WP No 19-81-02

METRIC

OTONABEE RIVER BRIDGE
W.B.L.
FOOTING LAYOUT

SHEET

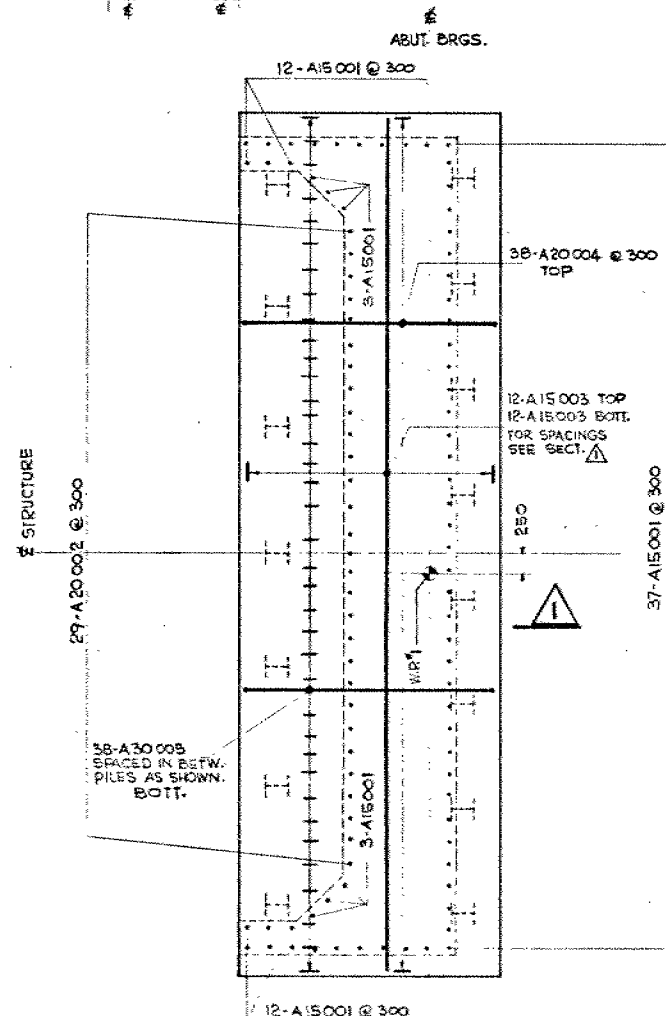
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.



FOOTING LAYOUT
1:100

- NOTES:
- FILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
 - SHEET PILES ARE NOT DESIGNED TO PENETRATE THE COBBLES, BOULDERS OR ROCK FRAGMENTS. REMOVAL OF COBBLES, BOULDERS AND ROCK FRAGMENTS MIGHT BE NECESSARY TO INSTALL SHEET PILES TO REQUIRED ELEVATION, PARTICULARLY FOR PIER #2.

SIMILAR TO W. ABUTMENT



PLAN OF ABUTMENT
FOOTING
1:50

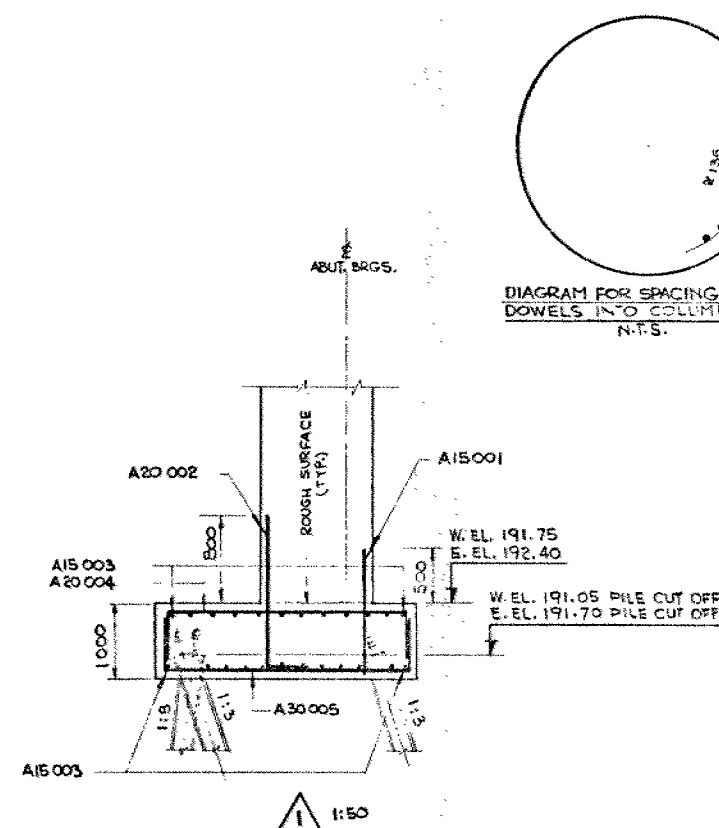
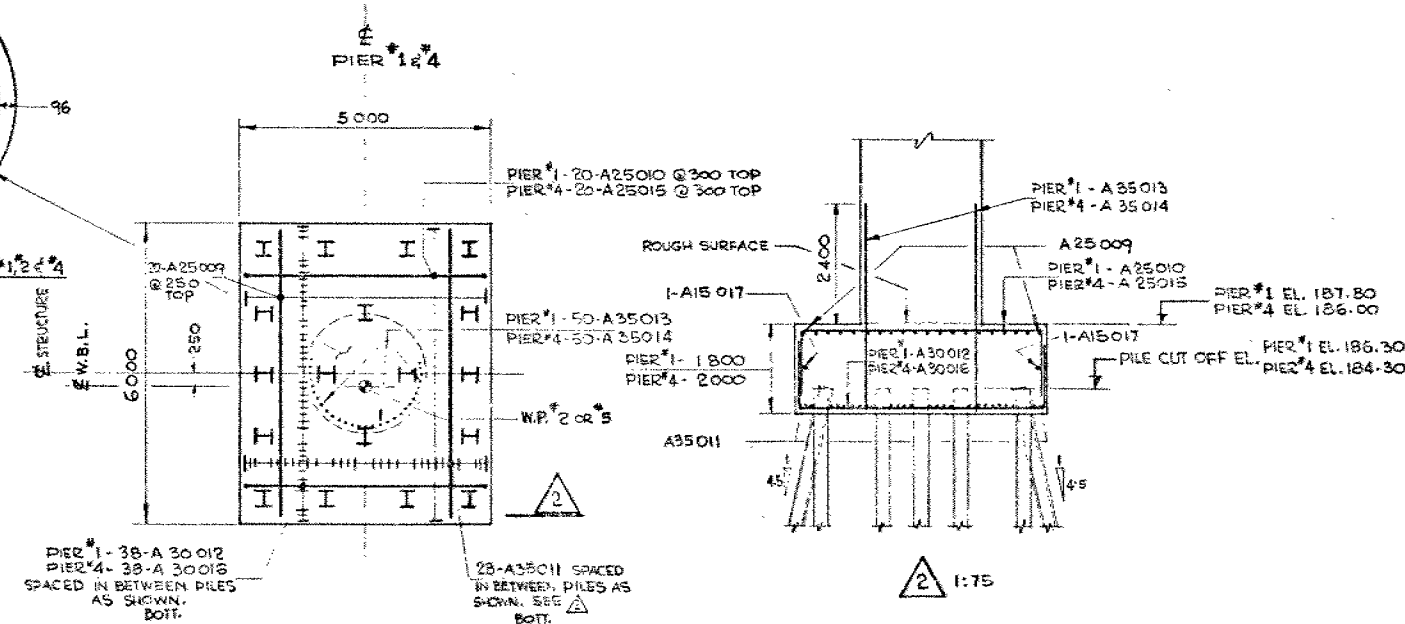


DIAGRAM FOR SPACING OF
DOWELS INTO COLUMNS #1, 2, 4
N.T.S.



PLAN
1:75

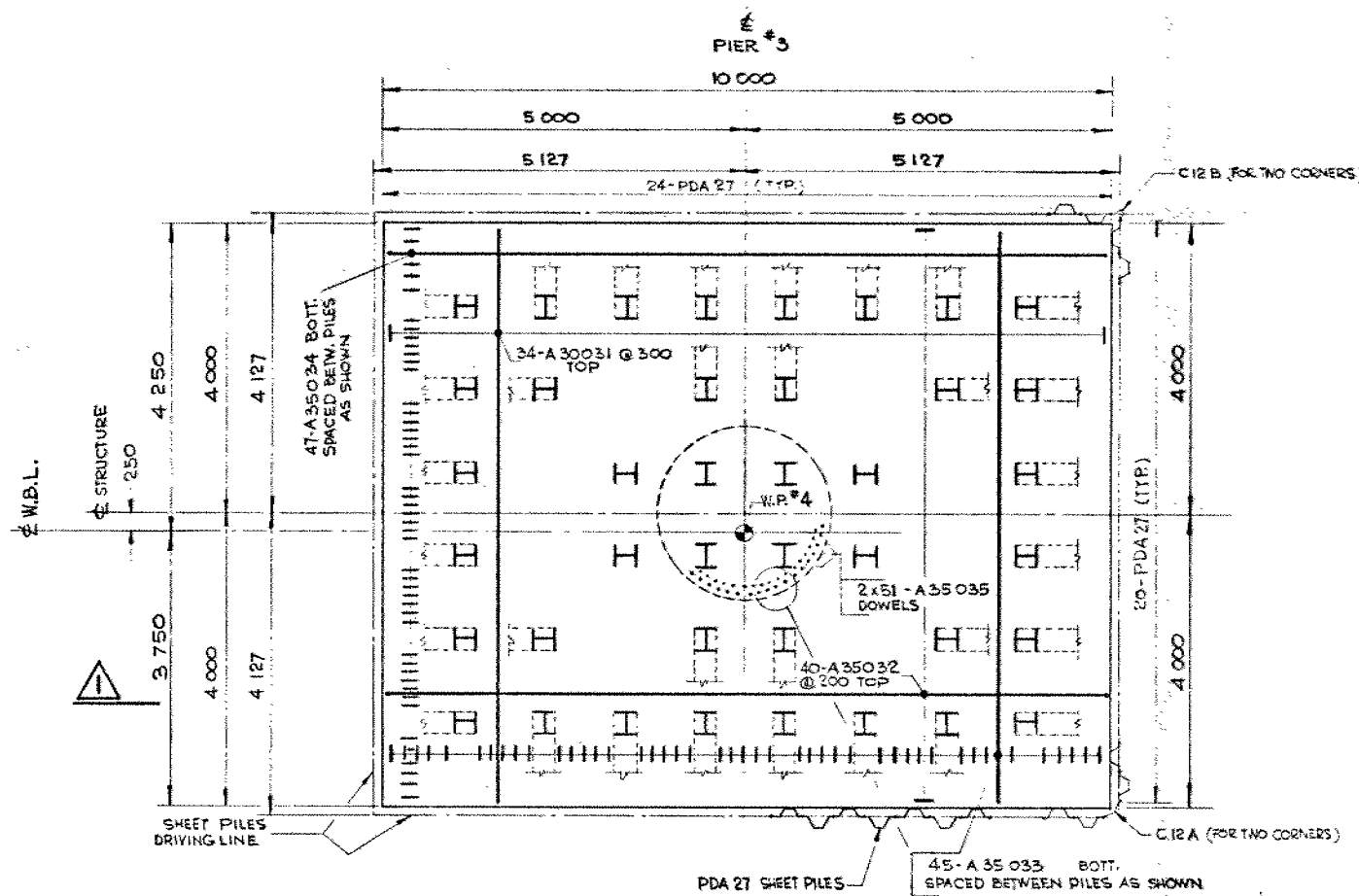


DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

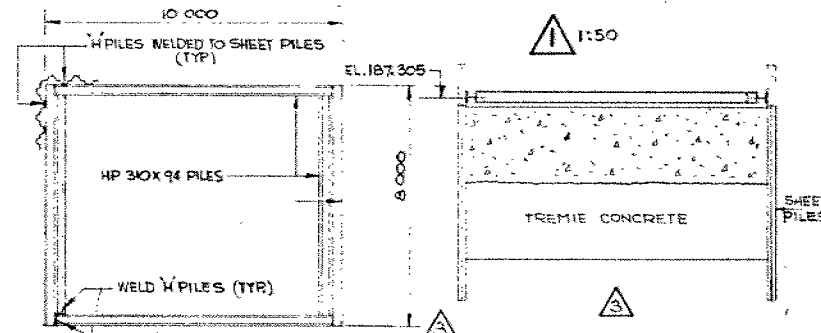
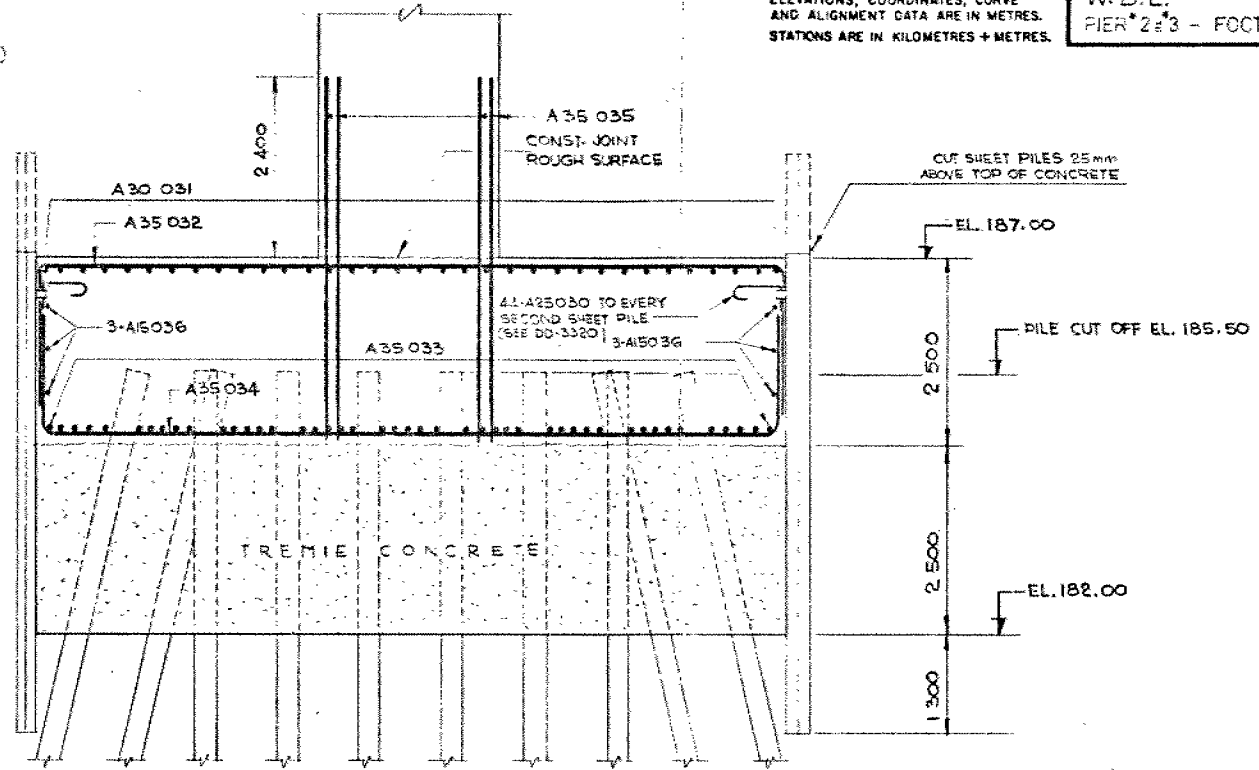
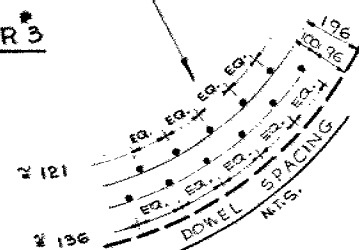
REVISIONS	DATE	BY	DESCRIPTION
DESIGN			LOADING 2-31-81 DATE FEB 82
DRAWING			CHECK SITE 2-31-81 DWS

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.



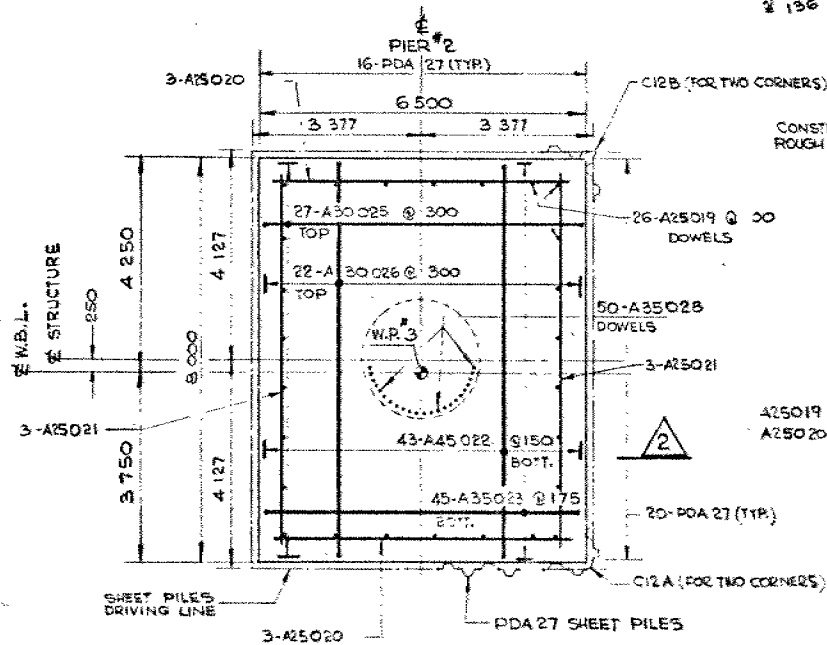
PLAN-PIER #3
1:50



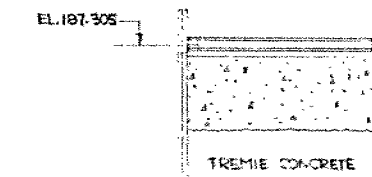
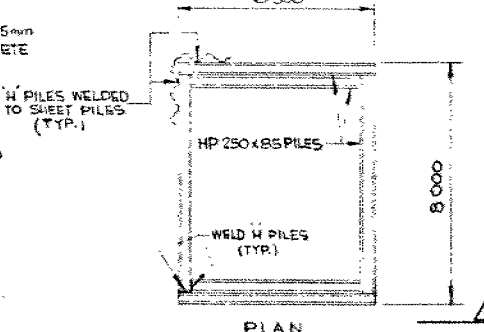
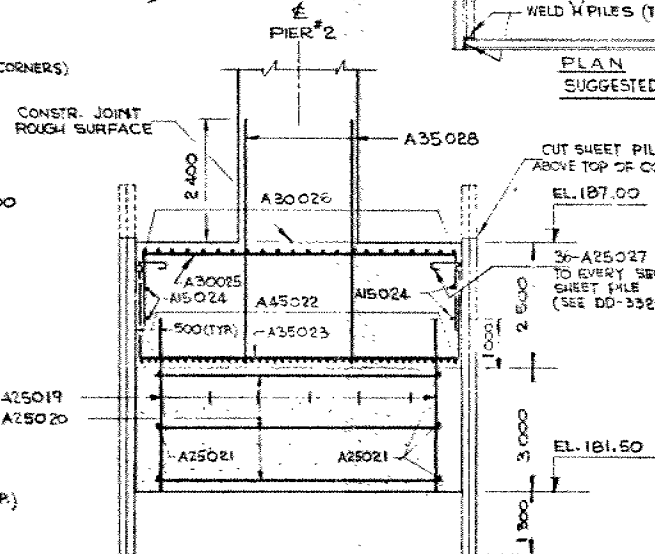
PLAN
SUGGESTED SHEET PILE BRACING SCHEME FOR PIER #3
N.T.S.

PILE DATA									
LOCATION	Nº	BATTER	LENGTH (mm)	CUT OFF ELEVATION	TYPE	PILE DESIGN DATA LOAD @ 5% S TYPE II	FACTORED CAPACITY @ 5% S	PILE CONST. DATA ULTIMATE CAPACITY	REMARKS
W. ABUT.	4	1:8	13,000	191.05	HP30x110	980 KN/PILE	1600 KN/PILE	2940 KN/PILE	WITH DRIVING SHOES
	11	1:3	13,500						
PIER #1	4	STR.	7,200	186.30	HP30x110	DO	DO	DO	DO
	14	1:4.5	7,500						
PIER #3	8	STR.	8,000	185.50	HP30x110	DO	DO	DO	DRIVEN TO BEDROCK
	22	1:4.5	8,800						
PIER #4	4	STR.	3,800	184.30	HP30x110	DO	DO	2940 KN/PILE	DO
	14	1:4.5	3,500						
E. ABUT.	4	1:8	9,000	191.70	HP30x110	DO	DO	DO	DO
	11	1:3	9,500						

NOTE: PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW CUT-OFF ELEVATION.



PLAN-PIER #2
1:75



PLAN
SUGGESTED SHEET PILE BRACING SCHEME FOR PIER #2
N.T.S.

SHEET PILE DATA			
LOCATION	TYPE	Nº	LENGTH
PIER #2	PDA 27	72	7,000
	C12A	2	
	C12B	2	
PIER #3	PDA 27	88	6,500
	C12A	2	
	C12B	2	



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST. 7

CONT No 82-89

WP No 19-81-02

OTONABEE RIVER
BRIDGE (W.B.L.)
GENERAL ARRANGEMENT

SHEET
15

NOTES

REINFORCING STEEL
REINFORCING STEEL SHALL BE OF GRADE 470
UNLESS OTHERWISE SPECIFIED. BARS MARKED
WITH THE SUFFIX 'C' SHALL BE COATED
BARS.

CLASS OF CONCRETE
DECK, BARRIER WALLS, ABUTMENTS,
WINGWALLS, PIER FOOTINGS AND
PIERS
REMAINDER 30 MPa
20 MPa

CLASS COVER TO REINFORCING STEEL
FOOTINGS 100 ± 25 mm
ABUTMENTS & WINGWALLS:
FRONT FACE 80 ± 20 mm
BACK FACE 70 ± 20 mm
PIERS 80 ± 20 mm
DECK: TOP 70 ± 20 mm
BOTTOM 40 ± 10 mm
BARRIER WALLS 70 ± 20 mm
APPROACH SLABS 70 ± 20 mm
UNLESS OTHERWISE NOTED ON DRAWINGS.

CONSTRUCTION NOTES
THE CONTRACTOR SHALL FINISH THE
BEARING SEATS DEAD LEVEL TO THE
SPECIFIED ELEVATIONS TO A TOLERANCE
OF ± 3 mm.

LIST OF DRAWINGS

- 26-458-61-
- 1 GENERAL ARRANGEMENT
- 2 SOLE HOLE LOCATIONS & SOIL STRATA
- 3 SECTIONS & SOIL STRATA
- 4 FOOTING LAYOUT
- 5 PIER #2 & #3-FOOTINGS
- 6 WEST ABUTMENT
- 7 EAST ABUTMENT
- 8 PIER #1
- 9 PIERS #2, #3 & #1
- 10 BEARINGS
- 11 STRUCTURAL STEEL I
- 12 STRUCTURAL STEEL II
- 13 STRUCTURAL STEEL III
- 14 DECK
- 15 DECK SCREED ELEVATIONS
- 16 WEST ABUTMENT EXPANSION JOINT
- 17 BARRIER WALL
- 18 6000 mm APPROACH SLAB
- 19 PILE DRIVING - STEAM & DIESEL HAMMERS
- 20 BRIDGE DATA & SITE NUMBER DATA
- 21 AS CONSTRUCTED ELEV. & DIM.
- 22 STANDARD DETAILS
- 23 DETAILS OF CONC. SLOPE PAVING
- 24 ELECTRICAL EMBEDDED WORK

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED
BELOW FOR THE APPROPRIATE CONCRETE
LUMP SUM TENDER ITEMS:

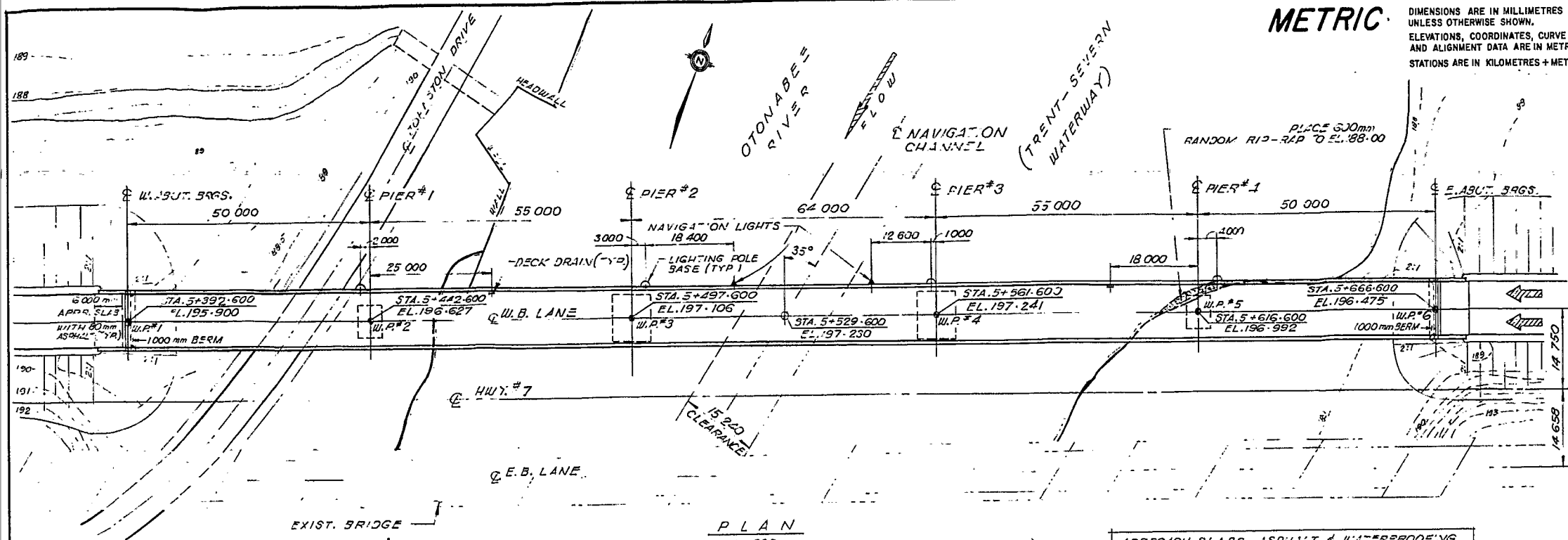
CONCRETE IN PIERS, ABUTMENTS
& WINGWALLS 367 m³
CONCRETE IN DECK 737 m³
CONCRETE IN BARRIER WALLS 172 m³
CONCRETE IN APPROACH SLABS 32 m³
CONCRETE IN SLOPE PAVING 9 m³

STRUCTURAL STEEL QUANTITY
586 TONNE

B.M. M.T.C. 75-171 (ON BRIDGE)

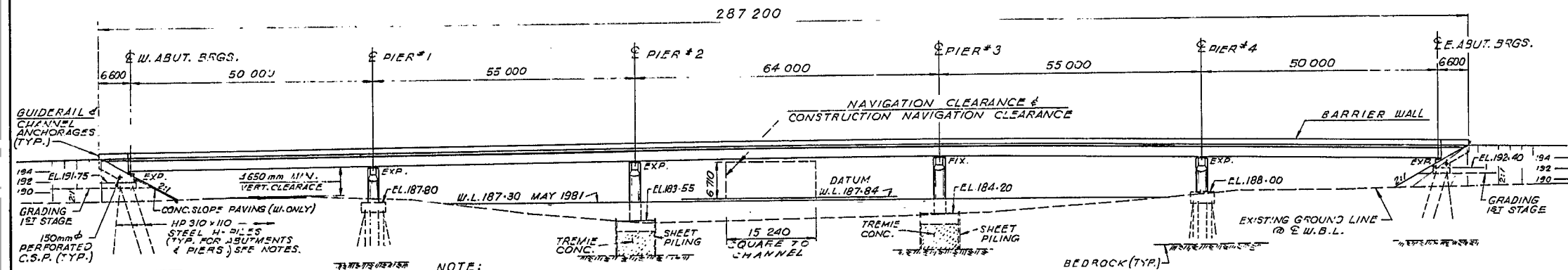
EL. 195.213

TABLET IS SET HORIZONTALLY IN THE
NORTH FACE OF THE EAST ABUTMENT
OF THE EXISTING OTONABEE RIVER
BRIDGE, BEING 1.04 m WEST OF THE
NORTH EAST CORNER AND 21 cm BELOW
THE TOP OF COPING.



NOTE:
FOR PROFILE & ALIGNMENT
OF JOHNSTON DRIVE SEE
GRADING DRAWINGS.

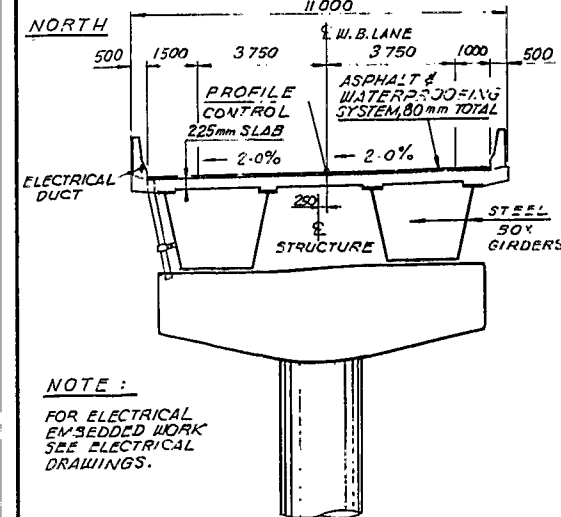
APPROACH SLABS, ASPHALT & WATERPROOFING
NOT PART OF THIS CONTRACT



NOTE:
ALL PILES TO BE DRIVEN IN
ACCORDANCE WITH STANDARDS
SS 103-11 USING AN ULTIMATE
CAPACITY OF 2940 kN
PER PILE BUT SHALL BE
DRIVEN TO ELEVATIONS GIVEN BELOW:
W. ABUTMENT 178.50
PIER #1 179.50
PIER #4 182.00
E. ABUTMENT 183.00

NOTE:

BACKFILL MATERIAL IN THE
AREA OF THE ABUTMENT PILES
SHALL BE RESTRICTED TO
A MAXIMUM GRADATION OF 75 mm.



NOTE:
FOR ELECTRICAL
EMBEDDED WORK
SEE ELECTRICAL
DRAWINGS.

TYP. DECK SECTION
1:100

ELEVATION
1:500

PROFILE @ E.W.B. LANE
N.T.S.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE BY	DESCRIPTION
DESIGN P.O.L.	CHECK M.G.	LOADING CHDCA-79 DATE 8/8/89
DRAWING L.S.	CHECK P.O.L.	SITE No 26-458-61 DWG 1

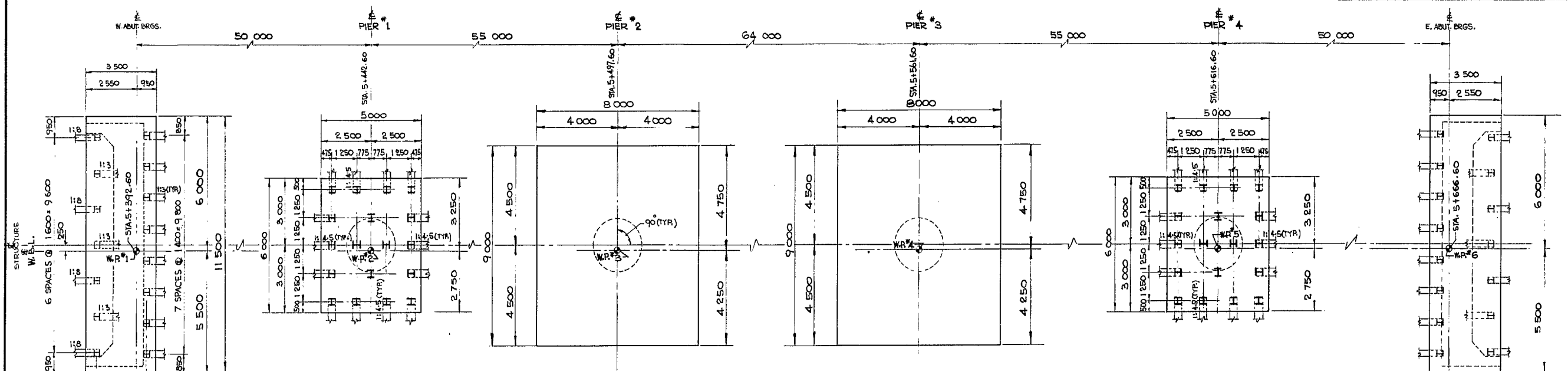
DIST. 7
 CONT No 82-89
 WP No 19-81-02

METRIC

DIMENSIONS ARE IN MILLIMETRES
 UNLESS OTHERWISE SHOWN.
 ELEVATIONS, COORDINATES, CURVE
 AND ALIGNMENT DATA ARE IN METRES.
 STATIONS ARE IN KILOMETRES + METRES.

OTONABEE RIVER BRIDGE
 (W.B.L.)
 FOOTING LAYOUT

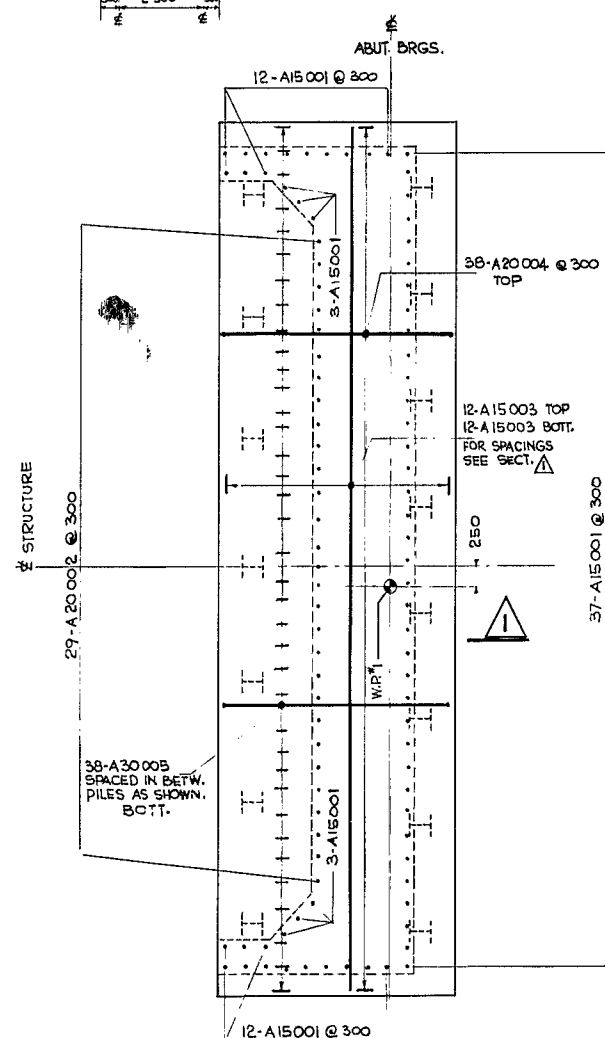
SHEET
 18



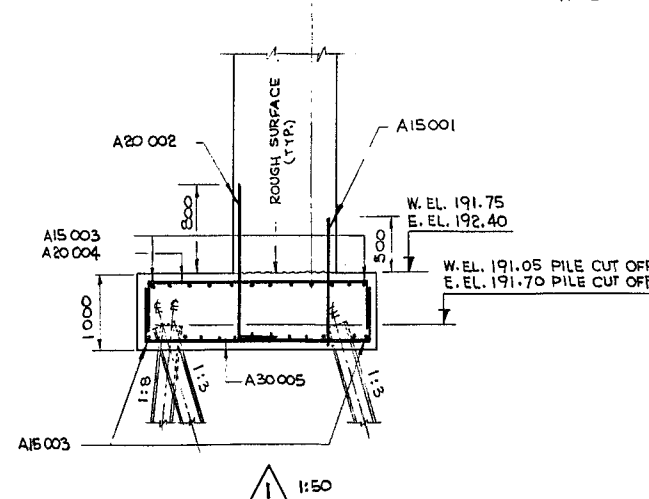
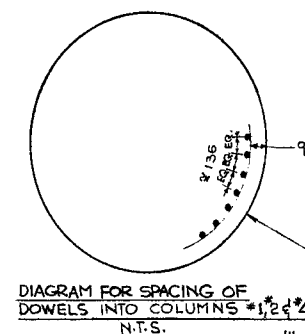
FOOTING LAYOUT
 1:100

NOTES:
 * PILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTINGS.
 * CONTRACTOR SHOULD BE AWARE OF THE POSSIBLE BOILING PROBLEM
 DURING DEWATERING THE FOOTING EXCAVATION FOR PIER #1 & #4.
 * CONTRACTOR SHOULD NOT DO DEWATERING
 WHEN WATER ELEVATION IS ABOVE 187.50 m.

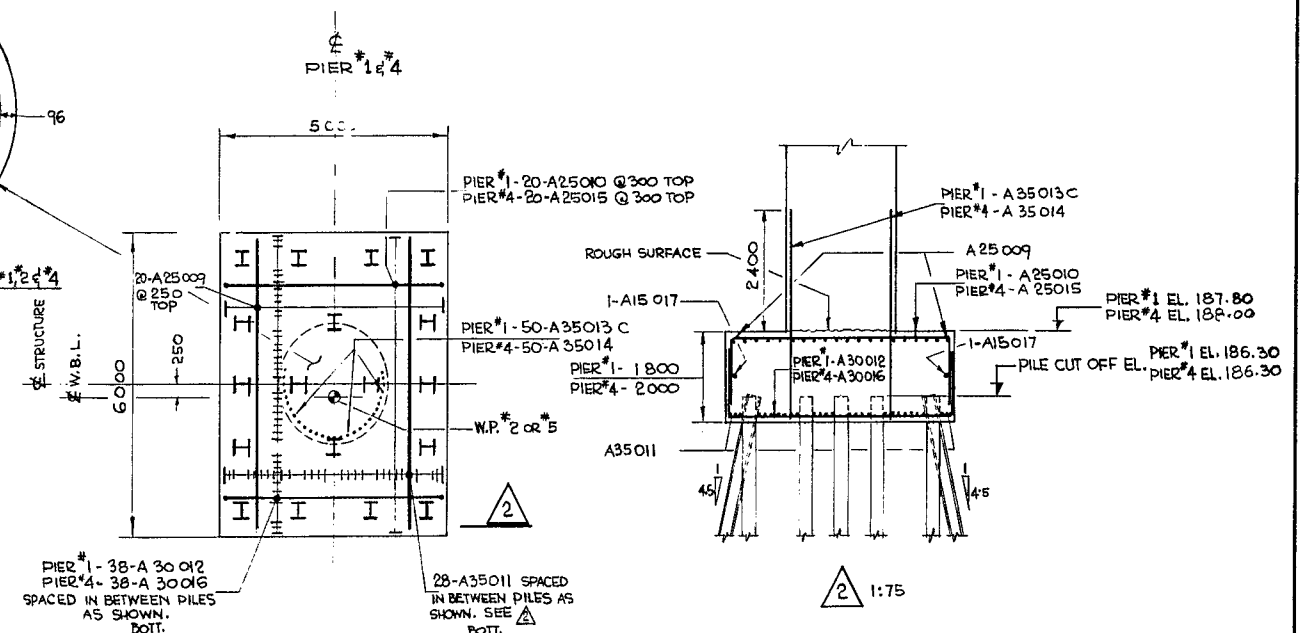
SIMILAR TO W. ABUTMENT



PLAN OF ABUTMENT
FOOTING
 1:50



1:50



PLAN
 1:75



DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

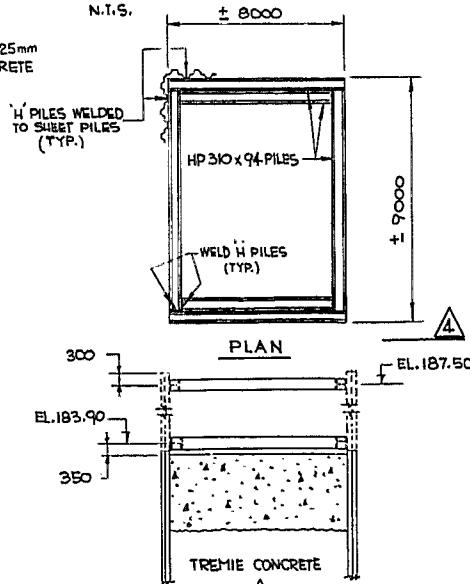
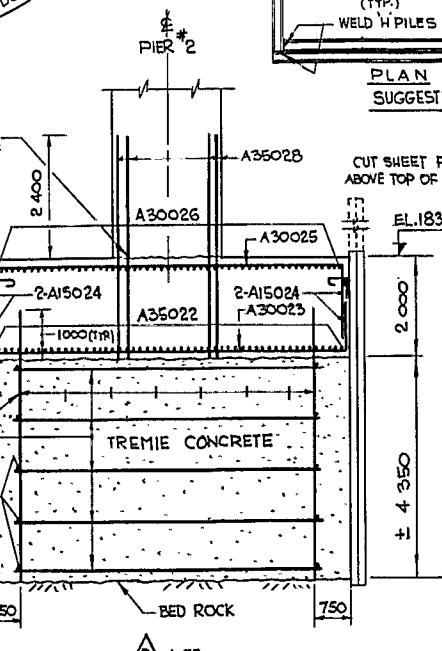
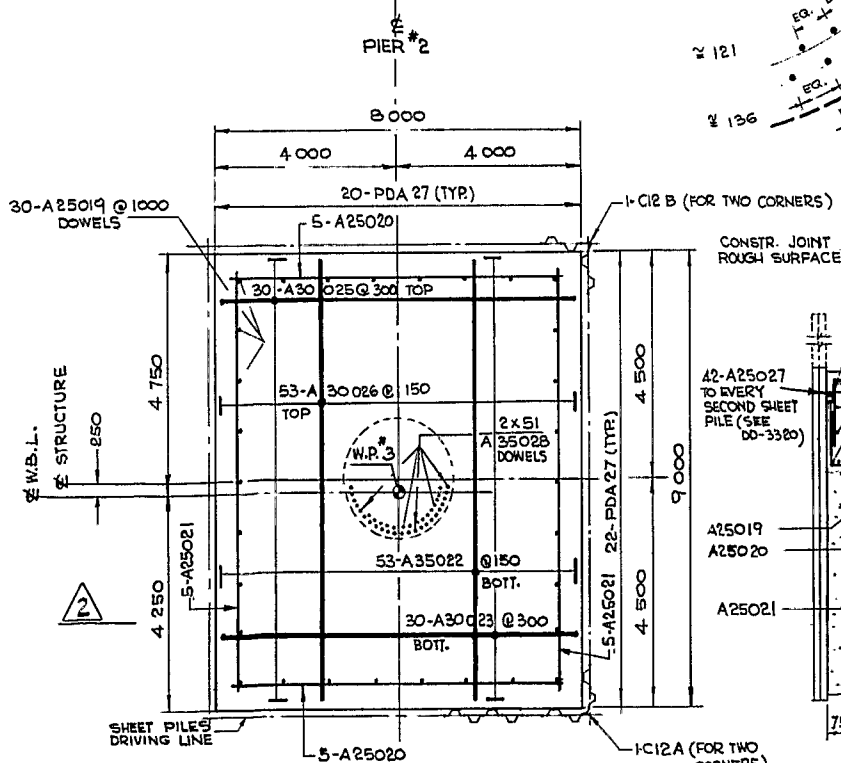
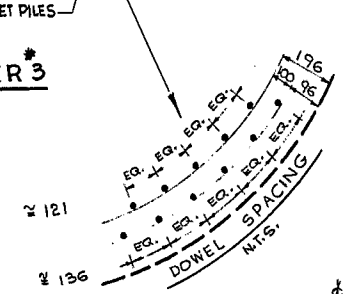
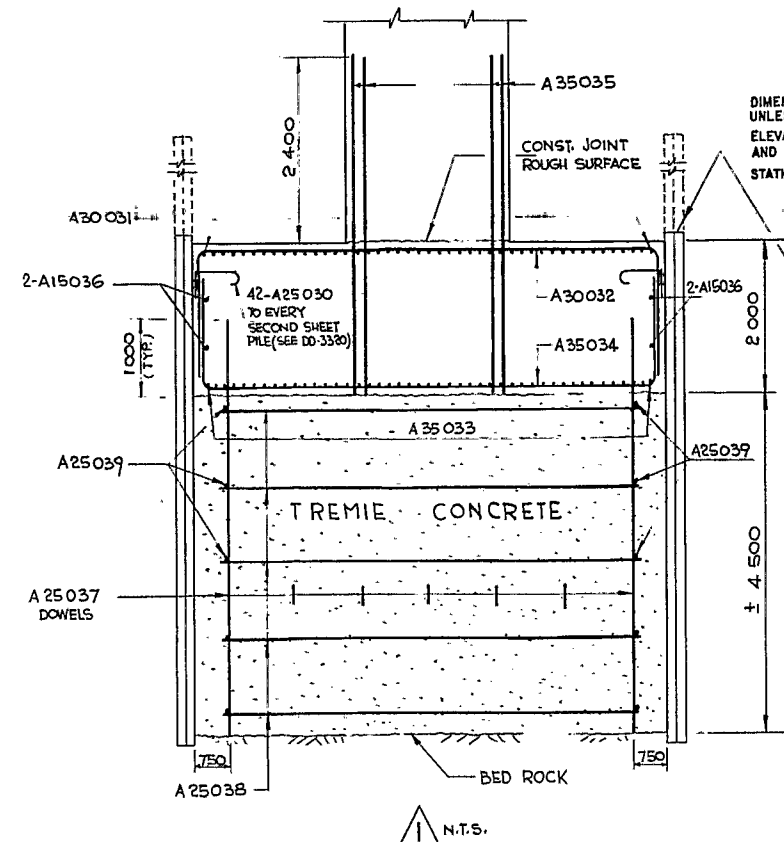
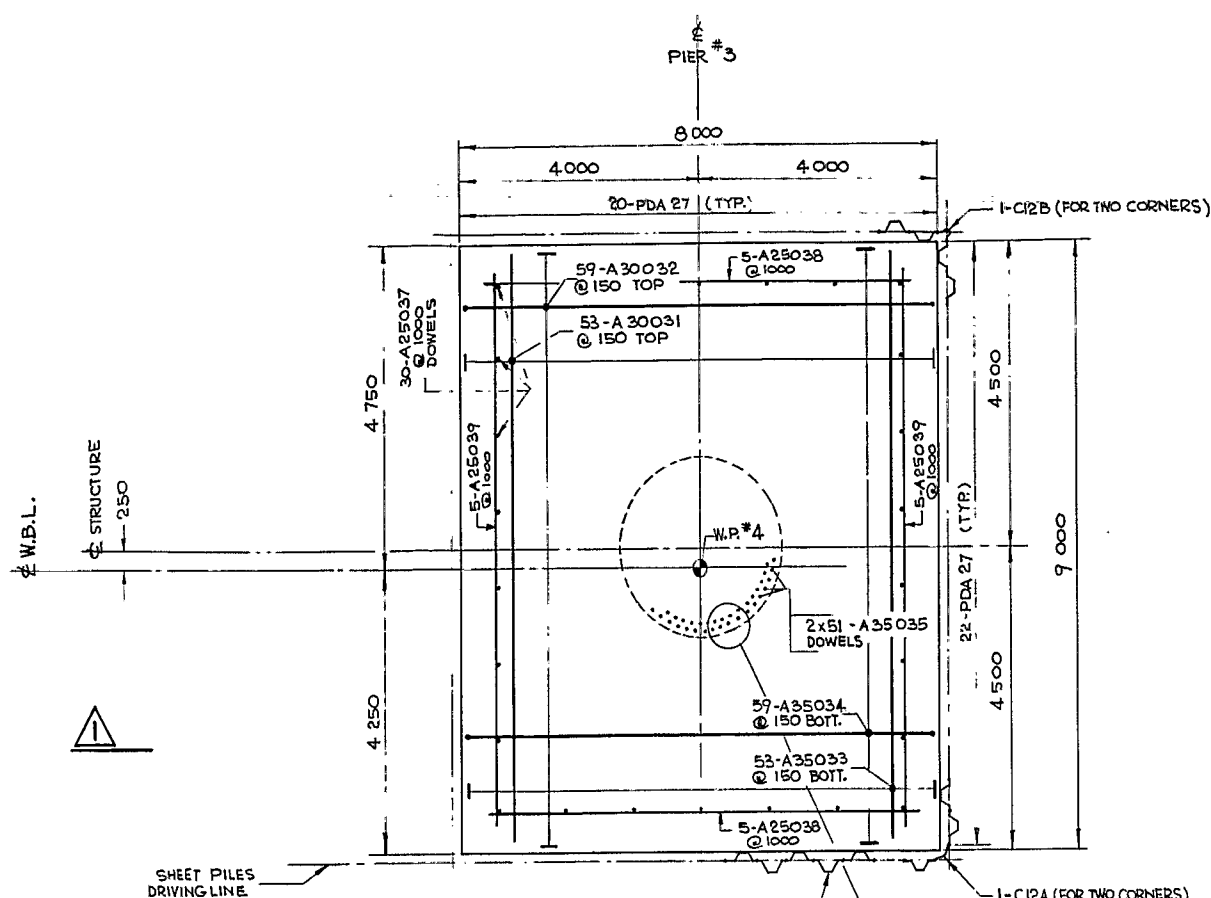
DESIGN: T.C. TAM CHECK: M.G. LOADING: 0.8-1.7-1.7 DATE: FEB 89
 DRAWING: A. CHECK: SITE 26-458-61 DWG 4

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

CUT SHEET PILES 25mm
ABOVE TOP OF CONCRETE

- NOTES:**
- EXCAVATIONS FOR PIERS MUST BE CLEAR OF ANY FOREIGN MATERIAL PRIOR TO PLACING TREMIE CONCRETE.
 - SHEET PILES TO BE DRIVEN TO BEDROCK.
 - SHEET PILES ARE NOT DESIGNED TO PENETRATE THE COBBLES, BOULDERS OR ROCK FRAGMENTS. REMOVAL OF COBBLES, BOULDERS AND ROCK FRAGMENTS MIGHT BE NECESSARY TO INSTALL SHEET PILES.



PILE DATA									
LOCATION	Nº	BATER	LENGTH (mm)	CUT OFF ELEVATION	TYPE	PILE DESIGN DATA LOAD @ 5% FACTORED TYPE II	PILE CONST. DATA FACTORED CAPACITY @ ULS	PILE CONST. DATA ULTIMATE CAPACITY	REMARKS
W. ABUT.	4	1:1.8	13 000	191.05	HP 310x110	980 KN/PILE	1600 KN/PILE	2940 KN/PILE	WITH DRIVING SHOES
	11	1:1.3	13 500						
PIER #1	4	STR.	7 000	186.30	HP 310x110	DO	DO	DO	DO
	14	1:1.4.5	7 500						
PIER #4	4	STR.	4 500	186.30	HP 310x110	DO	DO	2940 KN/PILE	DO
	14	1:1.4.5	4 500						
E. ABUT.	4	1:1.8	9 000	191.70	HP 310x110	DO	DO	DO	DO
	11	1:1.3	9 500						

NOTE: PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW CUT-OFF ELEVATION.

SHEET PILE DATA			
LOCATION	TYPE	Nº	LENGTH LEFT IN PLACE
PIER #2	PDA 27	84	
	C12 A	2	6400
	C12 B	2	
PIER #3	PDA 27	84	
	C12 A	2	6550
	C12 B	2	



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN: T.C. TAM CHECK: M.G. LOADING: H.A.D.C. DATE: FEB. 82
DRAWING: A. CHECK: A.V. SITE: 26-458-61 DWG: 5