

## MEMORANDUM

TO: Mr. B. R. Davis,  
Bridge Engineer,  
Bridge Division,  
Admin. Bldg.

FROM: Foundation Section,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

ATTENTION: Mr. S. McCombie

DATE: October 4, 1968

OUR FILE REF:

IN REPLY TO

SUBJECT

PRELIMINARY  
FOUNDATION INVESTIGATION REPORT  
For

Proposed New Hwy. 17, 6.5 Miles  
Northwest of Arnprior, westerly 2.8  
Miles, Lots 18 and 21, Concessions  
VI - VIII, McNab Twp., Renfrew Co.  
District No. 9 (Ottawa)  
W.J. 68-F-70 -- W.P. 4-67-03

1. INTRODUCTION:

Following a request from Mr. G. Scott, Regional Bridge Location Engineer, Kingston, by memo dated August 29, 1968, a preliminary foundation investigation was carried out at two sites along the above proposed alignment. A review of the site and subsoil conditions, together with our preliminary recommendations for the design of structure foundations and approach fills, follows.

2. SITE AND SUBSOIL CONDITIONS:

2.1) Site 'A':

Site 'A' is located at the western limit of the proposed 2.8 mile section of the new alignment and includes the existing Hwy. 17 - C.N.R. level crossing as well as that portion of Lochell Creek which lies between the existing Hwy. 17 and the C.N.R. bridge across the creek. Lochell Creek in this area is some 20 to 30 ft. wide and is bordered by marshy flats beyond which the valley slopes

cont'd. /2 ...

2. SITE AND SUBSOIL CONDITIONS: (cont'd.) ...

2.1) Site 'A': (cont'd.) ...

extend towards the east and west. Bedrock outcrops occur some 1500 ft. east of the creek.

The subsoil conditions at this site were investigated by carrying out 3 boreholes, each accompanied by a dynamic cone penetration test. In addition, one dynamic cone penetration test was carried out to supplement the boreholes. The locations and elevations of the boreholes are shown on Drawing 68-F-70A which also shows the estimated stratigraphical sections at the site. Surveying was carried out by the Kingston Region Engineering Surveys Section.

Underlying a surficial stratum of sand of about 5 ft. thickness is a deposit of sensitive, very stiff to firm, silty clay to clay. The thickness of the deposit ranges from 30 ft. at Borehole 1 to 75 ft. at Borehole 3. The upper 12 to 25 ft. of the deposit is desiccated with undrained shear strengths of the order of 2000 p.s.f. or greater. Below the desiccated zone, the shear strength decreases to a minimum value of about 600 p.s.f. (at about elevation 400) before increasing with depth. The physical properties of the deposit are summarized on Figure 1 in the Appendix as well as on Figures 3 and 4. In the vicinity of Lochell Creek (Boreholes 2, 3 and 4), the clay deposit is underlain by a stiff to hard or very dense cohesive to sandy glacial till stratum ('N' values: 14 blows/ft. to 50 blows/1"). Bedrock was encountered or is inferred to have been encountered at depths of about 79 to 86 ft. below ground surface in the vicinity of Lochell Creek. At Borehole 2, the bedrock was a crystalline limestone containing occasional solution cavities. At the C.N.R. and existing Hwy. 17 level crossing, (Borehole 1) the clay deposit is underlain by a compact silty sand stratum followed by sound granite bedrock at a depth of 50 feet.

cont'd. /3 ...

2. SITE AND SUBSOIL CONDITIONS: (cont'd.) ...

2.1) Site 'A': (cont'd.) ...

Observations of the groundwater conditions at Site 'A' are summarized below:

<u>Borehole</u>	<u>Ground Elev.</u>	<u>Elevation of Water Level</u>		<u>Piezometer Tip Elev.</u>
		<u>Overburden</u>	<u>Piezometer</u>	
1	459.0	450.8	448.4	405.7
2	448.0	443.2	447.1	373.0
3	435.3	433.0	-	-
4	447.2	No Observations		-

Locheil Creek: Creek Level 433.0 on September 19, 1968.

The piezometers in Boreholes 1 and 2 were installed in or slightly above the bedrock and the observations indicate that the water level in the glacial till or bedrock is independent of the water level in the overburden.

2.2) Site 'B':

Site 'B' is located in the vicinity of the McNab Twp. office and garage on the existing Hwy. 17 and is bordered on the north by the C.N.R. level crossing in the Village of Glasgow. The ground level is generally flat in the southern portions of the site, but rises towards the north in the vicinity of the C.N.R., intersecting bedrock outcrops just north of the C.N.R. level crossing.

The subsoil conditions at this site were investigated by carrying out two boreholes and 3 dynamic cone penetration tests, two of which accompanied the boreholes. The locations and elevations of these boreholes are shown on Drawing 6C-F-70B, together with the estimated stratigraphical sections.

cont'd. /4 ...

2. SITE AND SUBSOIL CONDITIONS: (cont'd.) ...

2.2) Site 'B': (cont'd.) ...

Beneath a surficial cover of topsoil at Boreholes 6 and 7 or fill material at Borehole 5 is a deposit of sensitive, stiff to very stiff, silty clay to clay. The thickness of this deposit ranges from 35 ft. at Borehole 5 to 47 ft. at Boreholes 6 and 7. The upper 11 to 15 ft. of the deposit is desiccated and fissured with undrained shear strengths generally in excess of 2000 p.s.f. The shear strength below the upper crust varies between 1000 p.s.f. to 1500 p.s.f. as shown on Figure 2, Appendix I. The physical properties of the deposit are shown on Figures 2 to 4 inclusive, in the Appendix. Underlying the clay deposit is a compact to very dense stratum of silty sand with gravel, which was found to be 7.5 ft. thick and was followed by sound crystalline bedrock at elevation 370 at Borehole 6. The dynamic cone penetration tests indicate the probable presence of bedrock at approximately elevations 395 and 376 respectively, at Boreholes 5 and 7.

Observations of the groundwater conditions at this site indicate that the water level is at depths of about 3 to 8 ft. below the ground surface.

3. DISCUSSION AND RECOMMENDATIONS:

3.1) General:

It is proposed to construct a new Highway 17, 6.5 miles northwest of Arnprior, westerly for 2.8 miles. For this alignment consideration has been given to two possible future structure sites 'A' and 'B', the locations of which have been discussed elsewhere in this memo. At the present time, it is proposed to construct only 2 lanes which, at a later date, will become the Eastbound lanes of the New 4-lane Hwy. 17. According to available information this will be accomplished in two stages as discussed on the following page.

cont'd. /5 ...

3. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

3.1) General: (cont'd.) ...

At Site 'A', during the first stage, the proposed 2 lanes will cross Lochell Creek in a westerly direction, merging northwardly with the existing Hwy. 17 some 400 ft. west of Lochell Creek. At a later date (Stage 2) the Westbound lanes will be constructed at which time the new 4-lane Hwy. 17 will cross the existing Hwy. 17 in a westerly direction, paralleling, more or less, the C.N.R. tracks. A median width of about 100 ft. is proposed at this time for the New Hwy. 17. Since the new Hwy. 17 will cross the existing Hwy. 17, an underpass structure is required at this location.

At Site 'B' an interchange is proposed so as to connect the future Twp. Roads with the New Hwy. 17. An underpass structure will, therefore, be required for this interchange.

In addition to the above proposed structures, it is expected that the future development of the area will necessitate the construction of overheads at the existing C.N.R. level crossings at Site 'A' (existing Hwy. 17) and Site 'B' (Milton Stewart Ave., Glasgow).

3.2) Recommendations:

A summary of foundation recommendations for the proposed structures and their approaches, is tabulated as follows:

cont'd. /6 ...

Structure Location and Borehole No(s)	R E C O M M E N D A T I O N S	
	Structure Foundations	Approaches
<p><u>SITE 'A'</u></p> <p><u>Stage I</u></p> <p>New Hwy. 17 (2-lane) and Lochell Creek Crossing.</p> <p>(B.H.'s 2, 3 and 4)</p>	<p>(i) Piled Foundation - Steel H-piles (12 BP 74) driven to bedrock - (approx. depth 79 - 86 ft.), 90 Tons/pile.</p> <p>(ii) Alternatively, if a culvert is contemplated, a flexible pipe arch on 18" granular bedding should be adopted. Settlements due to imposed loads of 20 ft. of fill will be in the order of 1.5 to 2 ft. The culvert should be cambered in order to accommodate these orders of settlement.</p>	<p>If future fills are added at this location, stresses will be increased, resulting in additional settlements up to 3 ft. for total fill heights of 40 ft.</p>
<p><u>Stage II</u></p> <p>Hwy. 17 and New Hwy. 17 (4-lane) Underpass.</p> <p>(B.H.'s 2 and 3)</p>	<p>Piled Foundation - Steel H-piles (12 BP 74) driven to bedrock - (approx. depth 86 ft.), 90 Tons/pile.</p>	<p>(1) No stability problems are anticipated for standard 2:1 side slopes and fill heights of the order of 20 - 24 ft. Expected settlement based on preliminary computations for 24-ft. fill height, will be of the order of 3-1/2 ft.</p>

cont'd. /7 ...

Structure Location and Borehole No(s)	R E C O M M E N D A T I O N S	
	Structure Foundations	Approaches
<p>C.N.R. Overhead at Existing Hwy. 17. (B.H. 1)</p>	<p>Piled Foundation - Steel H-Piles (12 BP 74) driven to bedrock - (approx. depth 50 ft.,, 90 Tons/pile.</p>	<p>(11) If creek relocation is contemplated, this should be carried out in such a way as to provide a minimum distance of 20 ft. between toe of forward slope of the approach fill and the crest of the relocated channel. Re-assessment of the stability is necessary once further details are known, since the exact geometry of the scheme is not known.</p> <p>cont'd. /8 ...</p>

Structure Location and Borehole No(s)	R E C O M M E N D A T I O N S	
	Structure Foundations	Approaches
<p><u>SITE 'B'</u></p> <p>Underpass for Interchange - New Hwy. 17 and Twp. Roads. (B.E.'s 6 and 7)</p> <p>C.N.R. Overhead at Milton Stewart Ave., Glasgow. (B.E. 5)</p>	<p>(1) Spread footings at elevation 425 ±, 2 TSF. Differential settlements will be in the order of 1 to 2 inches.</p> <p>(11) Alternative - Piled Foundation - Steel H-piles (12 BP 74) to bedrock (approx. depth 57 ft.), 90 Tons/pile.</p> <p><u>North Abutment</u>-can be supported on spread footings since rock outcrop is visible on the north side of the C.N.R. tracks.</p> <p><u>South Abutment</u>-on Piled Foundation-Steel H-piles (12 BP 74) driven to bedrock (approx. depth 41 - 45 ft.), 90 Tons/pile.</p>	<p>No stability problems are anticipated with 2:1 side slopes for fills 25 ft. in height. For a 25-ft. high fill, settlements will be of the order of 6", based on preliminary analyses.</p> <p>No stability problems with 2:1 side slopes.</p>

cont'd. /9 ...



3. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

3.2) Recommendations: (cont'd.) ...

It will be necessary to carry out additional boreholes in the field for the various proposed structures when the final design details become available. The recommendations given in this report are, therefore, to be regarded as conditional only, and as such, are subject to revision at a later date when and if new information becomes available.

If you have any further queries, or if any of the foregoing requires clarification, kindly call us.

This memo was prepared by Mr. C. Mirza, Project Foundation Engineer, under the general supervision of Mr. M. Devata, Supervising Foundation Engineer.

MD/MdeF  
Attach.

cc: Messrs. B. R. Davis (2)  
D. W. Farren  
S. J. Markiewicz  
C. R. Robertson  
G. Scott  
J. E. Gruspier  
J. L. Forster (2)  
B. A. Singh

Foundations Files  
Gen. Files

*M. Devata*

M. Devata,  
SUPERVISING FOUNDATION ENGR.  
For:  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGR.

ALABAMA 2

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OF 15 IS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

# RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 68-F-70 LOCATION Sta. 166 + 75 E New Hwy. 17 o/s 26' Lt. ORIGINATED BY CM  
W P 4-67-03 BORING DATE Sept. 12-16, 1968 COMPILED BY CM  
DATUM Geodetic BOREHOLE TYPE Diamond Drill, Washboring CHECKED BY SL

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — W <sub>L</sub> PLASTIC LIMIT — W <sub>P</sub> WATER CONTENT — W			H <sub>100</sub> DENSITY P C F	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	20	40	60	80	100	W <sub>P</sub>	W <sub>L</sub>	
459.0	Ground Level													
0.0	Sand with occ. silty clay seams.													
454.5	Compact		1	SS	16									
4.5	Silty clay to clay, Sensitive		2	SS	28									
	Fissured		3	SS	16	450								
	Very stiff to stiff													
	Grey - Brown		4	TW	PM									
434.0	(desiccated crust)		5	TW	PM	440								
25.0	Firm to stiff.		6	TW	PM									
429.0	Grey.		7	TW	PM	430								
30.0	Silty sand with occ. silty clay seams, trace of gravel.		8	SS	11									0 13 (87)
	Compact.		9	SS	17	420								0 60 33 7
	Grey.		10	SS	18									14 46 30 10
406.9	Granite Bedrock		11	AXT RC	80% Rec	410								
404.7	Sound		12	AXT RC	100% Rec									405.7
54.3	End of Borehole					400								

0  
15 + 5 % strain at failure  
10

450.8  
448.4  
W.L. in Piez.

## RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

## MATERIALS &amp; TESTING DIVISION

JOB 68-F-70

LOCATION Sta. 154 + 44 E EBL New Hwy. 17 o/s 143' Rt. ORIGINATED BY CM

W P 4-67-03

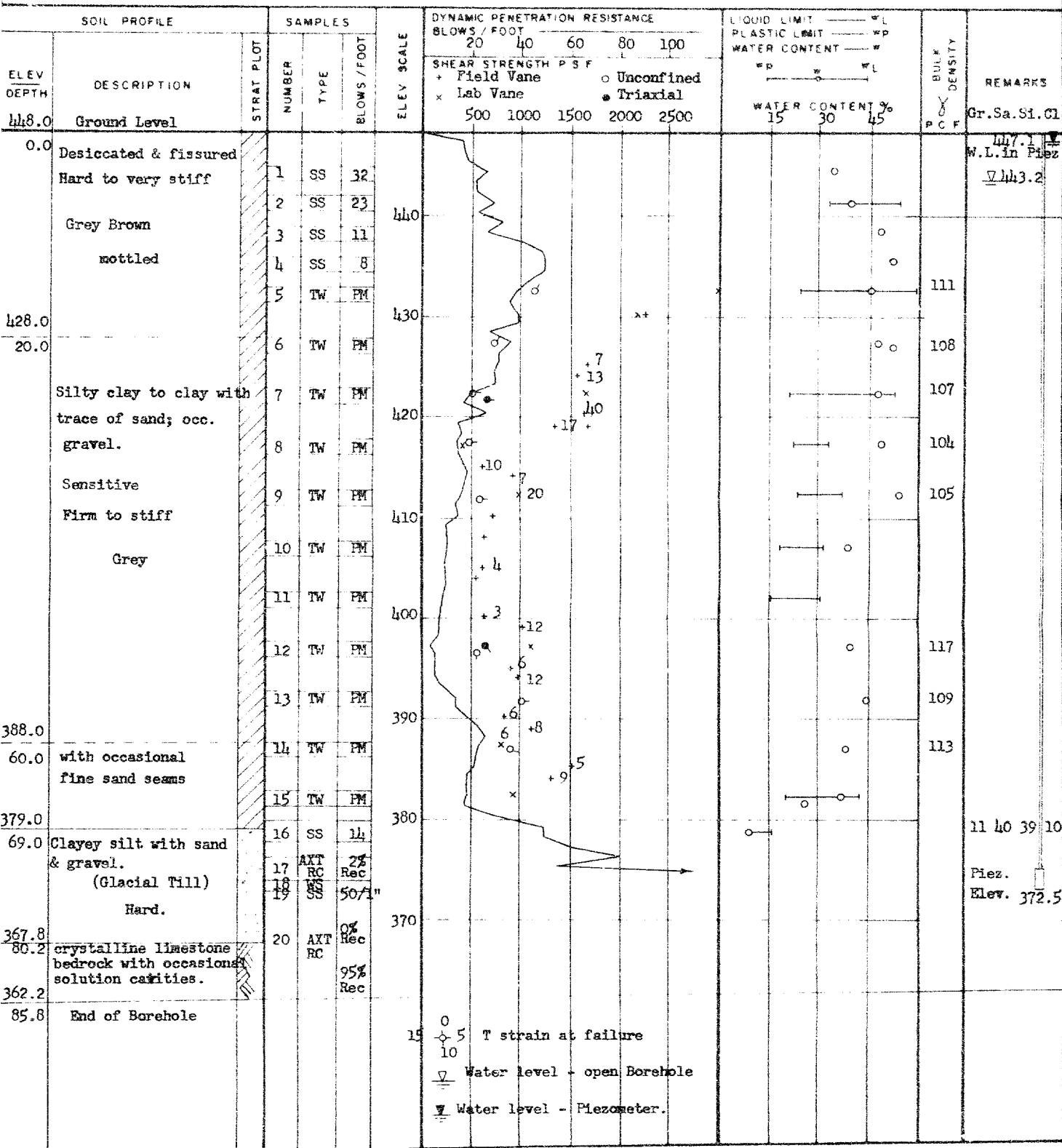
BORING DATE Sept. 10-13, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill - Washboring

CHECKED BY LH



DEPARTMENT OF HIGHWAYS - ONTARIO

## MATERIALS &amp; TESTING DIVISION

68-F-70

LOCATION Sta. 150 + 44 @ EBL New Hwy. 17 o/s 86' Lt.

FOUNDATION SECTION

ORIGINATED BY CM

W. P. 4-67-03

BORING DATE Sept. 18-19, 1968

COMPILED BY CM

Geodetic

BOREHOLE TYPE Diamond Drill, Washboring

CHECKED BY                     

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT						LIQUID LIMIT ——— % PLASTIC LIMIT ——— % WATER CONTENT ——— %			BULK DENSITY P.C.F.	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P.S.F.					w <sub>p</sub>	w <sub>L</sub>	%				
							+ Field Vane    o Unconfined x Lab Vane      • Triaxial											
435.3	Ground Level						500	1000	1500	2000	2500					Gr.Sa.Si.Cl		
0.0	Desiccated & fissured Very stiff to stiff.  Grey-Brown		1	TW	PM	430										110	▽ 433.0	
423.8			2	TW	PM						+11							111
11.5			3	TW	PM	420					+20	x 8						109
			4	TW	PM						+50	+34						109
	Silty clay to clay with occ. sand seams.  Sensitive.		5	TW	PM	410					+24							107
	Firm to stiff.		6	TW	Lost	400					+56	400						
			7	TW	PM	390					+28	+28						109
	Gbey		8	TW	PM	380					+6	+7						116
			9	TW	PM	370					+14	+6	+3					118
			10	TW	PM													
360.5						360												
74.8	Probably sand and gravel.																	
356.0																		
79.0	End of Borehole Practical refusal Probably Bedrock					350												
							0	15	5	% strain at failure								
							10											

## FOUNDATION SECTION

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 219. **SKETCH** \_\_\_\_\_  
 220. **DESCRIPTION** \_\_\_\_\_  
 221. **CONCLUSION** \_\_\_\_\_  
 222. **SIGNATURE** \_\_\_\_\_  
 223. **DATE** \_\_\_\_\_  
 224. **TIME** \_\_\_\_\_  
 225. **LOCATION** \_\_\_\_\_

[illegible]

FOUNDATION SECTION

LOCATION 160' S. of intersection CNR & <sup>6/8</sup> M. Stewart Ave., Glasgow

o/s 15' E

FOUNDATION SECTION

LOCATION 160' S. of intersection CNR & E M. Stewart Ave., Glasgow

ORIGINATED BY CM

W P 4-67-03

BORING DATE Sept. 16-17, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Diamond Drill, Washboring

CHECKED BY \_\_\_\_\_

▽ 432.9

DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

## MATERIALS &amp; TESTING DIVISION

JOB 68-F-70

LOCATION

Sta. 71 + 60  $\nabla$  EBL New Hwy.17 c/s 10' Rt.

ORIGINATED BY CM

W P 4-67-03

BORING DATE

Sept. 16-18, 1968

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE

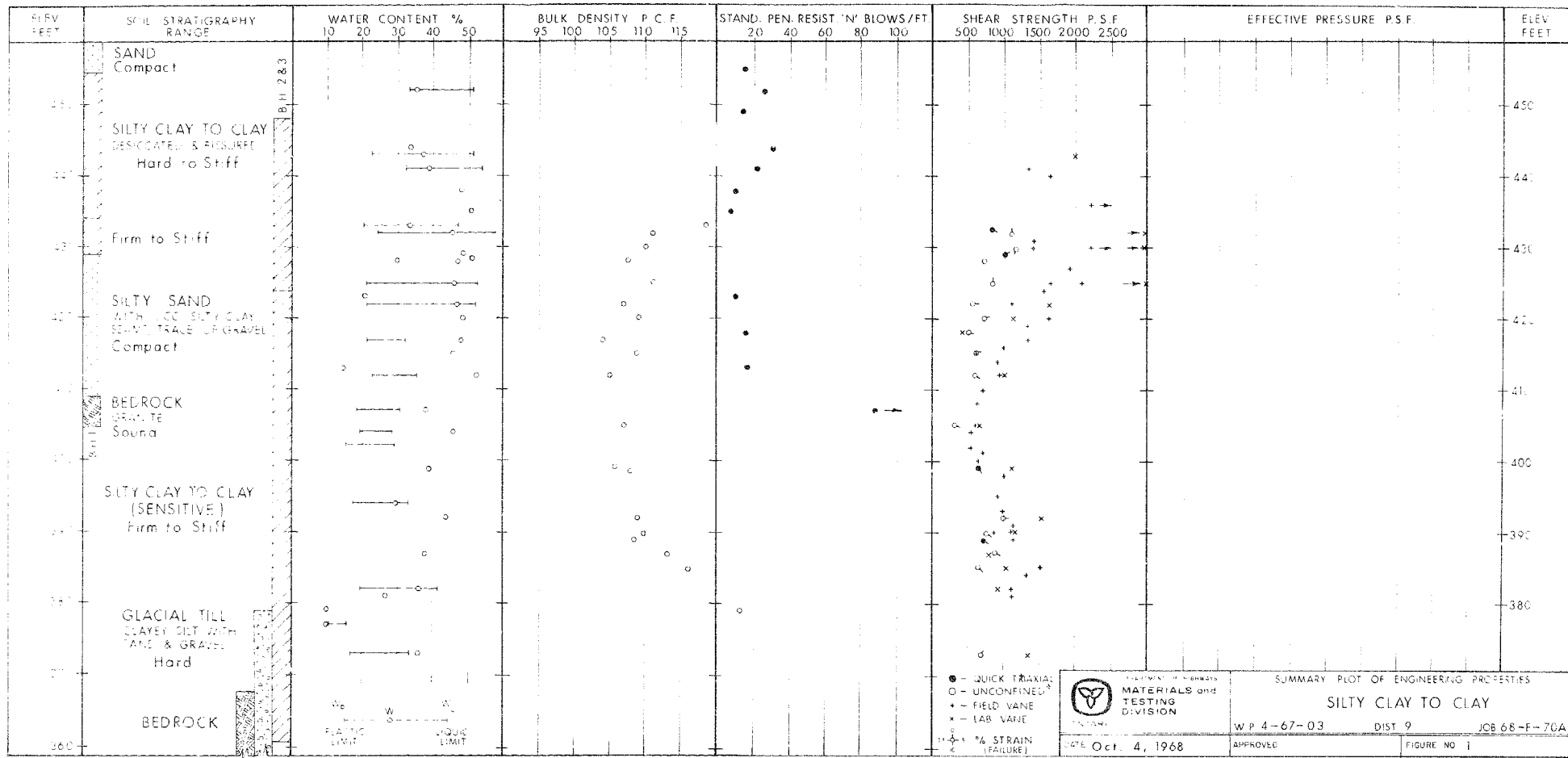
Diamond Drill, Washboring

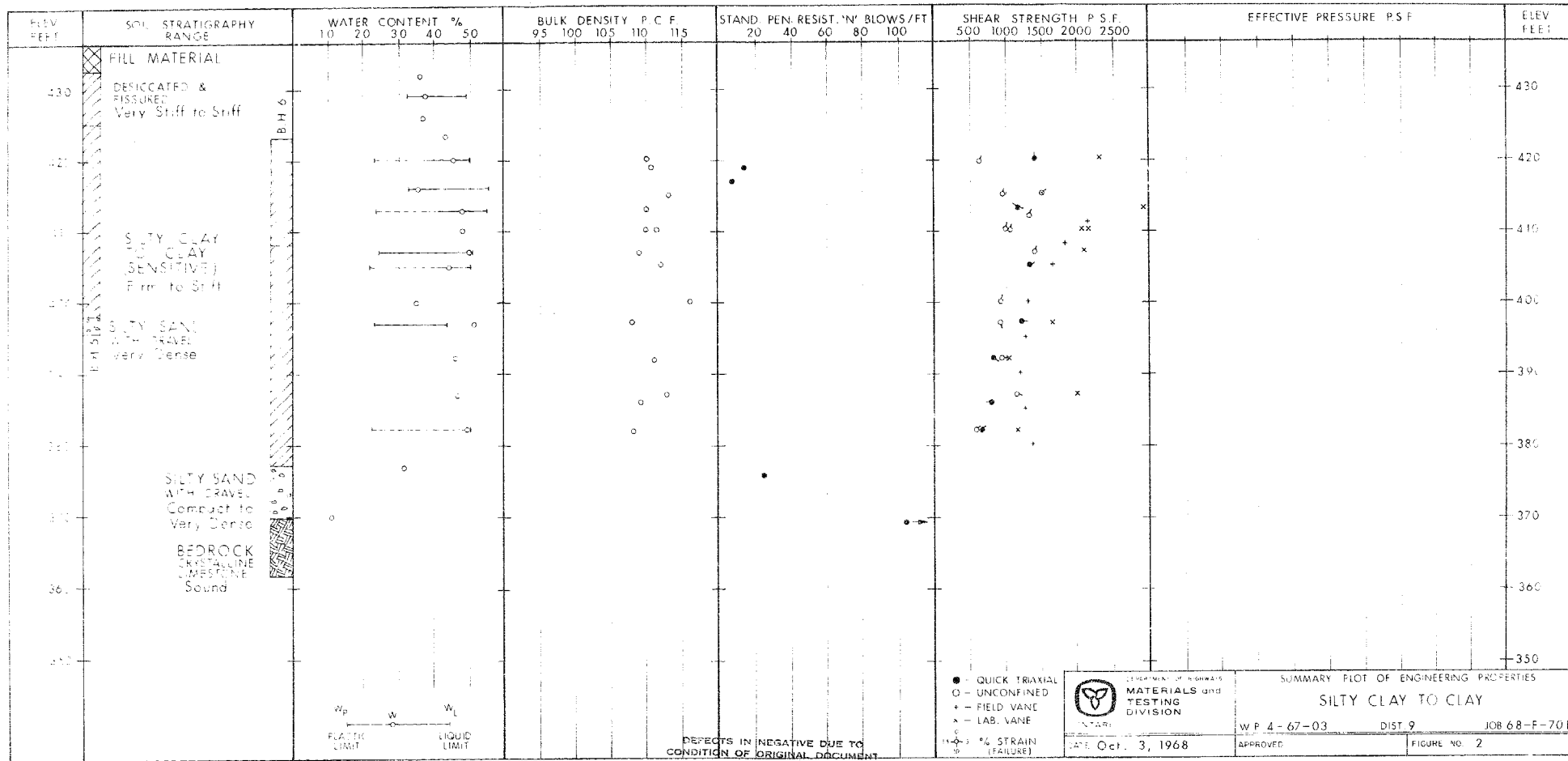
CHECKED BY

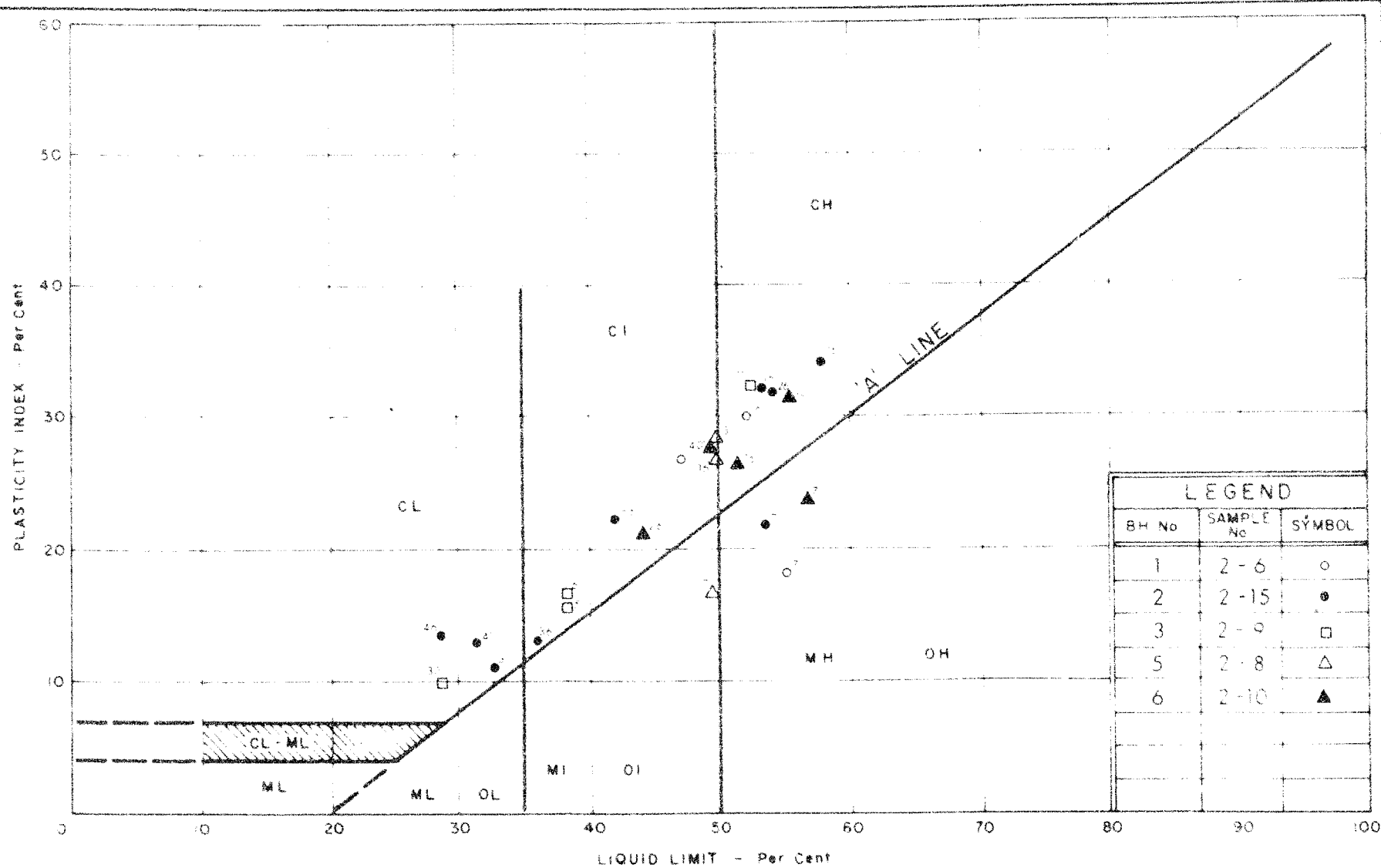
SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — *L PLASTIC LIMIT — *P WATER CONTENT — % *P — *L			BULK DENSITY PCF	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P S F + Field Vane      ○ Unconfined x Lab Vane        ● Triaxial			WATER CONTENT %					
423.3	Ground Level						20	40	60	80	100	15	30	45	Gr.Sa.Si.Cl
0.0	Desiccated & fissured Very stiff to stiff		1	SS	15	420									422.0
			2	SS	8										419.7
			3	TW	PM										
408.3	Mottled grey-brown		4	TW	PM	410									
15.0			5	TW	PM										
			6	TW	PM										
	Silty clay to clay		7	TW	PM	400									
	Sensitive		8	TW	PM										
	Stiff		9	TW	PM	390									
	Grey		10	TW	PM										
377.3			11	TW	PM	380									
46.0	Silty sand with gravel compact to very dense.		12	SS	26										
369.8			13	SS	105	370									29 46 23 2
53.5	Crystalline limestone bedrock		14	AXT RC											
362.1	Sound		15	AXT RC											
61.2	End of Borehole					360									











DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

# PLASTICITY CHART SILTY CLAY TO CLAY SITES 'A' & 'B'

WP No. 4-67-03

JOB No. 68-F-70

FIG. No. 3

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

Coarse

Fine

Coarse

PERCENT PASSING

SILTY SAND  
TO  
SANDY SILT

GLACIAL TILL

## LEGEND

3 H SAMPLE  
NO NO SYMBOL

PERCENT PASSING

GRAIN SIZE DISTRIBUTION  
GLACIAL TILL & SILTY SAND TO SANDY SILT  
SITES 'A' & 'B'

DEPARTMENT OF HIGHWAY  
MATERIALS AND  
TESTING  
DIVISION

W.P. No 4-67-03

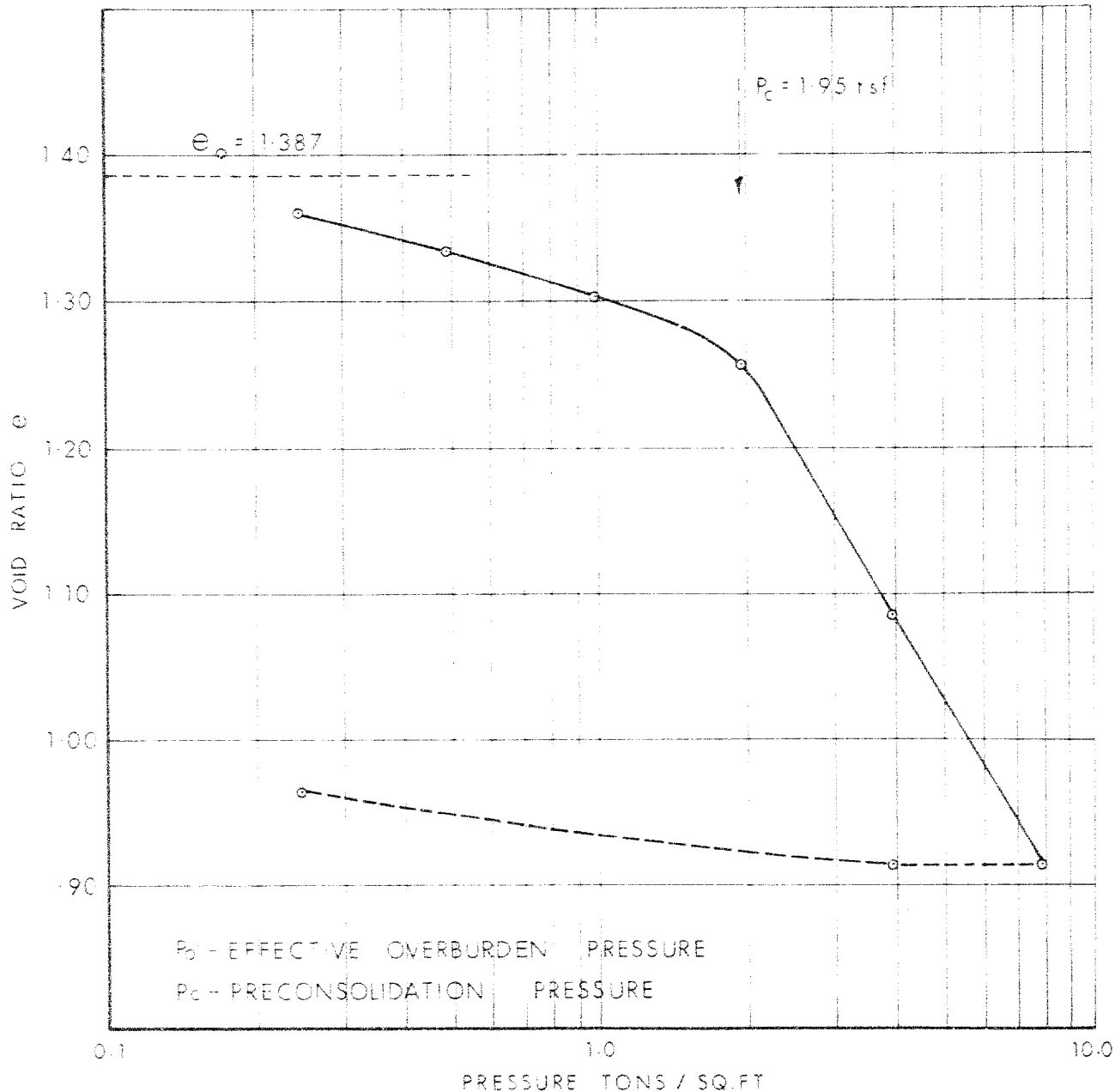
JOB No 68-F-70

FIG. No. 4

# VOID RATIO vs PRESSURE

$W_L = 32$   
 $W_p = 21$   
 $W = 48\%$   
 $C_c = 0.567$

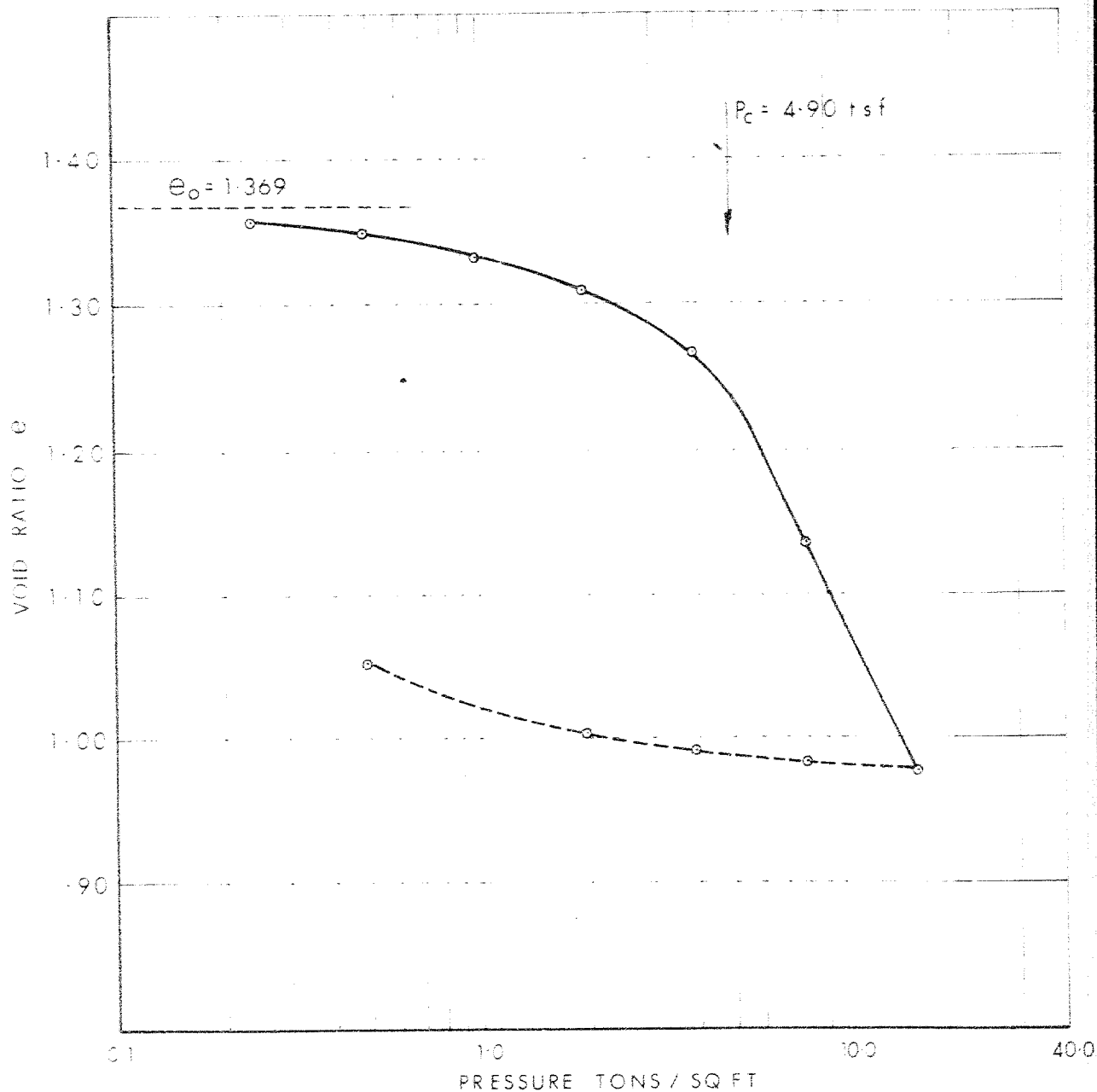
BORE HOLE 2  
 SAMPLE 8  
 DEPTH 30'  
 ELEV. 418.0



# VOID RATIO vs PRESSURE

$W_L = 44$   
 $W_p = 24$   
 $W = 51\%$   
 $C_c = -520$

BORE HOLE 6  
 SAMPLE 7  
 DEPTH 29' 9"  
 ELEV. 393.5



DEFECTS IN NEGATIVE DUE TO  
 CONDITION OF ORIGINAL DOCUMENT

68-F-70

FIG. 6

## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

### TYPE OF SAMPLE

SS	SPLIT SPOON	TW	THINWALL OPEN
WS	WASHED SAMPLE	TP	THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	OS	OESTERBERG SAMPLE
AS	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE SAMPLE		
	PH	SAMPLE ADVANCED HYDRAULICALLY	
	PM	SAMPLE ADVANCED MANUALLY	

### SOIL TESTS

QU	UNCONFINED COMPRESSION	LV	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	FV	FIELD VANE
QCU	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY



## ABBREVIATIONS USED IN THIS REPORT

### SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
s	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_c$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$C_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$\sigma_s$	SENSITIVITY

### GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

### STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

### EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

### FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

68-E-70

100 JUN 6 AM 10:24

0678

K

KINE DOWN 4 JUNE 6/68 1010A 0VR

M J MACMASTER SR PROJECT DESIGN ENGR ROAD DESIGN SECT

RE CAMBER FOR LOCKEIL CREEK WPA-67-03 HWY 17 NORTH 6.9 MILES

WEST OF ARNPRIOR WESTERLY DIST 9 OTTAWA

FURTHER TO YOUR MEMO WE HAVE CARRIED OUT ADDITIONAL SETTLEMENT  
ANALYSES FOR YOUR PROPOSAL AND SUGGEST THAT A MINIMUM CAMBER  
OF 12 INCHES SHOULD BE PROVIDED FOR THE STAGE ONE CONSTRUCTION.

M DEVATA SUPVR FOUNDATION ENGR FOR

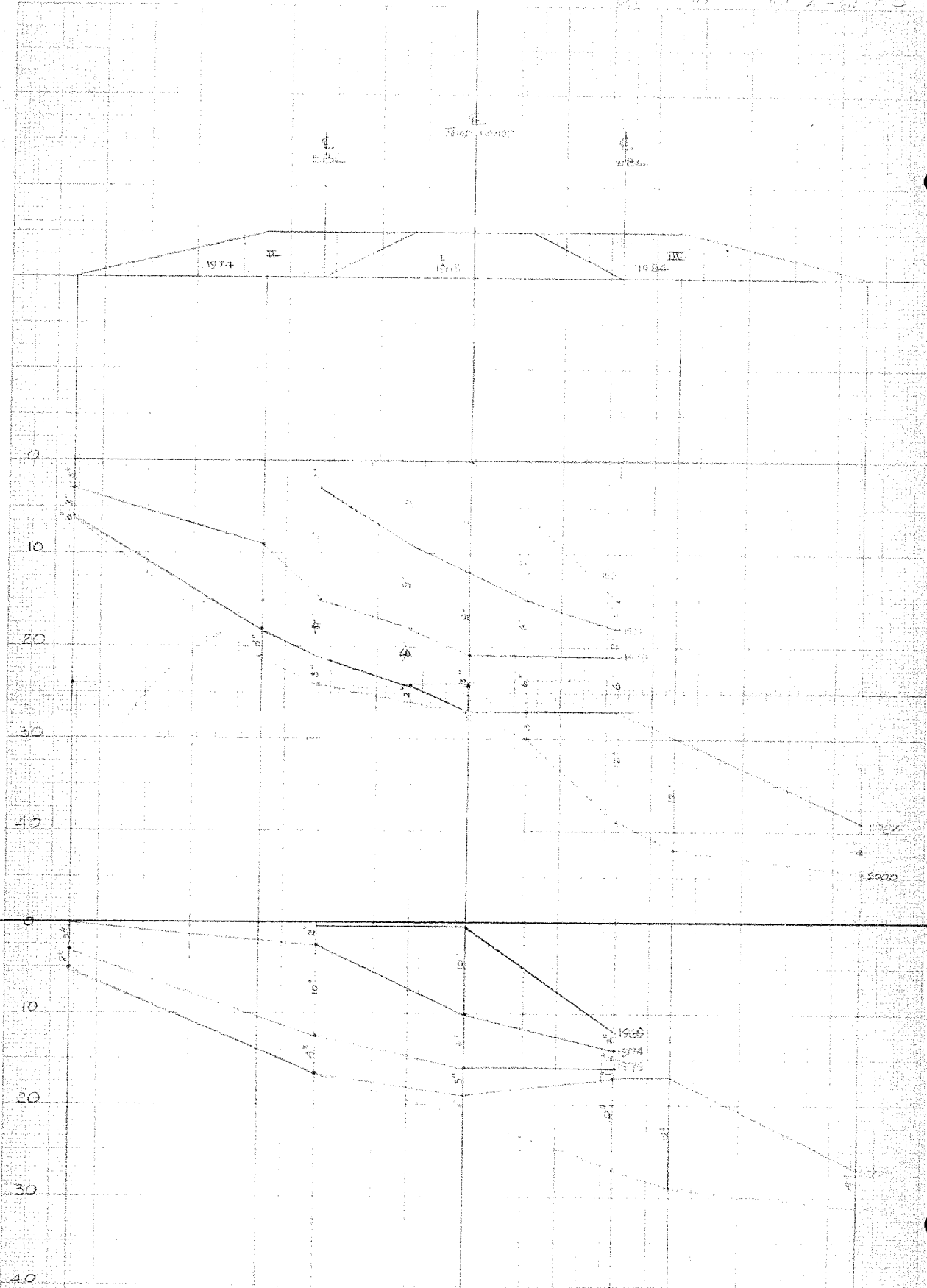
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MAT AND TEST OFF

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TEMPERATURE



DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

C. M. B. Z. A.  
JUNE 1975

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

...the ... ..



W. P. 4-67-03

IN REPLY TO

Department of Highways Ontario

Copy for the information of

MR. M. DEVATA

Mr. E. Khojajian,  
Project Planning Engineer,  
Kingston, Ontario.

Bridge Division,  
Kingston, Ontario.

November 29, 1968.

A.R. 4-67-02, New Hwy. 17, 0.8 Miles West  
of Appleton - easterly 3.0 Miles, District 8

This will confirm our discussion concerning the proposed relocation of the subject structure. To assist you in your consideration, we have marked our proposal on a portion print of the plan attached herewith and request that consideration be given to this new alignment before we request further information from our Foundation section, as would be necessary if we consider the 42 ft. high approach fill on your present proposal.

Briefly, we would recommend a clearance of 30 ft. between the profile grades as compared with your figure of 24 1/2 ft. This would enable placing the structure at a distance some 880 ft. from the railway crossing to the centre line of the westbound lane and, in this case, we have been able to reduce the skew angle from 51° to 28°.

For a preliminary estimate at this time we would estimate the cost of the structures as follows:

on existing alignment	-	\$ 406,400
on revised alignment	-	<u>192,900</u>
<u>saving</u>	-	<u>\$ 214,400</u>

I believe you will agree that this saving warrants reconsideration of this proposal.

We anticipate shortly involving the Foundation section in several projects on Highway 417 east of Ottawa and hope in this way to reduce their already heavy workload.

Gavin Scott, F. Eng.  
Regional Bridge Location Engineer

cc: Mr.  
Encl.  
c.c. (with encl.)  
Mr. S. McFarlane  
Mr. M. Devata

DEFECTS IN NEGATIVE PHOTOCOPIES  
CONDITION OF ORIGINAL DOCUMENT

Telephone call from Peter Brier - Kingston  
3:50 PM.

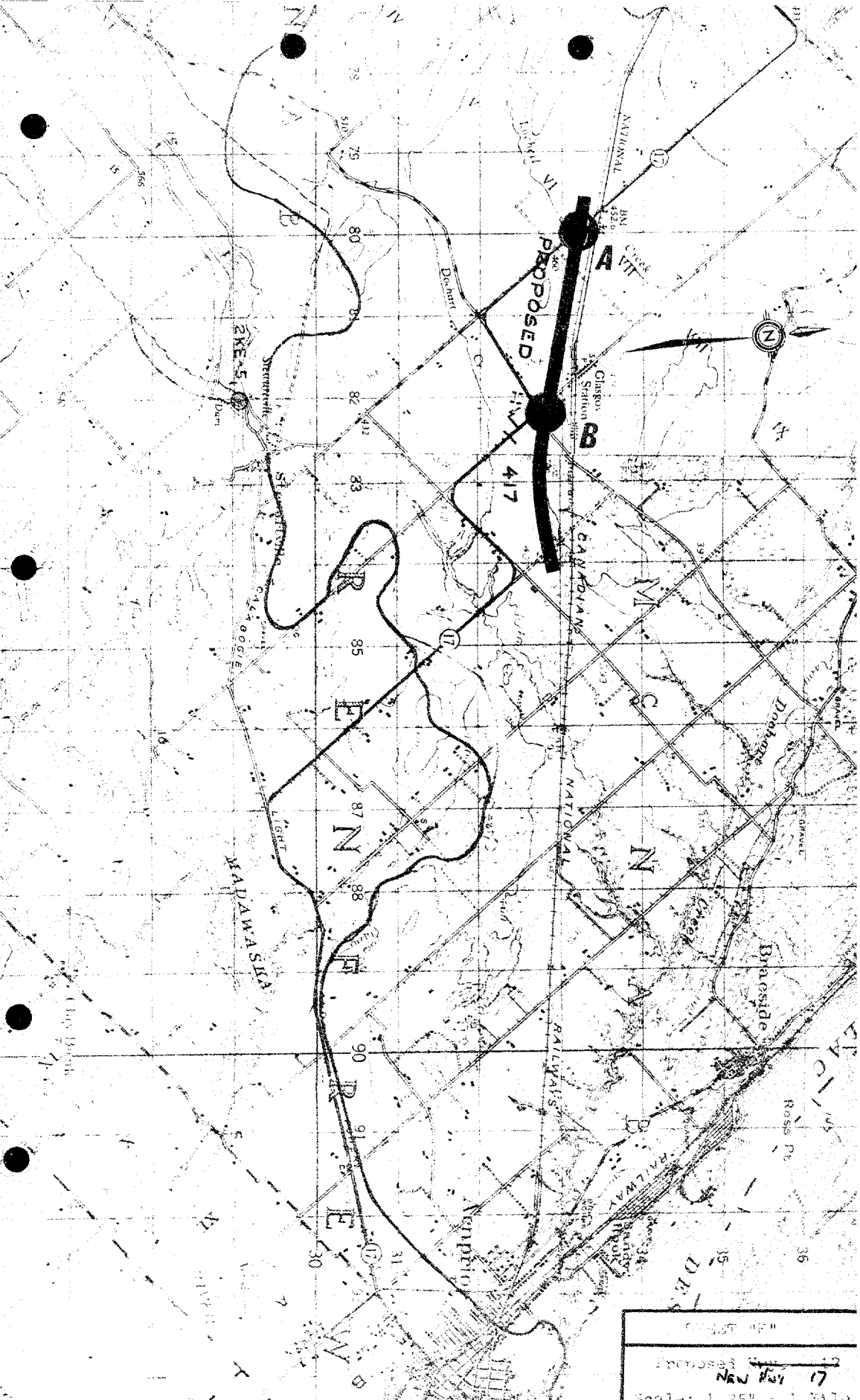
Site A

1. Enquired about underpass for Existing Hwy 17 - New Hwy 17 - Is it feasible to construct fills upto 45' in height.

Proposed Grade New Hwy 17 = Elev 453.  
Proposed grade Underpass = Elev 478 ±

Existing Hwy 17 grade at Creek Crossing ~ 441  
Existing Lachell Creek Bed Elev ~ 431 ±

2. It is proposed (tentative) to divert Creek east of present location. Probably culvert will be used. Culvert will therefore be located beneath approach fill for Hwy 17 (existing).
3. E - E distance, Stage 2, EBL & WBL = 124'.
4. EBL Stage 2 is aligned on a tangent off about sta. 146.
5. Clarified to Peter that (page 6) for fills upto 40',  $\delta = 3'$  in addition to  $1\frac{1}{2}$  to 2' for 20' fill.
6. Peter wants us to re-assess settlement & stability for the above conditions.  
For reference, use Profile C-11-3 and SB-67 of existing Hwy 17.
7. I mentioned that since investigation was preliminary, it may not be advisable to proceed wholly on bases of our findings - more work needed.



DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

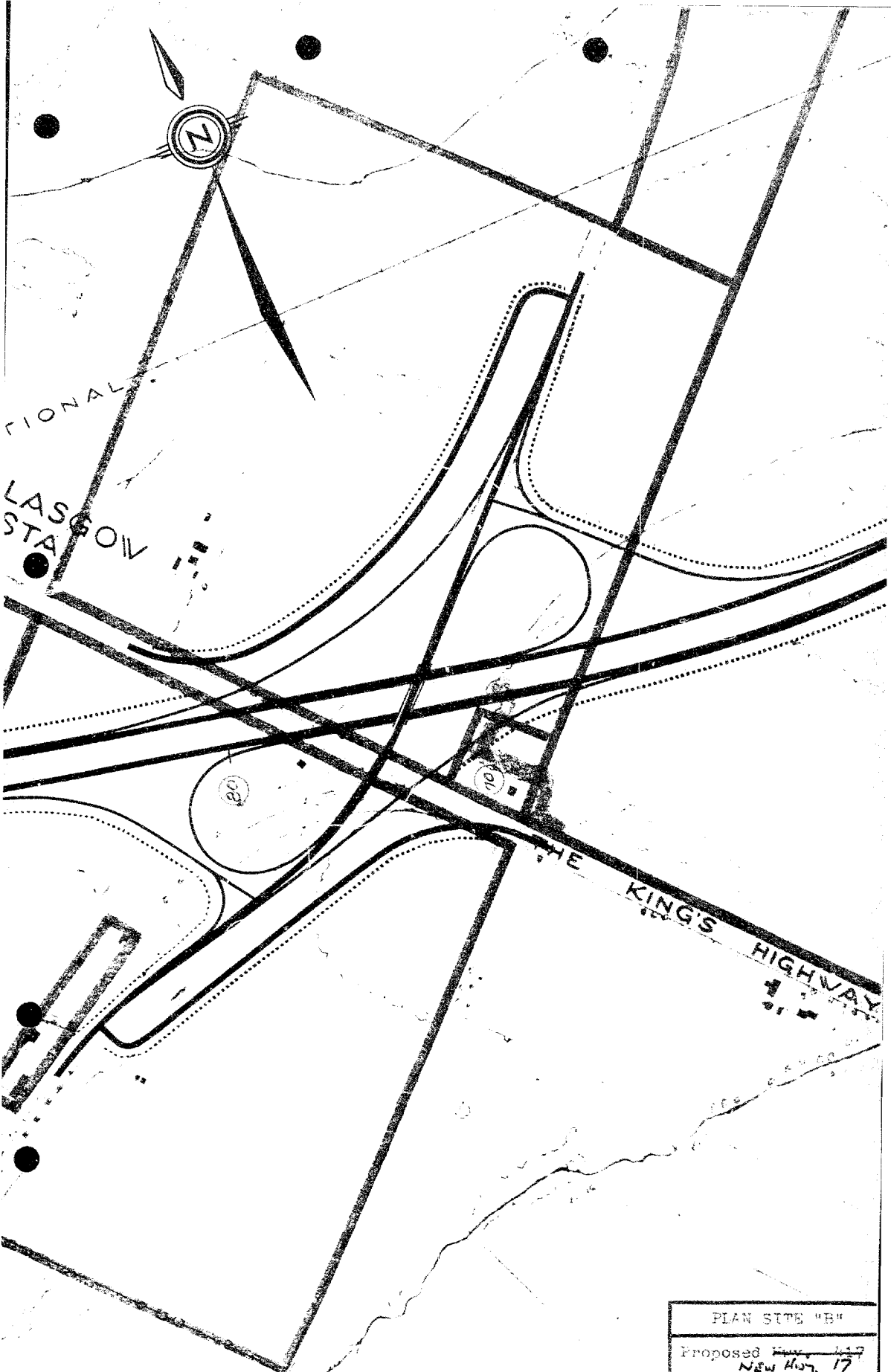
Sheet "F"

Proposed ~~NEW RIVER~~ 17

Scale: 1.25" = 1 Mile

Copyright 1917, 1918





DEFECTS IN NEGATIVE COPY  
CONDITION OF ORIGINAL DOCUMENT

PLAN SITE "B"
Proposed <del>Highway</del> <sup>1417</sup> New Hwy. 17
Scale: 1" = 400'
August 27th, 1968

TENTATIVE BRIDGE  
ELEVATION

BRIDGE NO.

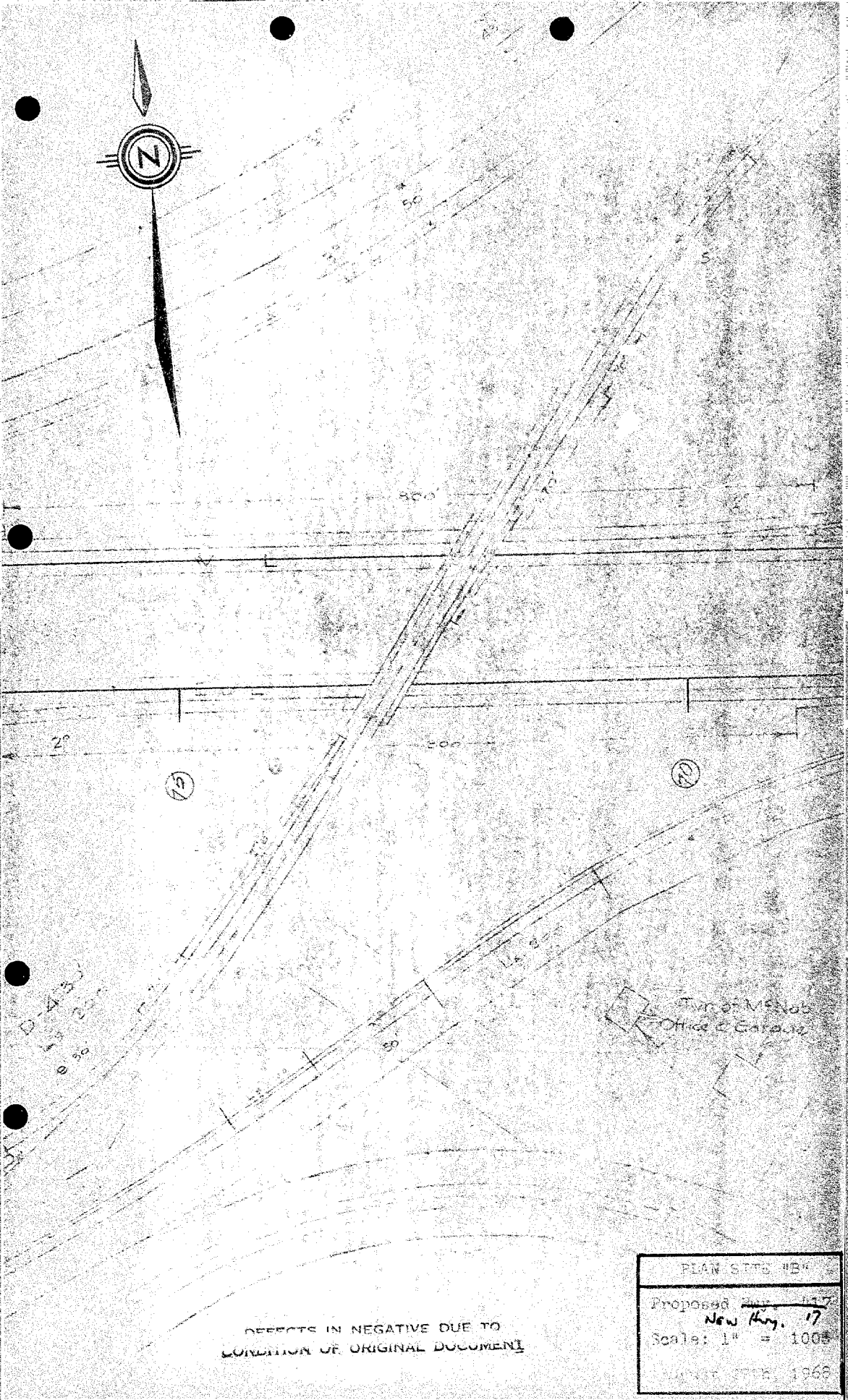
DEVIATION



KIEFFEL & ESSER CO  
NEW YORK

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

NEW 189. 17



D-435  
0.8%

Type A Slab  
Office & Garage

PLAN SITE "B"

Proposed New Hwy. 17  
New Hwy. 17  
Scale: 1" = 100'

APR 1966

DEFECTS IN NEGATIVE DUE TO  
LOCATION OF ORIGINAL DOCUMENT!

PLAN SITE "B"

Proposed 1977  
New Hwy. 17  
Scale: 1" = 100'

DEFECTS IN NEGATIVE DUE TO  
LOCATION OF ORIGINAL DOCUMENT

PLAN SITE "B"

Proposed 1977  
New Hwy. 17  
Scale: 1" = 100'

DEFECTS IN NEGATIVE DUE TO  
LOCATION OF ORIGINAL DOCUMENT

PLAN SITE "B"

Proposed 1977  
New Hwy. 17

Scale: 1" = 1000

DEFECTS IN NEGATIVE DUE TO  
LOCATION OF ORIGINAL DOCUMENT

PLAN SITE "B"

Proposed 1977  
New Hwy. 17

Scale: 1" = 1000

DEFECTS IN NEGATIVE DUE TO  
LOCATION OF ORIGINAL DOCUMENT



G 2685

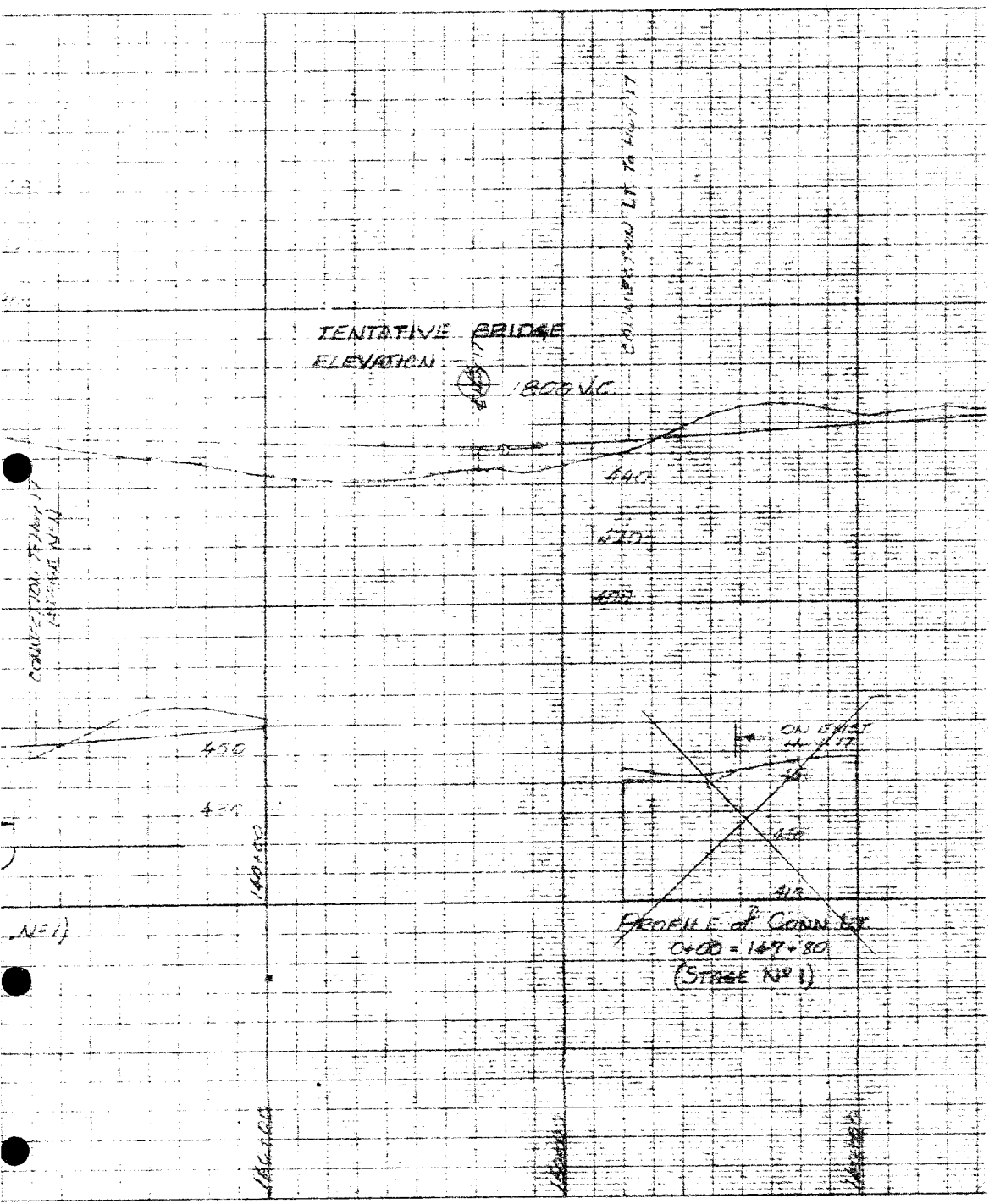
PLAN SITE "A"

Proposed ~~May~~ 17

Scale: 1" = 400'

August 27th, 1968

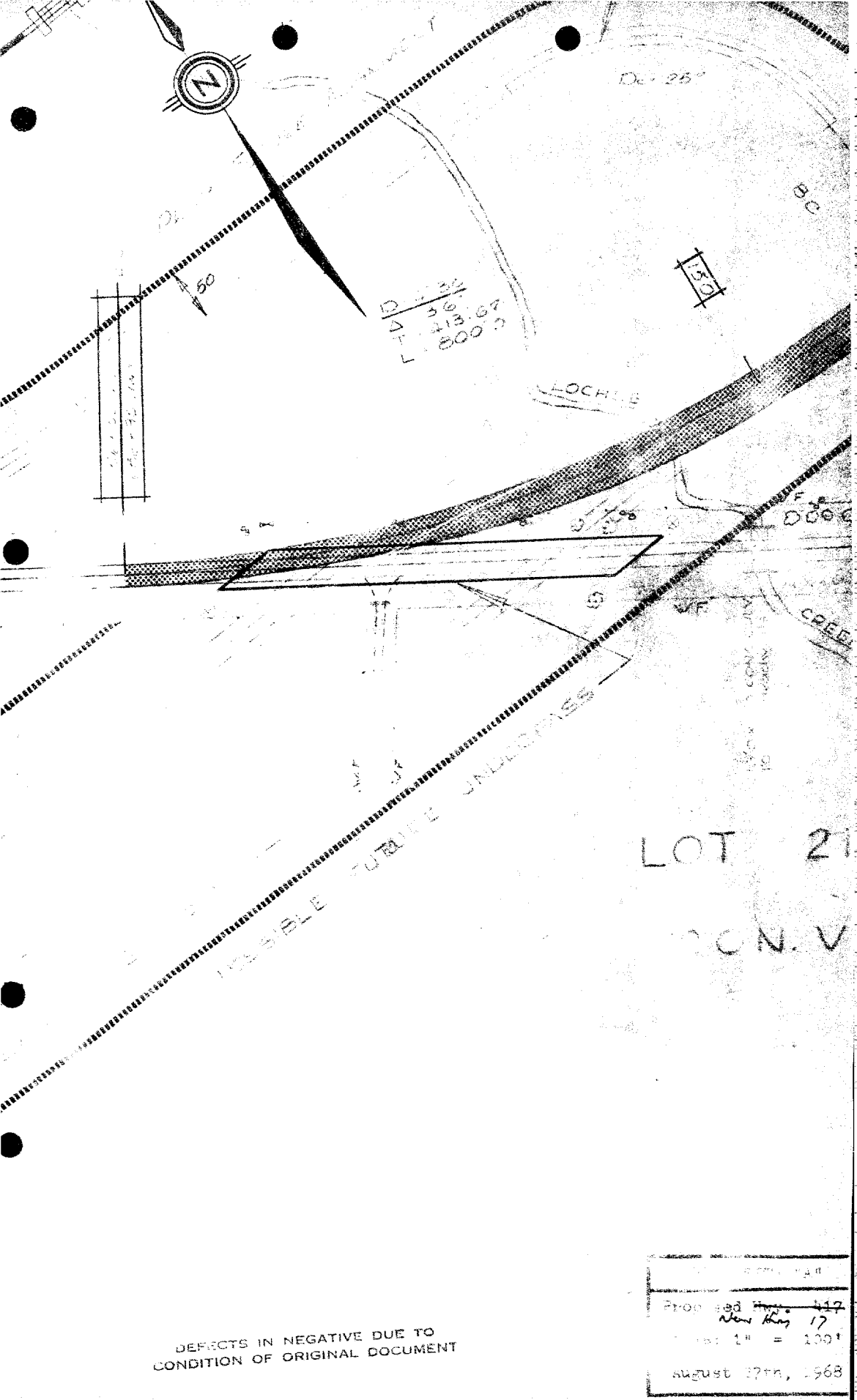
DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT



KEUFFEL & ESSER CO.  
NEW YORK

DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

DATE	1917
BY	W. H. J. 17
PROJECT	147+80
STATION	147+80



DEFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

Proposed Hwy. 412  
New Hwy. 17

Scale: 1" = 100'

August 27th, 1968

Copy for the information of

A. G. Stermac

Mr. J. L. Forster,  
Regional Functional Planning Engr.,  
Kingston, Ontario.

Materials & Testing Division,  
Kingston, Ontario.

August 27th, 1968.

Re: Hwy. 17, W.P. 4-67-03,  
6.5 mi. W. of Arnprior W'ly. 2.8 mi.,  
District 9, Ottawa.

A functional planning field meeting was held for this project on August 22nd with representatives of the District, Functional Planning, Road Design Office, Traffic and Property Sections.

The project traverses a clay plain except for the section between sta. 94<sup>+</sup> and sta. 135<sup>+</sup>. This high section consists of outcrops of granitic bedrock.

It is understood that you will request through the Bridge Office a preliminary foundation investigation for the proposed grade separation structure just south of Glasgow Station since it is located on the clay plain. If a grade separation structure is proposed at the west limits of the project, it is suggested that a preliminary investigation also be carried out at this site at the same time.

Weak foundation conditions may exist at Lochell Creek (sta. 151+50) and if so, box type concrete structures or C.S.P. may be recommended and some settlement of the approaches can be expected.

Sandy earth borrow is located at an average haul distance of 2 miles to the west. Sand Cushion and G.B.C. Class 'A' are located to the north at a haul distance of approximately 4 miles.

*H. A. Meyer*  
H. A. Meyer

for J. E. Gruspier,  
Regional Materials Engineer.

HAM/jtk

c.c. G. A. Wrong  
A. G. Stermac

#68-F-70

W.P. #4-67-03

Hwy #17

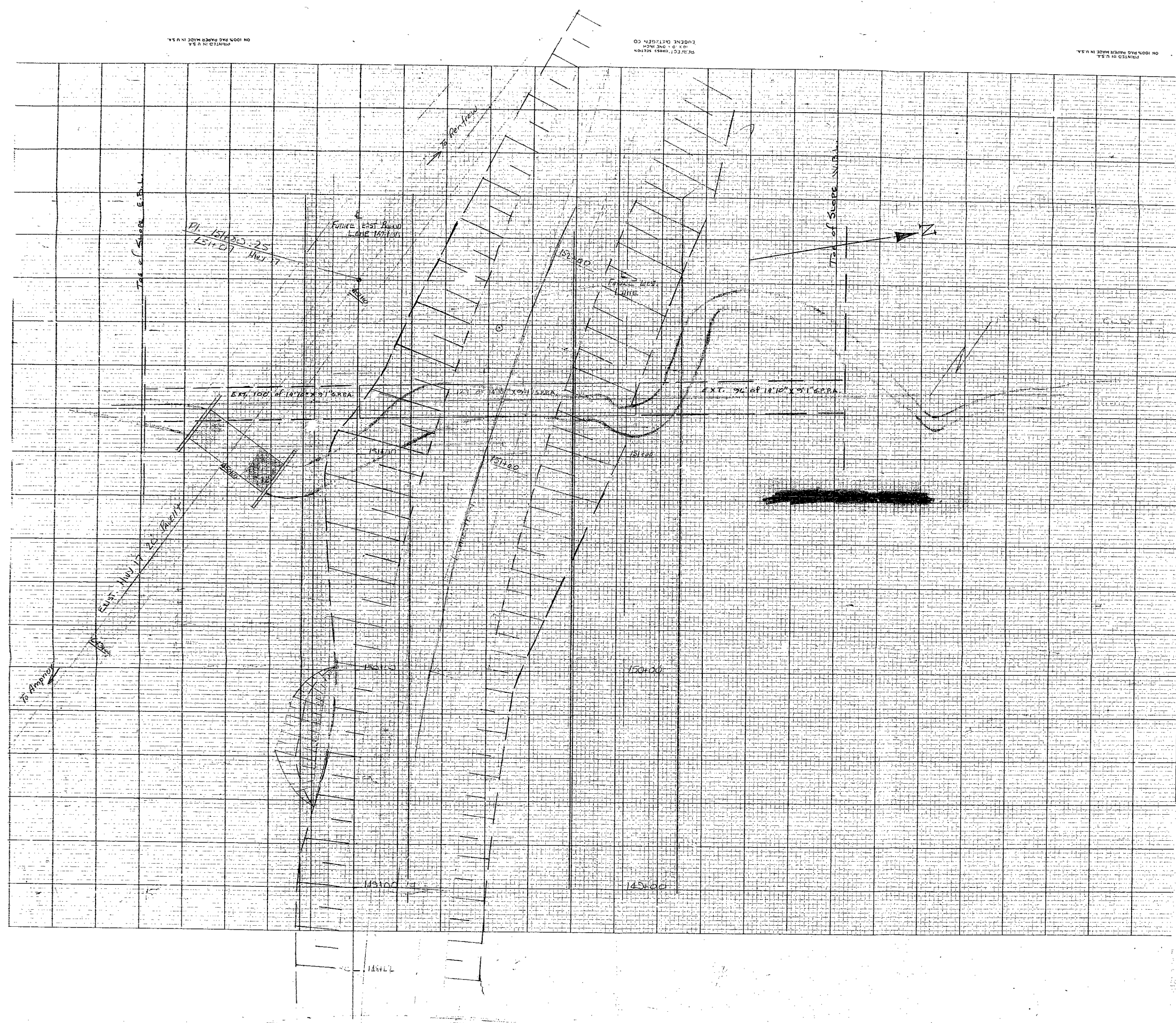
NEW HWY #17

SITES 'A' & 'B'









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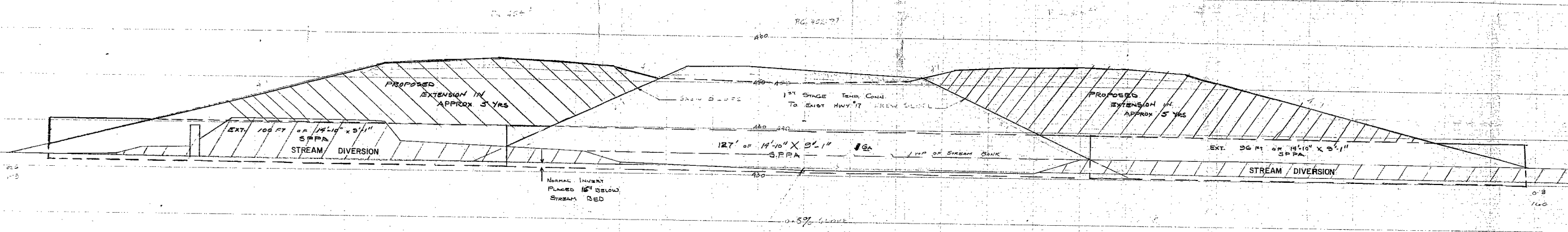
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FUTURE E.B.L.  
151+24

CONNECTION TO EXIST. HWY. 77  
AT WEST END OF PROJECT  
151+30

FUTURE V.B.L.  
151+27



PROFILE OF PROPOSED E.B.L. - NEW

0+70  
STATION

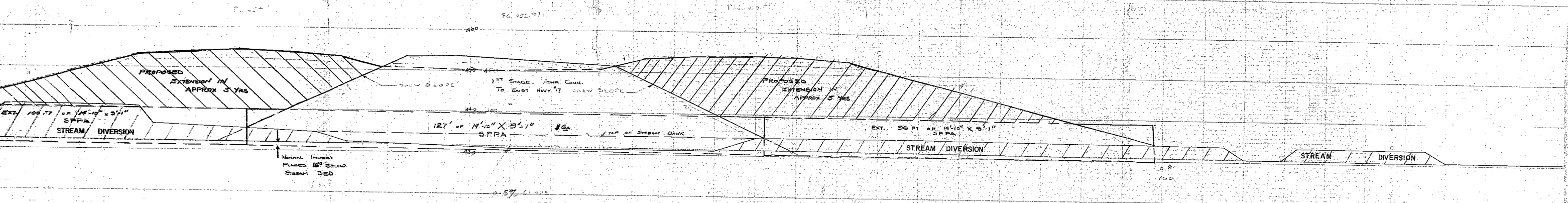
PROFILE OF EXIST. E.B.L.



FUTURE E.B. 15124

CONNECTION TO EXIST. HWY 17  
AT WEST END OF PRO. LOT  
151130

FUTURE W.B. 151127



PROFILE OF PROPOSED NEW

0+00  
151130  
E.B. 151130