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W.P. No. 195-80-02

CONT. No. 83-19

W. O. No.

STR. SITE No. 17-77

HWY. No. 401 EBL

LOCATION Millhaven Creek

No. of PAGES - 1

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - 19

Ontario
Ministry of
Transportation and
Communications

INDEX

NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

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 (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

FOUNDATION INVESTIGATION REPORT

For

Millhaven Creek, Hwy. 401 E.B.L.
W.P. 195-80-02, Site 17-77
District 8, Kingston

INTRODUCTION

This report contains the results of a foundation investigation that was performed at the above-mentioned site. The fieldwork for the proposed widening was carried out on 81 06 04 and consisted of four test pits. These test pits were all excavated through a thin veneer of overburden to bedrock using a 580 Case Construction King backhore.

SITE DESCRIPTION

The site is located approximately 0.3 kilometres west of Wilton Road on Highway 401 E.B.L. in the Township of Ernestown, County of Lennox and Addington.

The existing bridge is an approximate 17 x 13 metre single span rigid frame structure. The structure is presently in good condition, showing no signs of foundation distress. At the location, Millhaven Creek flows southerly at an almost negligible rate of velocity. At the time of the foundation investigation, the depth of the water was generally in the order of 1 metre which indicates a water level at elevation 123.8. The creek bed is flat, about 17 metres wide at this location and limestone bedrock is observed immediately beneath a thin layer of muck. The creek banks are in the order of 3.5 metres high with slopes of 2:1.

Land use in the vicinity is predominantly agricultural and the topography is relatively flat.

Physiographically, the site is located in the region known as the Napanee Plains which is characterized by a flat to undulating plain of limestone.

SUBSURFACE CONDITIONS

The site is covered by a surficial deposit of topsoil lined with a layer of rip-rap and underlain by a layer of silty sand to silty clay of low plasticity with sand and gravel ranging in depth from 3.7 metres to 150 mm. Competent bedrock underlying the surficial deposit was found by the use of a 580 Case Construction King backhoe.

The boundaries between the various soil types are shown on the attached Record of Test Pit Sheets. The locations and elevations of the test pits, along with estimated stratigraphical sections based on the test pit data, is shown on Drawing No. 2.

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

Silty Sand to Silty Clay (Fill)

The subsurface conditions across the site were found to be generally uniform. Beyond the limits of the creek on the south banks, the subsoil consists of a surficial deposit of topsoil lined with a layer of rip-rap and underlain by a layer of silty sand to silty clay of low plasticity (SM - CL), with some gravel ranging in depth from 3.7 metres at the top of the embankment to 150 mm at the toe of the slope.

Bedrock

Immediately below this surficial deposit can be found a generally flat, sound limestone bedrock except on the southeast bank

where immediately above the sound bedrock a fairly large 150 mm thick limestone slab was upheaveled with the use of the backhoe. Although no rock cores were obtained, other studies in the immediate area describe the limestone bedrock as very hard to hard medium grey colour with numerous irregular shale partings and small calcite crystals present. The bedrock is generally estimated to have an excellent quality.

The surface of the bedrock is below elevation 122.0 to 122.5 dipping to lower elevations as it approaches the existing footings. The exact bedrock profile in the vicinity of the existing southeast and southwest footings are indicated on Record of Test Pits No. 1 to 4.

GROUNDWATER CONDITIONS

In view of the proximity of the creek to the test pits and the shallow nature of the bedrock, groundwater levels at the proposed footing locations can be assumed to reflect the prevailing creek water levels. The creek water level at the time of the investigation (81 06 04) was at elevation 123.8.

M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

RECORD OF TEST PIT NO 1

JOB NO _____ LOCATION Millhaven Crk & Hwy401 EBL ORIGINATED BY: N.S.

W.P 195-80-01 DATE 81-06-04 ELEV. See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

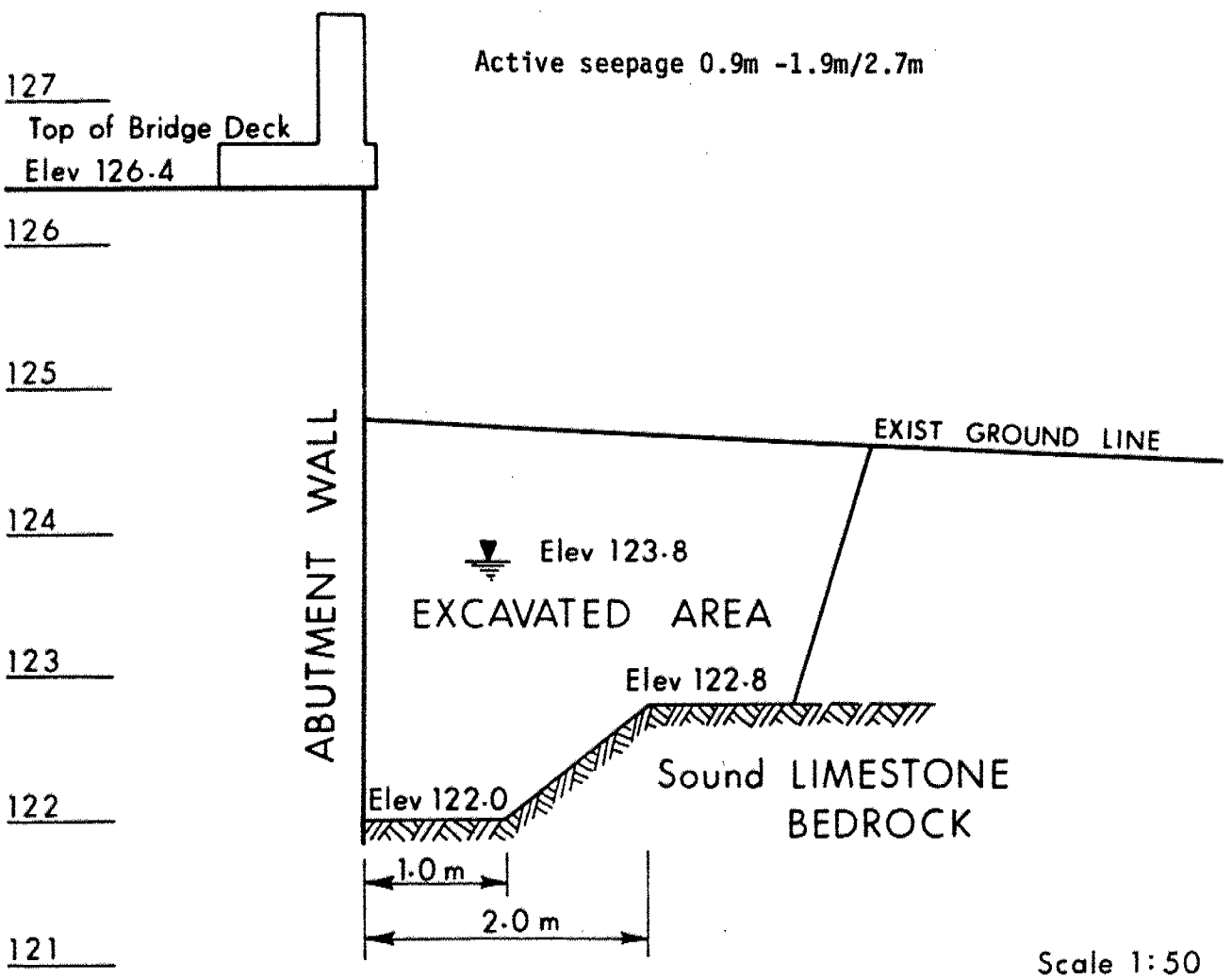
TIME OF EXCAVATION _____

SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil intermingled with rip-rap
0.5m - 1.9/2.7m	Silty Sand with some clay and traces of gravel (fill)
1.9m/2.7m	Sound Limestone Bedrock

OBSERVATIONS

REMARKS



NOTE : For Test Pit Dimension See Above

RECORD OF TEST PIT NO. 2

JOB NO. _____ LOCATION Millhaven Crk & Hwy401 EB ORIGINATED BY: N.S.

W. P. 195-80-02 DATE 81-06-04 ELEV. See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

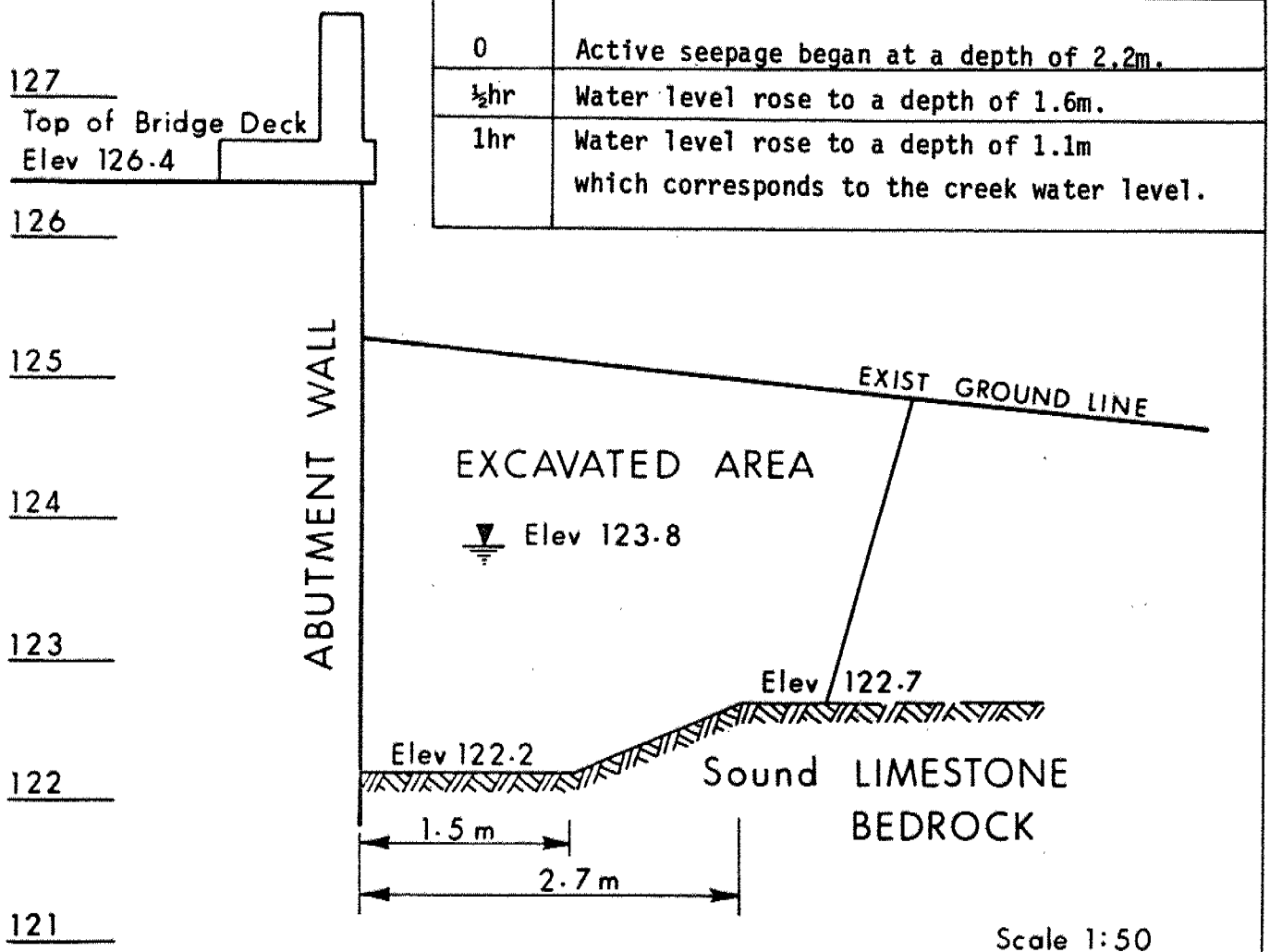
TIME OF EXCAVATION _____

SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil
0.5m - 2.2/3.1m	Silty Clay of low plasticity with sand and traces of gravel (fill)
2.2m/3.1m	Sound Limestone Bedrock

OBSERVATIONS

TIME	REMARKS
0	Active seepage began at a depth of 2.2m.
½hr	Water level rose to a depth of 1.6m.
1hr	Water level rose to a depth of 1.1m which corresponds to the creek water level.



NOTE : For Test Pit Dimension See Above

RECORD OF TEST PIT NO. 3

JOB NO. _____ LOCATION Millhaven Crk & Hwy401 EB ORIGINATED BY: N.S.

W. P 195-80-02 DATE 81-06-04 ELEV. See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

TIME OF EXCAVATION _____

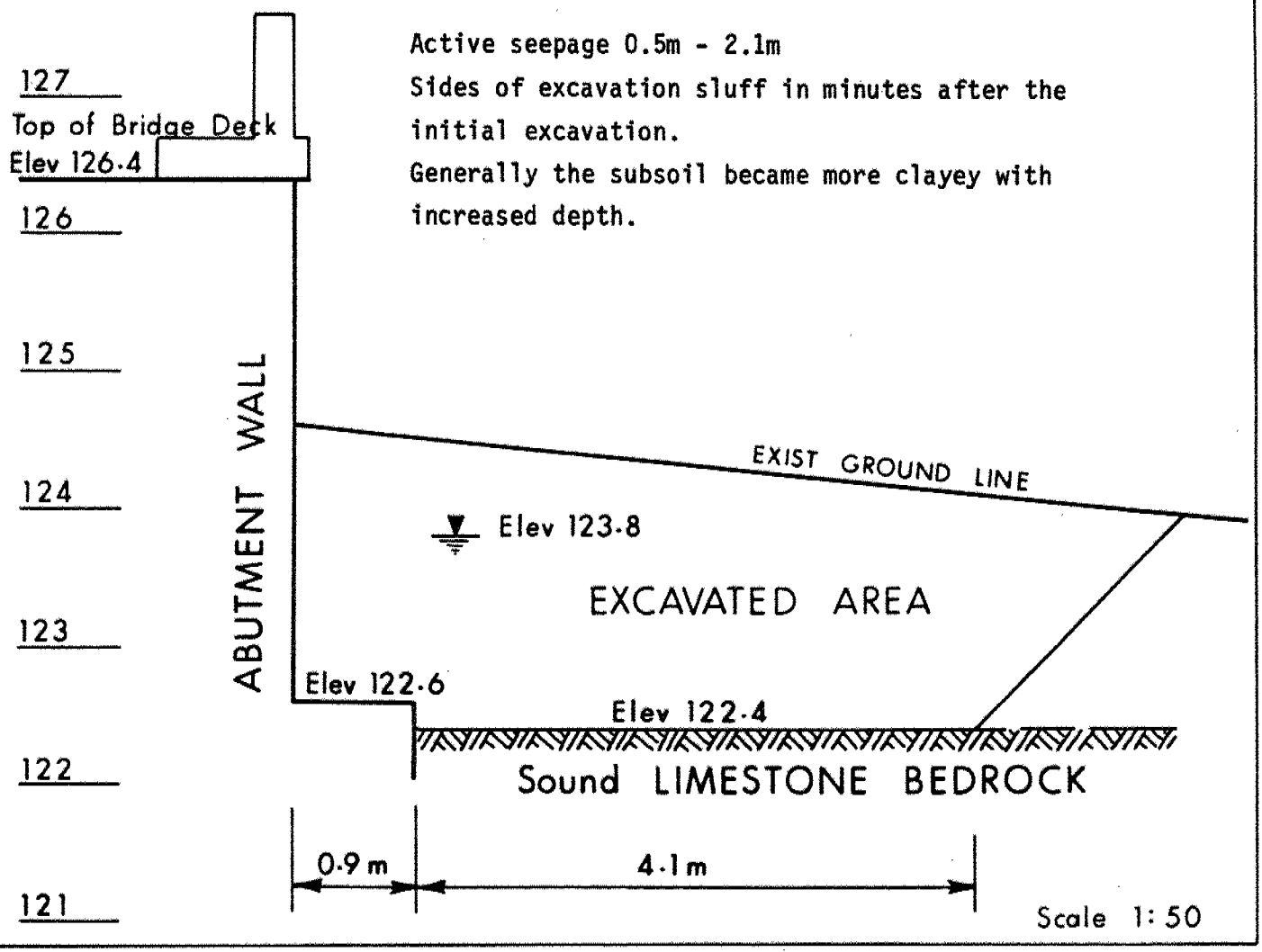
SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil intermingled with rip-rap
0.5m - 2.1m	Silty Sand with some clay and gravel (fill)
2.1m	Sound Limestone Bedrock, generally flat

OBSERVATIONS

REMARKS

Active seepage 0.5m - 2.1m
Sides of excavation sluff in minutes after the initial excavation.
Generally the subsoil became more clayey with increased depth.



NOTE : For Test Pit Dimension See Above

RECORD OF TEST PIT NO 4

JOB NO. _____ LOCATION Millhaven Crk & Hwy 401 EB ORIGINATED BY: N.S.

W P. 195-80-02 DATE 81-06-04 ELEV See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

TIME OF EXCAVATION _____

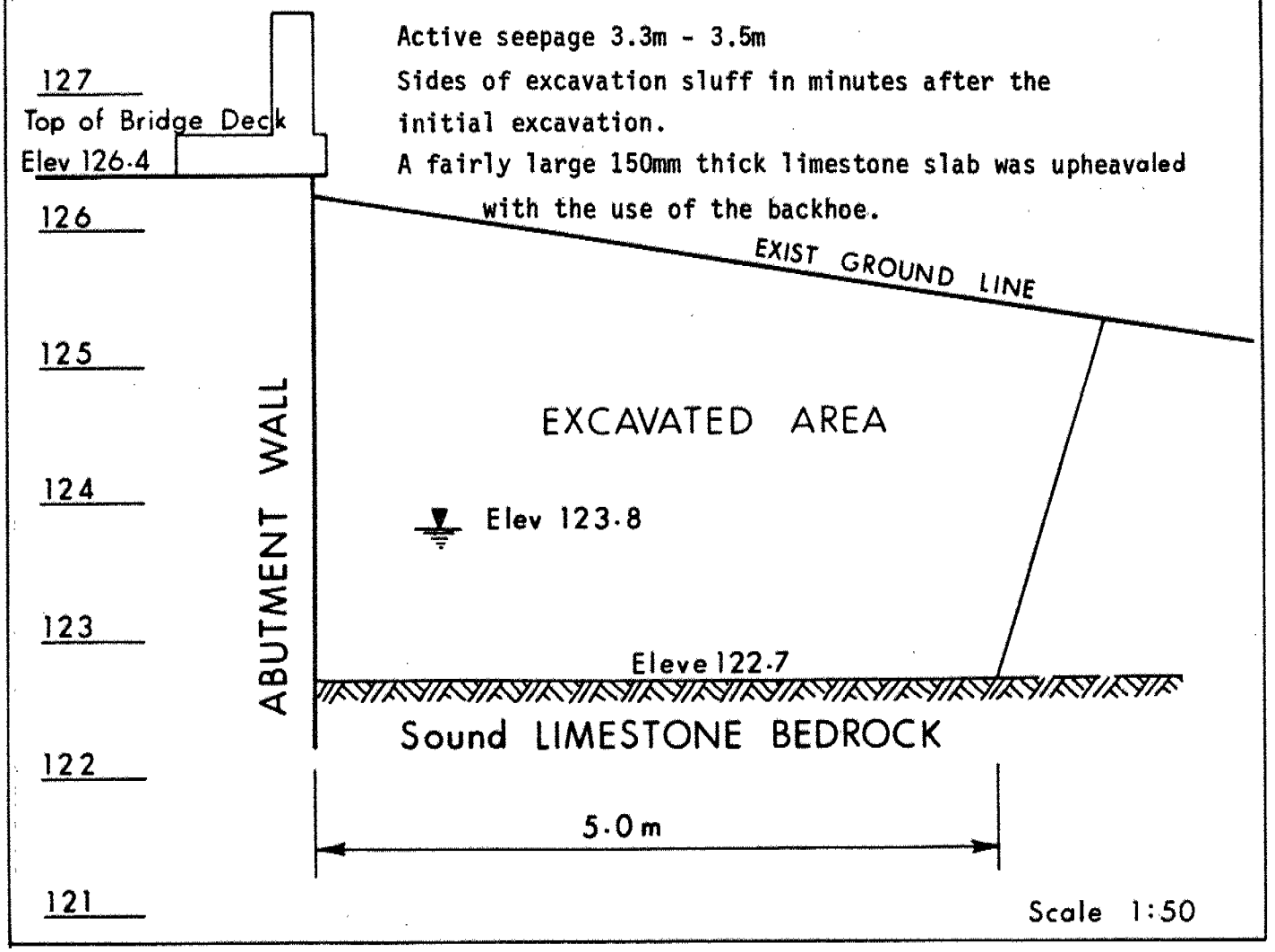
SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil
0.5m - 3.5m	Silty Clay of low plasticity with sand and gravel (fill)
3.5m	Sound Limestone Bedrock, generally flat

OBSERVATIONS

REMARKS

Active seepage 3.3m - 3.5m
Sides of excavation sluff in minutes after the initial excavation.
A fairly large 150mm thick limestone slab was upheavaled with the use of the backhoe.



NOTE : For Test Pit Dimension See Above

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 195-80-02 DIST 8

HWY 401 E. B. L. STR SITE 17-77

Millhaven Creek

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GEOCRES 31C - 138

DATE SEP 04 1981

FOUNDATION INVESTIGATION REPORT

For

Millhaven Creek, Hwy 401 E. B. L.
W. P. 195-80-02, Site 17-77
District 8, Kingston

INTRODUCTION

This report contains the results of a foundation investigation that was performed at the above-mentioned site and provides recommendations regarding the structure widening foundations and the related earthworks. The fieldwork for the proposed widening was carried out on 81 06 04 and consisted of four test pits. These test pits were all excavated through a thin veneer of overburden to bedrock using a 580 Case Construction King backhoe.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 0.3 kilometers west of Wilton Road on Highway 401 E. B. L. in the Township of Ernestown, County of Lennox and Addington.

The existing bridge is an approximate 17 x 13 metre single span rigid frame structure. The structure is presently in good condition, showing no signs of foundation distress. At the location, Millhaven Creek flows southerly at an almost negligible rate of velocity. At the time of the foundation investigation, the depth of the water was generally in the order of 1 metre which indicates a water level at elevation 123.8. The creek bed is flat, about 17 metres wide at this location and limestone bedrock is observed immediately beneath a thin layer of muck. The creek banks are in the order of 3.5 metres high with slopes of 2:1.

Land use in the vicinity is predominantly agricultural and the topography is relatively flat.

Physiographically, the site is located in the region known as the Napanee Plains which is characterized by a flat to undulating plain of limestone.

SUBSURFACE CONDITIONS

The site is covered by a surficial deposit of topsoil lined with a layer of rip-rap and underlain by a layer of silty sand to silty clay of low plasticity with sand and gravel ranging in depth from 3.7 metres to 150 mm. Competent bedrock underlying the surficial deposit was found by the use of a 580 Case Construction King backhoe.

The boundaries between the various soil types are shown on the attached Record of Test Pit Sheets. The locations and elevations of the test pits, along with estimated stratigraphical sections based on the test pit data, is shown on Drawing No. 1958002-A.

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

Silty Sand to Silty Clay (Fill)

The subsurface conditions across the site were found to be generally uniform. Beyond the limits of the creek on the south banks, the subsoil consists of a surficial deposit of topsoil lined with a layer of rip-rap and underlain by a layer of silty sand to silty clay of low plasticity (SM - CL), with sand and gravel ranging in depth from 3.7 metres at the top of the embankment to 150 mm at the toe of the slope.

Bedrock

Immediately below this surficial deposit can be found a generally flat, sound limestone bedrock except on the southeast bank

where immediately above the sound bedrock a fairly large 150 mm thick limestone slab was upheavaled with the use of the backhoe. Although no rock cores were obtained, other studies in the immediate area describe the limestone bedrock as very hard to hard medium grey colour with numerous irregular shale partings and small calcite crystals present. The bedrock is generally estimated to have an excellent quality.

The surface of the bedrock is below elevation 122.0 to 122.5 dipping to lower elevations as it approaches the existing footings. The exact bedrock profile in the vicinity of the existing southeast and southwest footings are indicated on Record of Test Pits No. 1 to 4.

GROUNDWATER CONDITIONS

In view of the proximity of the creek to the test pits and the shallow nature of the bedrock, groundwater levels at the proposed footing locations can be assumed to reflect the prevailing creek water levels. The creek water level at the time of the investigation (81 06 04) was at elevation 123.8.

DISCUSSION AND RECOMMENDATIONS

The project concerns the widening on the south side of the existing 17 metre clear span rigid frame structure which is located at the crossing of Highway 401 E. B. L. and Millhaven Creek just north of the Town of Odessa.

In view of the relatively shallow surficial deposits overlying the competent bedrock, our recommendations pertaining to the foundations and earthworks of the proposed widening are as follows:

Structure Foundations

The proposed structure widening can be supported on spread footings placed within the sound bedrock. To ensure that the footing

is located on sound bedrock, the footing should be located at least 150 mm below the existing bedrock surface or at least 50 to 100 mm below the previous founding level. If loose rock is encountered at the footing founding level, this deleterious material shall be completely removed and brought up to the founding level by mass concrete. If sloped bedrock is encountered at the footing founding level, as is the case at the southwest abutment location, this bedrock is to be removed and brought up to the founding level by mass concrete. Spread footings constructed in such a manner can be designed using an allowable load of 2400 kPa. In accordance with O. H. B. D. C., the factored capacity at U. L. S. is 2870 kPa. For design purposes, the bottom of footings elevation founded on competent bedrock are approximately:

Footing Location	Bottom of Footing Elevation
Southwest Abutment Footing	121.8 ±
Southeast Abutment Footing	122.2 ±

In order to resist lateral forces acting on the abutment wall and foundations, frictional forces between the footing base and horizontal bedrock surface can be calculated assuming a coefficient of friction of 0.8 against sliding. Greater lateral resistance can be achieved by keying or dowelling the footing into competent rock.

To prevent the buildup of hydrostatic pressures behind the abutment wall, backfill should be composed of well compacted free-draining granular material with provision made for adequate drainage.

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

The base of all footings should be protected from frost action by a minimum of 1.8 metres of cover.

Earth fill slopes should be constructed with 2:1 slopes with an adequate rip-rap protection scheme to protect against river scour action.

Construction Considerations

All rock surfaces within the planned limits of the foundations should be clean, free from any muck and loose rock fragments, before placement of the footings.

Any variations in bedrock surface along the full length of the abutment should be removed and levelled out through the use of mass concrete placed between the bedrock surface and the established abutment footing elevation.

In consideration of the proximity of the creek water levels, provisions should include for a temporary dewatering scheme, to facilitate the construction of the footings in the dry. This could be done by the construction of a temporary earth dyke.

No heavy vibratory compaction equipment or other heavy machinery should be allowed within a distance of twice the height of the fill at any given time.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. N. Stea, Project Foundations Engineer. The backhoe used for the investigation was owned and operated by Mr. N. Rogers, Kingston.

This report was written by Mr. N. Stea and reviewed by Mr. M. Devata, Senior Foundations Engineer.

Nick Stea

N. Stea,
Project Foundations Engineer

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

APPENDIX

RECORD OF TEST PIT NO 1

JOB NO _____ LOCATION Millhaven Crk & Hwy401 EBL ORIGINATED BY: N.S.

W P 195-80-01 DATE 81-06-04 ELEV See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

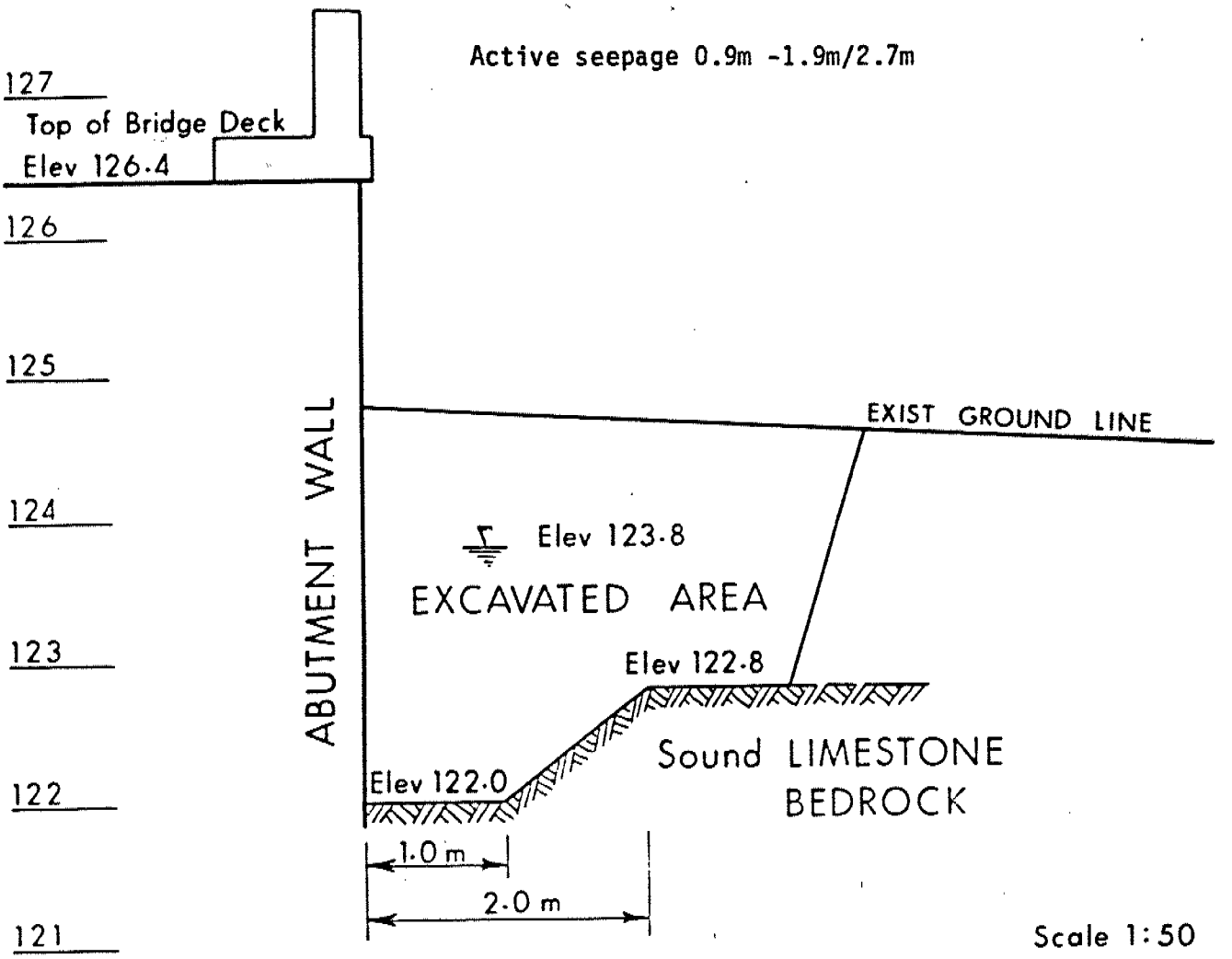
TIME OF EXCAVATION _____

SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil intermingled with rip-rap
0.5m - 1.9/2.7m	Silty Sand with some clay and traces of gravel (fill)
1.9m/2.7m	Sound Limestone Bedrock

OBSERVATIONS

REMARKS



NOTE : For Test Pit Dimension See Above

RECORD OF TEST PIT NO: 2

JOB NO _____ LOCATION Millhaven Crk & Hwy401 EB ORIGINATED BY: N.S.

W.P. 195-80-02 DATE 81-06-04 ELEV See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

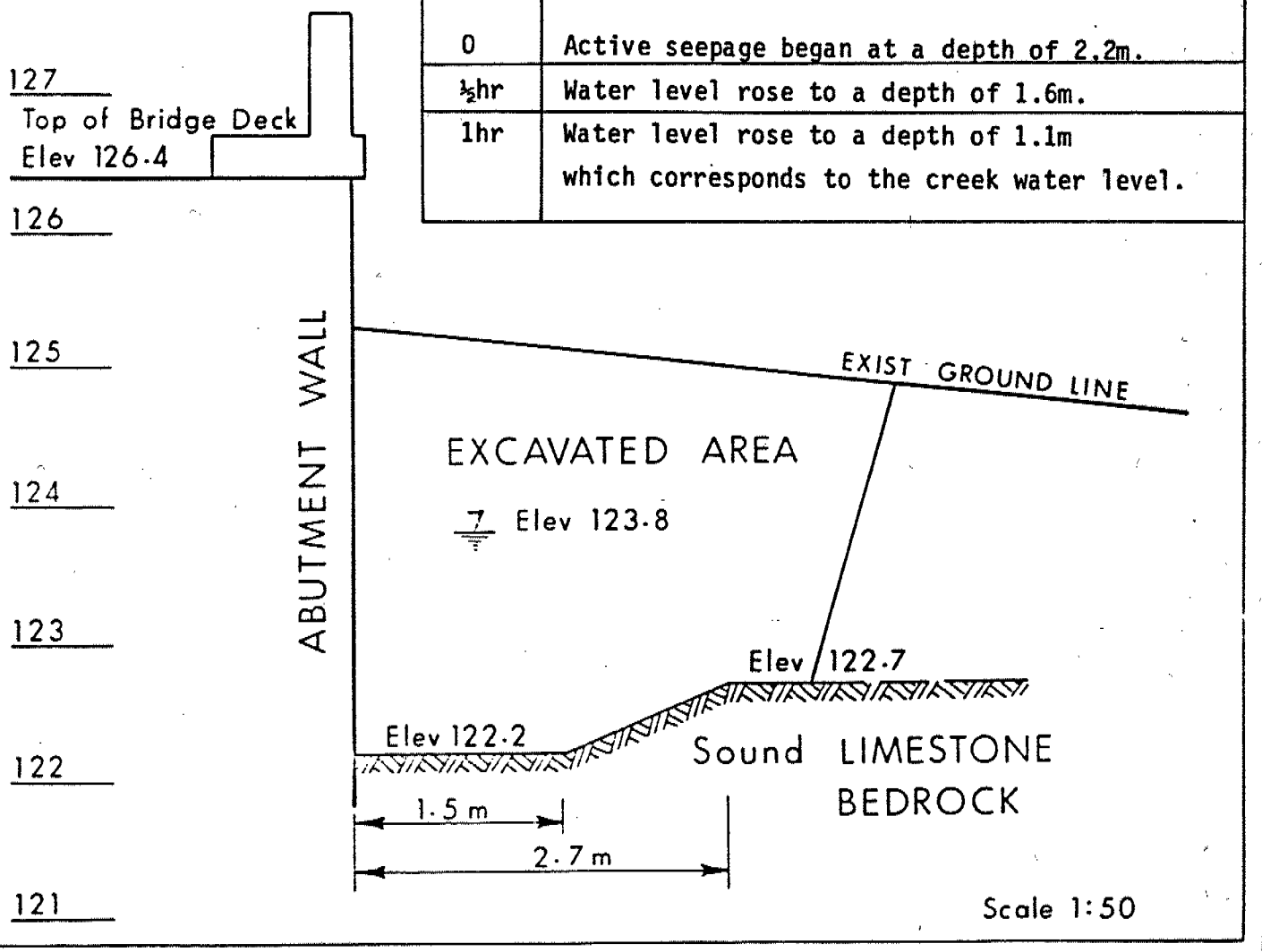
TIME OF EXCAVATION _____

SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil
0.5m - 2.2/3.1m	Silty Clay of low plasticity with sand and traces of gravel (fill)
2.2m/3.1m	Sound Limestone Bedrock

OBSERVATIONS

TIME	REMARKS
0	Active seepage began at a depth of 2.2m.
½hr	Water level rose to a depth of 1.6m.
1hr	Water level rose to a depth of 1.1m which corresponds to the creek water level.



NOTE : For Test Pit Dimension See Above

RECORD OF TEST PIT NO 3

JOB NO _____ LOCATION Millhaven Crk & Hwy401 EB ORIGINATED BY: N.S.

W P 195-80-02 DATE 81-06-04 ELEV. See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

TIME OF EXCAVATION _____

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DEPTH	SOIL DESCRIPTION
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OBSERVATIONS

REMARKS

Active seepage 0.5m - 2.1m
Sides of excavation sluff in minutes after the initial excavation.
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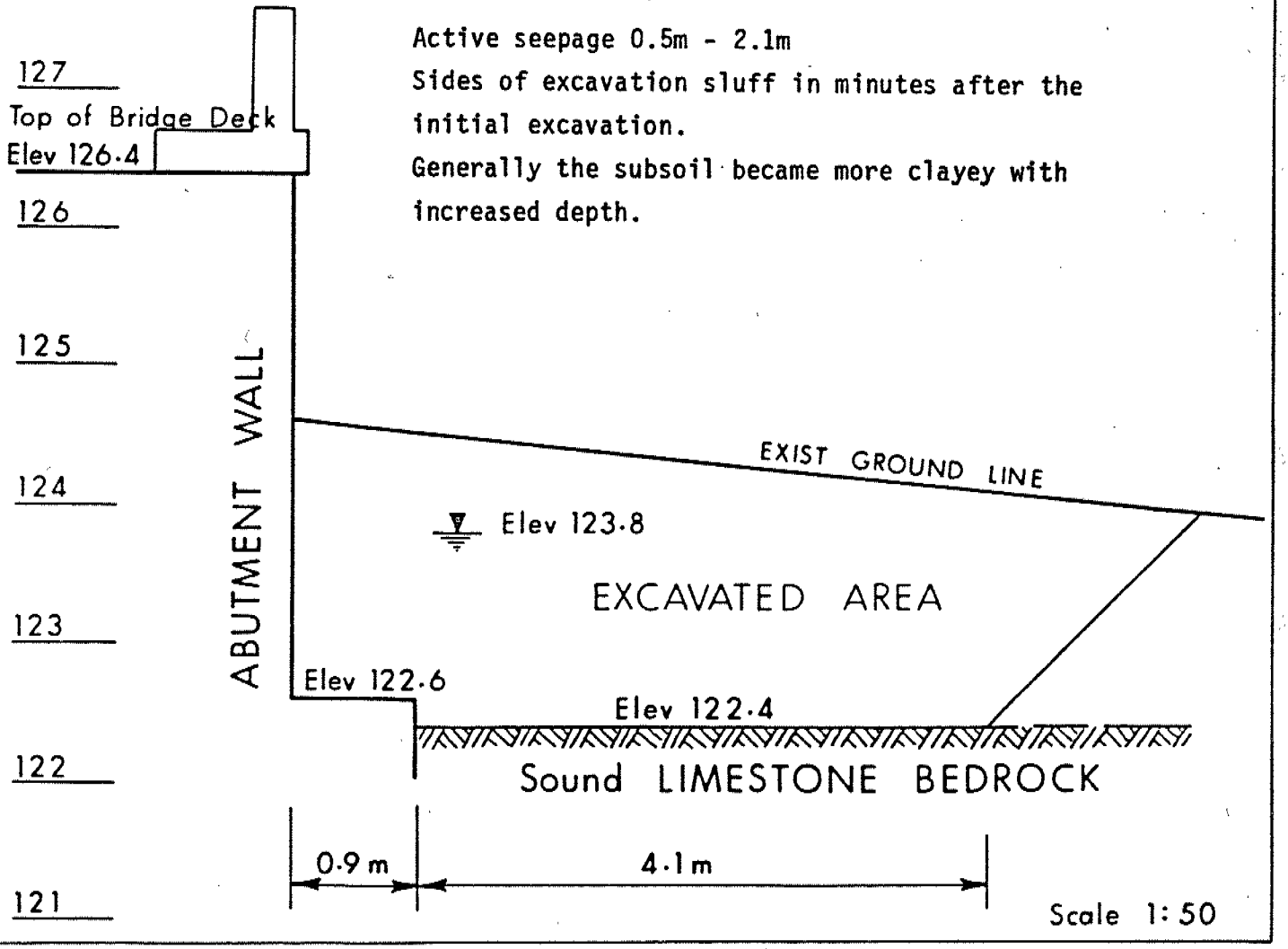

NOTE : For Test Pit Dimension See Above

JOB NO. _____ LOCATION Millhaven Crk & Hwy 401 EBL ORIGINATED BY N.S.

W P 195-80-02 DATE 81-06-04 ELEV See Section Below

MODE OF EXCAVATION 580 Case Construction King Backhoe

TIME OF EXCAVATION _____

SIMPLIFIED STRATIGRAPHY

DEPTH	SOIL DESCRIPTION
0 - 0.5m	Topsoil
0.5m - 3.5m	Silty Clay of low plasticity with sand and gravel (fill)
3.5m	Sound Limestone Bedrock, generally flat

OBSERVATIONS

REMARKS

Active seepage 3.3m - 3.5m
Sides of excavation sluff in minutes after the initial excavation.
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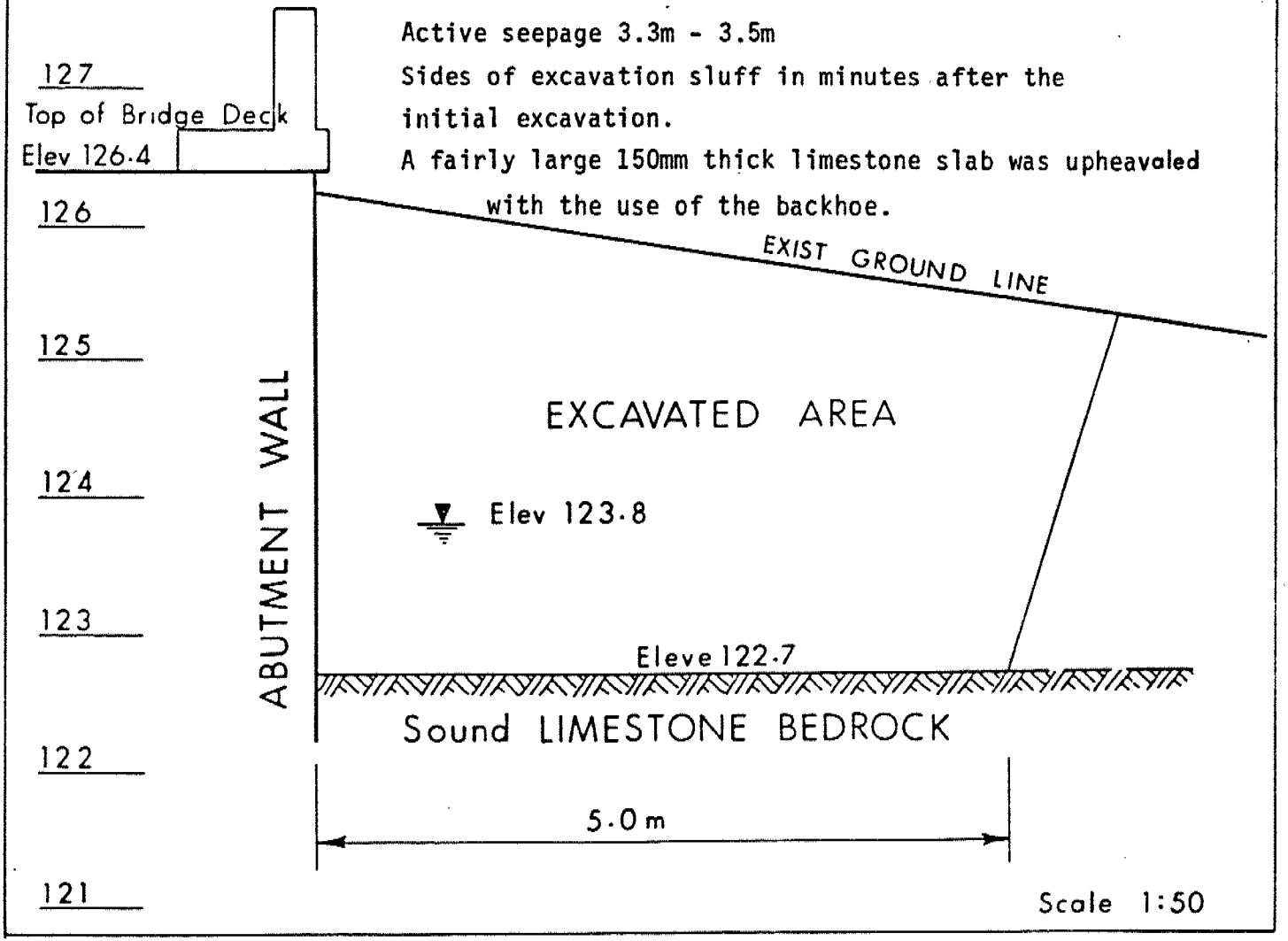


NOTE : For Test Pit Dimension See Above

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

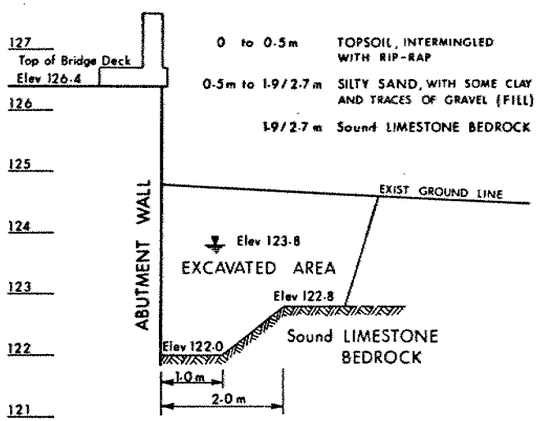
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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
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

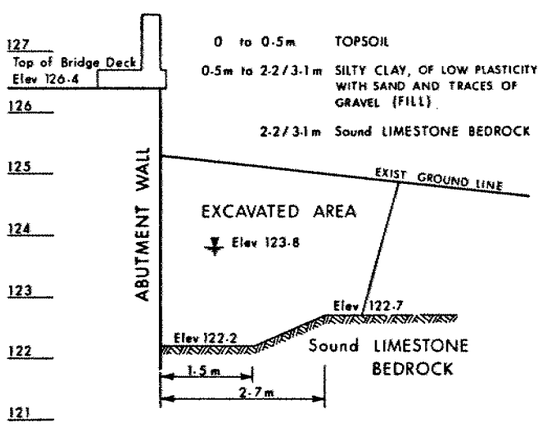


0 to 0.5m TOPSOIL, INTERMINGLED WITH RIP-RAP

0.5m to 1.9/2.7m SILTY SAND, WITH SOME CLAY AND TRACES OF GRAVEL (FILL)

1.9/2.7m Sound LIMESTONE BEDROCK

SECTION A-A (TEST PIT No 1)



0 to 0.5m TOPSOIL

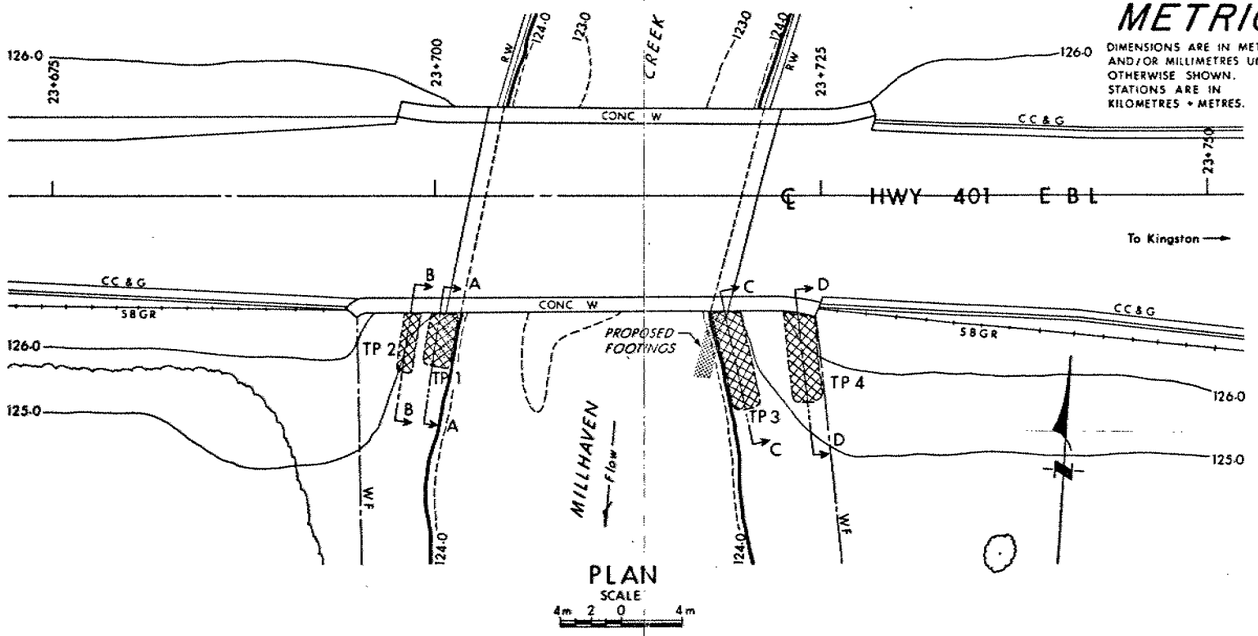
0.5m to 2.2/3.1m SILTY CLAY, OF LOW PLASTICITY WITH SAND AND TRACES OF GRAVEL (FILL)

2.2/3.1m Sound LIMESTONE BEDROCK

SECTION B-B (TEST PIT No 2)

SCALE FOR SECTIONS

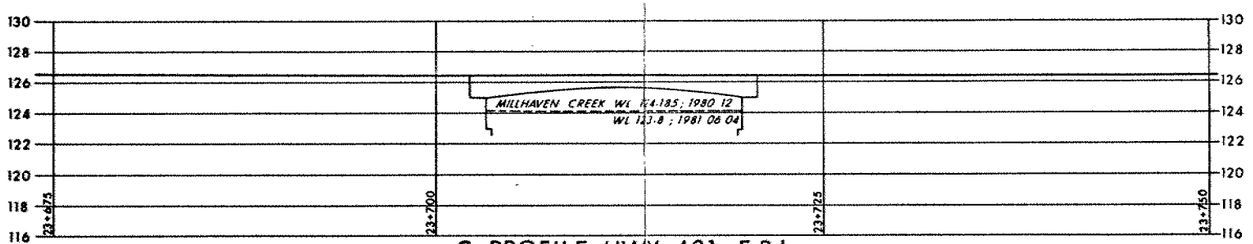
1m 0.5 0 1 2m



PLAN

SCALE

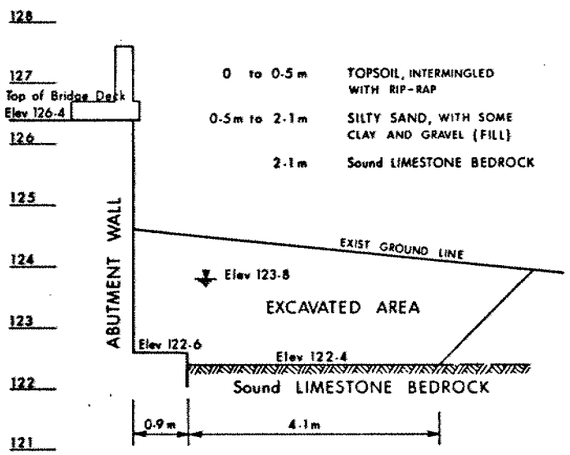
4m 2 0 4m



℄ PROFILE HWY 401 E B L

SCALE

4m 2 0 4m

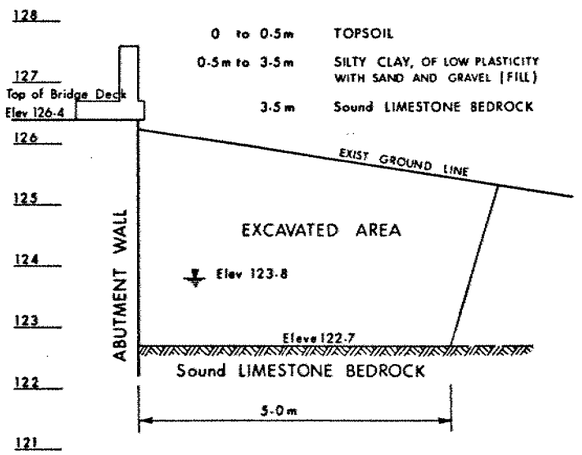


0 to 0.5m TOPSOIL, INTERMINGLED WITH RIP-RAP

0.5m to 2.1m SILTY SAND, WITH SOME CLAY AND GRAVEL (FILL)

2.1m Sound LIMESTONE BEDROCK

SECTION C-C (TEST PIT No 3)



0 to 0.5m TOPSOIL

0.5m to 3.5m SILTY CLAY, OF LOW PLASTICITY WITH SAND AND GRAVEL (FILL)

3.5m Sound LIMESTONE BEDROCK

SECTION D-D (TEST PIT No 4)

METRIC

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

CONT No

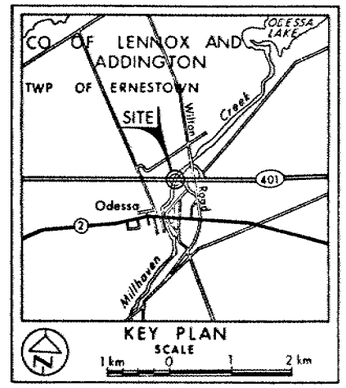
WP No 195-80-02

MILLHAVEN CREEK

(0.3 km West of Wilton Road)

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



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 1981 06 04
- Test Pit

No	ELEVATION	STATION	OFFSET
TP 1	REFER TO SECTIONS	REFER TO PLAN	
TP 2			
TP 3			
TP 4			

NOTE

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

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No 31C-138

HWY No 401 E B L		DIST 8
SUBM'D N S	CHECKED / DATE 1981 08 28	SITE 17-77
DRAWN	CHECKED / APPROVED	DWG 1958002-A

REF No E T R 18-401 ; 1981 01

memorandum

To: Mr. T.C. Kingsland
Head, Structural Planning
Eastern (Kingston) Region

Date: 82 04 16

Attn: Mr. E.C. Lane

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

Re: Millhaven Creek Widening
W.P. 195-80-02, Site 17-77
Hwy. 401, District 8, Kingston

We have reviewed the final bridge drawings Nos. 1 & 3 for the above-mentioned structure and provide the following comments:

1) An appropriate unwatering scheme will be required to control creek water infiltration and allow for placement of footings 'in-the-dry'.

2) Bedrock surface, as encountered by our investigation, should be indicated on the elevation schematic on drawing 1 and section 1 & 2 on drawing 3.

T. Kazmierowski, P. Eng.
Foundations Engineer

TK/syc

memorandum

Ontario

To: Mr. T. Kingsland
Head, Structural Section
Eastern Region, Kingston

Date: 1981 07 23

From: Pavement & Foundation Design Section
Room 313, Central Building
Downsview

Re: Millhaven Creek, Hwy. 401
Site 17-77, W.P. 195-80-01
Hwy. 401, District 8, Kingston

We have now completed the field work for the foundation investigation report pertaining to the above mentioned project as per your original request dated 81 03 09. In order to satisfy your scheduling and preliminary design requirements, this memo will summarize the subsurface conditions encountered across the site and present design recommendations regarding structure widening foundations and the related earthworks. The complete foundation investigation and design report for this site will be forwarded upon completion of laboratory testing and drafting requirements.

Subsurface Conditions

Briefly, the subsurface conditions across the site were found to be generally uniform. Beyond the limits of the creek on the south banks, the subsoil consists of a surficial deposit of topsoil lined with a layer of rip-rap and underlain by a layer of silty sand to silty clay with sand and gravel. Immediately below this layer can be found a generally flat, sound limestone bedrock except on the southeast bank where immediately above the sound bedrock a fairly large 150 ~~cm~~ mm thick limestone slab was upheaveled with the use of a 580 Case Construction King backhoe.

Although no rock cores were obtained other studies in the immediate area describe the limestone bedrock as very hard to hard medium grey colour with numerous irregular shale partings and small calcite crystals present. The bedrock is generally estimated to have an excellent quality. The surface of the bedrock is below elevation 122, to 122.5 dipping to lower elevations as it approaches the existing footings. The exact bedrock profile in the vicinity of the existing southeast and southwest footings will be provided in the final report.

Discussion and Recommendations

The project concerns the widening on the south side of the existing 17 metre clear span rigid frame structure which is located at the crossing of Highway 401 and Millhaven Creek just north of the Town of Odessa.

Recommendations pertaining to the foundations of the proposed widening and related earthworks are summarized as follows.

cont'd..../2

The proposed structure widening can be supported on spread footings placed within the sound bedrock. To ensure that the footing is located on sound bedrock, the footing should be located at least 150 ~~cm~~ mm below the existing bedrock surface or at least 5 to 10 ~~cm~~ mm below the previous founding level. If loose rock is encountered at the footing founding level this deleterious material shall be completely removed and brought up to the founding level by mass concrete. Spread footings constructed in such a manner can be designed using an allowable load of 2400 kPa. In accordance with O.H.B.D.C. the factored capacity at U.L.S. is 2870 kPa.

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

In order to construct the footings in the dry a temporary dewatering scheme will be required. This could be done by the construction of a temporary earth dyke.

To compute horizontal resistance to sliding between the rough concrete and the bedrock surface, a coefficient of friction of 0.8 may be used. If additional horizontal resistance is required the footing should be keyed into the bedrock or alternatively the footing may be dowelled to bedrock.

To prevent the build-up of hydrostatic pressures behind the abutment wall, free-draining granular material should be used for backfill.

No heavy vibratory compaction equipment or other heavy machinery should be allowed within a distance of twice the height of the fill at any given time.

The base of all footings should be protected from frost action by a minimum of 1.8 metres of cover.

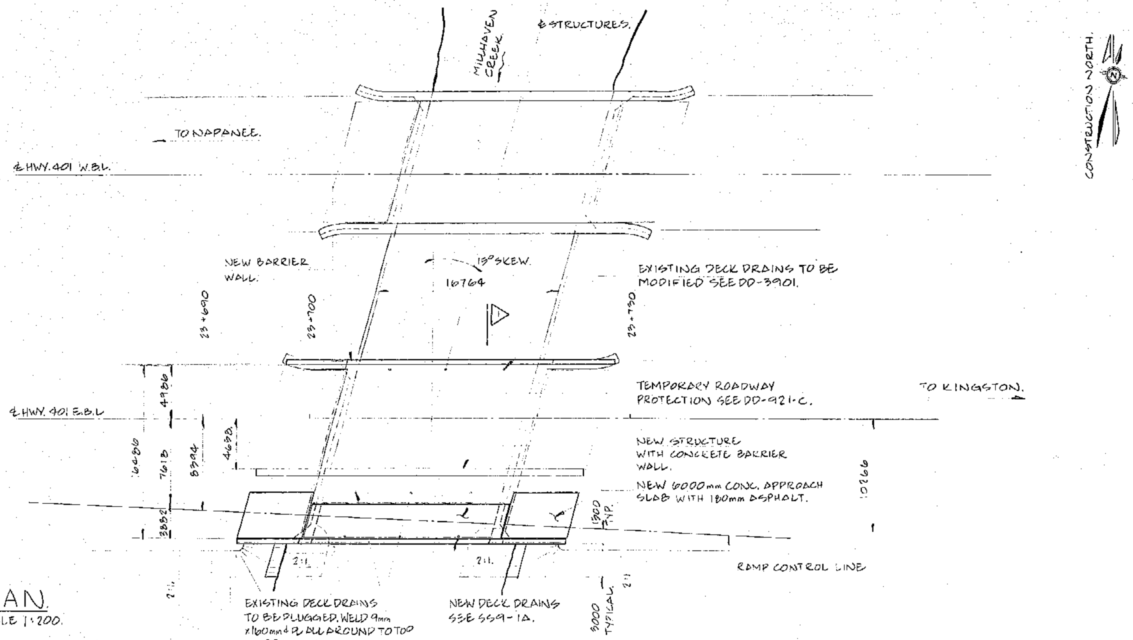
Earth fill slopes should be constructed with 2:1 slopes with an adequate rip-rap protection scheme to protect against river scour action.

We trust the information provided is sufficient in scope for your immediate design requirements. Should further discussion be warranted, please feel free to contact this Section.

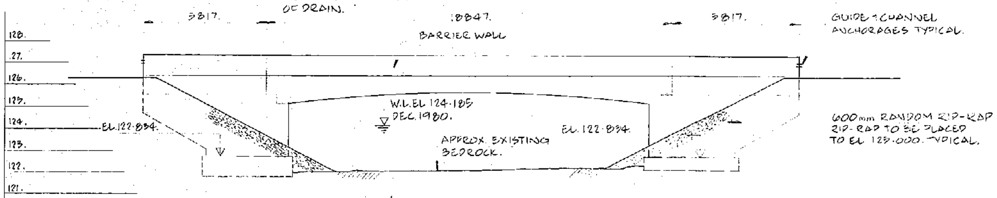
Nick Stea

NS:ea

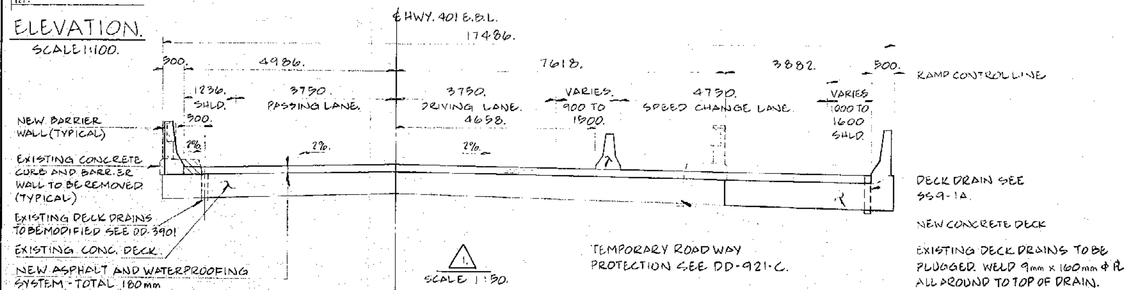
N. Stea
Project Foundations Engineer
For: M. Devata
Senior Foundations Engineer



PLAN.
SCALE 1:200.



ELEVATION.
SCALE 1:100.



1.
SCALE 1:50.

METRIC

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

DIST No 8 HWY. 401.
CONT No
WP No 195-80-02.

MILLHAVEN CREEK BRIDGE WIDENING.
GENERAL ARRANGEMENT.

SHEET

NOTES.

CLASS OF CONCRETE.
DECK, WINGWALLS, ABUTMENTS AND BARRIER WALLS. — 30 MPa
REMAINDER OR AS NOTED ON DRAWINGS. — 20 MPa

REINFORCING STEEL GRADE 400.
BARS MARKED WITH SUFFIX 'C' DENOTES COATED BAR.

CLEAR COVER TO REINFORCING STEEL.
FOOTINGS. — 100±25mm
DECK BOTTOM. — 40±10mm
ABUTMENTS AND WINGWALL FRONT SURFACES. — 80±20mm
REMAINDER UNLESS OTHERWISE NOTED. — 70±20mm

CONSTRUCTION NOTES
CONTRACTOR TO VERIFY EXISTING DIMENSIONS AND ELEVATIONS OF EXISTING STRUCTURE.

CONCRETE QUANTITIES.
CONCRETE IN BRIDGE AND WINGWALLS — 133 m³
CONCRETE IN APPROACH SLABS. — 24 m³
CONCRETE IN BARRIER WALLS. — 21 m³

LIST OF DRAWINGS.

1. GENERAL ARRANGEMENT.
2. BOREHOLE LOCATION AND SOIL STRATA.
3. FOOTING LAYOUT AND REINFORCEMENT.
4. EXTENSION FRAME DETAILS.
5. NORTH BARRIER WALL.
6. SOUTH BARRIER WALL.
7. 6000 mm APPROACH SLAB.
8. AS CONSTRUCTED ELEV. AND DIMENSIONS.
9. STANDARD DETAILS.
10. BRIDGE DATE AND SITE No DATA.

J. D. LEE ENGINEERING LTD.
MAR 18 1982

ISSUED

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	
DESIGN D.C.B.	CHECK		LOADING HS 20-44	DATE 82-03.
DRAWING J.T.F.	CHECK		SITE No 17-77	DWG 1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DRAWN ISSUED 79 04

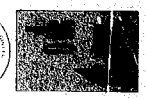
METRIC

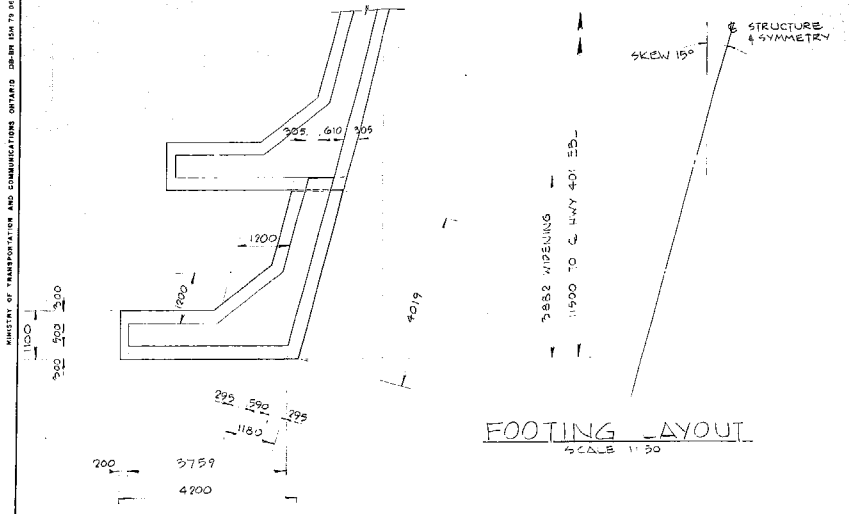
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST. No 8 HWY 401
CONT No
WP No 195-80-02

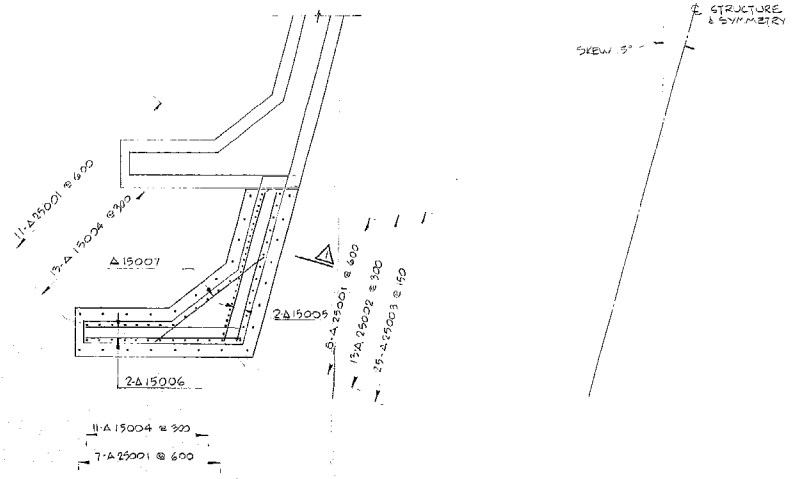
MILLHAVEN CREEK BRIDGE WIDENING
FOOTING LAYOUT & REINFORCING

SHEET

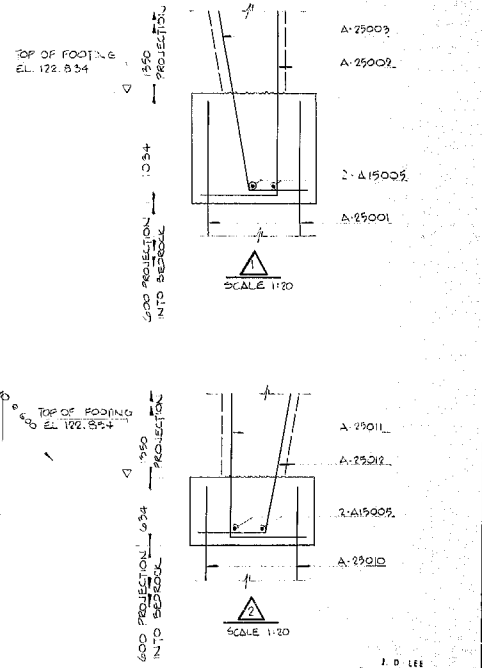




FOOTING LAYOUT
SCALE 1:50



FOOTING REINFORCING
SCALE 1:50



J. D. LEE ENGINEERING LTD.

MAR 16 1982

ISSUED

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
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