#59-F-236-C

W.P. 90-60

JEANNETTE CREEK

S.W. of CHATHAM,

N. of HWY #401

ON CO. RD. 27

BA953

# WILLIAM A. TROW AND ASSOCIATES LTD.

SITE INVESTIGATIONS
AND
SOIL MECHANICS CONSULTATION

W. A. TROW, MASC., M.E.I.C., P.ENG.

884 WILSON AVE.,
DOWNSVIEW, ONT.
ME. 5-5921

Project: J420

October 15, 1959

Mr. A. Rutka,
Department of Highways of Ontario,
Materials and Research Branch,
Parliament Buildings,
Toronto 5, Ontario.

59-F-236

Attention: Mr. L.G. Soderman, P. Eng.,
Principal Soils and Foundation Engineer.

Re: Foundation Investigation, Proposed Bridge
over Diverted Jeannette Creek, W.P. 90-60.

Dear Sirs:

Enclosed herewith is our report on the soil conditions encountered under the bridge site noted above.

The soil types at this location are essentially similar to those existing under the proposed overpass structure reported by us on Oct. 2nd. However, because the bridge loads will be light and no approach embankments are involved, no foundation problem of consequence appears to exist.

Abutment footings should be carried to support on very stiff clay till at levels ranging from elevation 574 to elevation 572 feet. This requirement places the footings about 17 feet below the present ground surface and about 8 to 10 feet below the proposed channel of diverted Jeannette Creek. The net safe bearing value to apply at these depths is 5000 psf. No ground water difficulties should be anticipated when digging to this level; the sides of the excavation should remain stable although light shoring of vertical walls will be required in order to comply with provincial safety regulations.

The sides of the proposed Jeannette Creek diversion can be cut on 1 : 1 slopes. This is the approximate natural slope of the existing creek banks.

We hope that this report is of assistance to you in the prepara..on of foundation designs for this structure. Please contact us if other thoughts come to mind after you have reviewed its contents.

Yours very truly,

W. A. Trow

William A. Trow, P. Eng.

WAT/kb
ENC.

DEPARTMENT OF HIGHWAYS OF ONTARIO
MATERIALS AND RESEARCH BRANCH
PARLIAMENT BUILDINGS, TORONTO, ONTARIO

# FOUNDATION INVESTIGATION
# PROPOSED BRIDGE OVER DIVERTED JEANNETTE CREEK
# W.P. 90-60

Project: J420

Oct. 15, 1959

William A. Trow & Associates Ltd.

## TABLE OF CONTENTS



## ENCLOSURES

# FOUNDATION INVESTIGATION
# PROPOSED BRIDGE OVER DIVERTED JEANNETTE CREEK
# W.P. 90-60

This report describes the soils investigation carried out at the above site. The type of foundation most suitable for the soil conditions encountered is indicated. Permissible footing capacities are reported.

## Description of Site

The site of this proposed creek crossing lies just north of the route of Highway 401, on county road No. 27 south west of Chatham, Ontario.

County road No. 27 passes through flat farmland at the proposed bridge location. The surrounding terrain is at the same relative elevation as the road or approximately elevation 589 feet. Ditches parallel the county road providing adequate drainage.

It is proposed to divert Jeannette Creek from its present course which passes some 800 feet north of the site investigated. The bed of the new waterway will be at elevation 582 feet approximately. The proposed structure will have a clear span of approximately 30 feet. Except for one minor pond Jeannette creek was dry at the time of the investigation. However, it is reported that the creek overflows its banks in low areas during flood periods. Its banks and bed were overgrown with willows and grasses and no evidence of river erosion could be seen. The slopes of the banks of the creek were approximately 1 : 1 and its bed was about 8 to 10 feet below the adjacent ground surface.

## Soil Types Encountered

Drawing 1 shows the locations of the two borings put down at this site and also illustrates the subsoil profile that was estimated from the borehole results.

Loose brown silt deposits were found to extend from ground surface to elevation 584. These brown silts are underlain by a thin layer of stratified silt-clay. This lacustrine stratum overlies silty clay till which normally extends to considerable depth in this locality. A thin zone of grey silty clay, apparently homogeneous in composition, marks the change from the stratified clay to the lower glacial till. This stratum ranges from about 1 to 2 feet in thickness and lies between elevation 575 and 580 feet.

The cohesive strata proven by the borings to a minimum elevation of 563 feet were generally of a very stiff consistency. This is with the exception of a medium stiff zone encountered in hole 5 between depths of 10 and 17 feet.

Both borings remained dry during their advance and for at least 24 hours after completion. From this observation it would appear that seepage would not be a problem even in very deep excavations.

Foundation Considerations

When choosing a suitable foundation depth for the support of the bridge abutments consideration must be given not only to bearing capacity requirements but also to the possible depth of scouring. Decisions on this latter matter are beyond the scope of this report. However, in view of the flatness of the ground in this area and the generally high resistance to erosion of clay soils, river bed scour should not be great provided the backfill of the footing excavations is suitably protected with gravel and rip-rap. The overgrown nature of the creek bed appears to confirm this view.

It is understood that the general rule, applied in the Dept. of Highways, for scour protection, is to set abutment footings 8 feet below creek bed level. This would place the footings at approximate elevation 574 feet or about 16 feet below the general surface of the county road. Very stiff clay till having a shearing resistance of the order of 2500 psf was encountered at and below this level, in hole 6, at the south west corner of the proposed bridge. However, about 2 feet of relatively softer clay overlies this stiff till below elevation 574 at the north abutment location. The shearing resistance of the clay at elevation 574 feet on this north side is about 900 psf increasing sharply at elevation approx. 572 feet to 2600 psf. Therefore, in order to obtain uniform bearing conditions, the north abutment should be taken down to the very stiff till which begins near elevation 572 feet.

The recommended safe bearing value of this very stiff till is 5000 psf. This is the net increase in pressure, in excess of overburden weight, that can be applied at footing level. Since some minor variations may exist in the contact level of this very stiff till particularly at the north abutment site it may be necessary to probe in order to ensure that none of the overlying medium stiff clay remains. A suggested criterion for resolving the uncertainty is to push a 1 inch square bar into the soil by hand. This bar should penetrate into the medium stiff clay under a load of about 40 pounds; however much higher resistance will be offered by the underlying till. The settlement to be experienced with the application of the recommended pressure of 5000 psf should be less than 1 inch particularly in view of the relief in stress to be experienced when the new channel for Jeannette Creek has been dug.

An alternative method of support for the bridge abutments is the use of displacement or end-bearing piles. However, the size of the structure and the necessity to provide scour protection would appear to favour simple spread footings. Work on the main underpass structure of Highway 401 immediately to the north indicated that displacement piles 1 foot in diameter and 40 feet long would have a safe capacity of 35 tons per pile. Bedrock exists probably at a depth of about 70 to 80 feet at this site. Steel H piles could be driven to refusal in the rock. The capacity of this type of pile will depend on its structural properties, acting as a short column. Sheet pile cut-off walls could be utilized to provide scour protection around the base of the abutments.

Summary of Comments and Conclusions

A surface deposit of loose brown silt extends to a depth of 5 feet below general ground level at this site. A stratified silt-clay stratum 4 to 7 feet thick was encountered below these loose silts. This lacustrine deposit is of a very stiff consistency. A thin zone of silty clay divides these stratified soils from the glacial till which underlies the area.

These latter soils were found to be of medium stiff consistency between elevations 579 and 572 feet in hole 5 at the north east corner of the site. At other levels and in hole 6 they were very stiff.

Proposed creek bed elevation is 582 feet approximately. In order to provide scour protection and to obtain support below the medium stiff clay indicated above, footings must be taken down to elevation 574 feet on the south side of the bridge and almost to elevation 572 under the north abutment. The recommended safe bearing value of the soil at these levels is 5000 psf. No seepage problem can be foreseen during excavations to the depths indicated.

Either large displacement or steel end-bearing piles could be used in conjunction with a sheet pile cut-off wall as an alternative foundation proposal for the bridge structure.

Maximum slopes of 1 : 1 appear feasible for the banks of the creek diversion. These slopes could be provided with a vegetative covering to minimize erosion.

D.H. Shields

Donald H. Shields, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
CIVIL
D. H. SHIELDS
PROVINCE OF ONTARIO

DHS/kb
Oct. 15, 1959
J420

# APPENDIX 1

## Description of Field Work

One boring was put down at each abutment location as shown in drawing 1. Continuous flight auger equipment was used to form the boreholes. The holes were 5 inches in diameter and were uncased to full depth.

Samples were recovered at various intervals as the holes progressed. Both disturbed and undisturbed samples were taken depending upon the soil encountered. A standard 2 inch O.D. split spoon was used to recover disturbed soil samples. This sampler was driven into the soil using a hammer transmitting 350 ft.lbs. of energy. The number of hammer blows of this magnitude required to drive the sampler from 6 to 18 inches penetration into the undisturbed soil ahead of the boring was recorded. This numerical value is the penetration resistance of the soil at the sampling depth. On withdrawal the sampler was dismantled and the soil classified and retained in moisture-proof containers.

Relatively undisturbed samples of the soil ahead of the boring were taken with thin-walled Shelby tubes. The tubes were 2 inches in inside diameter. Whenever possible, the Shelby tubes were pushed into the soil. If this proved impossible the tubes were driven in accordance with the procedure outlined for the split spoon. On withdrawal, the samples were sealed in the steel tubes and brought into the laboratory.

When the augers were withdrawn prior to each sampling operation, the soil retained in the flights was identified. In this way a continuous record of the subsoil types was made. Careful note was also taken of the ground water conditions in each boring both during the advance of the hole and for a period of time after its completion.

Borehole elevations were referenced to the centreline elevation of the county road apposite each boring. The centreline elevations were taken from the DHO Profile F 3533-3.

In addition to sampling, field vane measurements were made of the shear strength of the cohesive soil in each boring. A $2\frac{3}{4}$ inch diameter four-bladed vane was pushed into the undisturbed soil. The torque required to rotate the vane was recorded. When this value is related to the vane dimensions, the shear strength of the soil can be computed. The soil was then completely remoulded by rotating the vane several times. The ratio of the torque required to rotate the vane in undisturbed and remoulded material is recorded as the sensitivity of the soil to disturbance.

A log showing sampling intervals, field vane measurements, soil types encountered and water level observations is presented for each boring. Drawings 2 and 3 are the logs for borings 5 and 6 respectively.

Laboratory Testing

Measurement was made of the natural moisture content of each sample taken in the field. Atterberg limit determinations were carried out on selected representative samples. The natural unit weight of the soil was computed from the volume-weight measurements of the Shelby tube samples.

An undrained triaxial test was performed on each 2 inch diameter Shelby tube sample. A cylindrical specimen of soil was surrounded by a confining pressure equal at least to the total pressure existing in the soil at the depth from which the sample was taken. The sample was then failed in axial compression at a constant rate of strain. No drainage of the sample was permitted. The shear strength of the soil was considered to be ½ of its compression strength.

The results of these laboratory determinations are presented in table 1. The field vane measurements are also recorded here.

Actual stress-strain curves recorded during the triaxial and unconfined tests are presented in drawing 4.

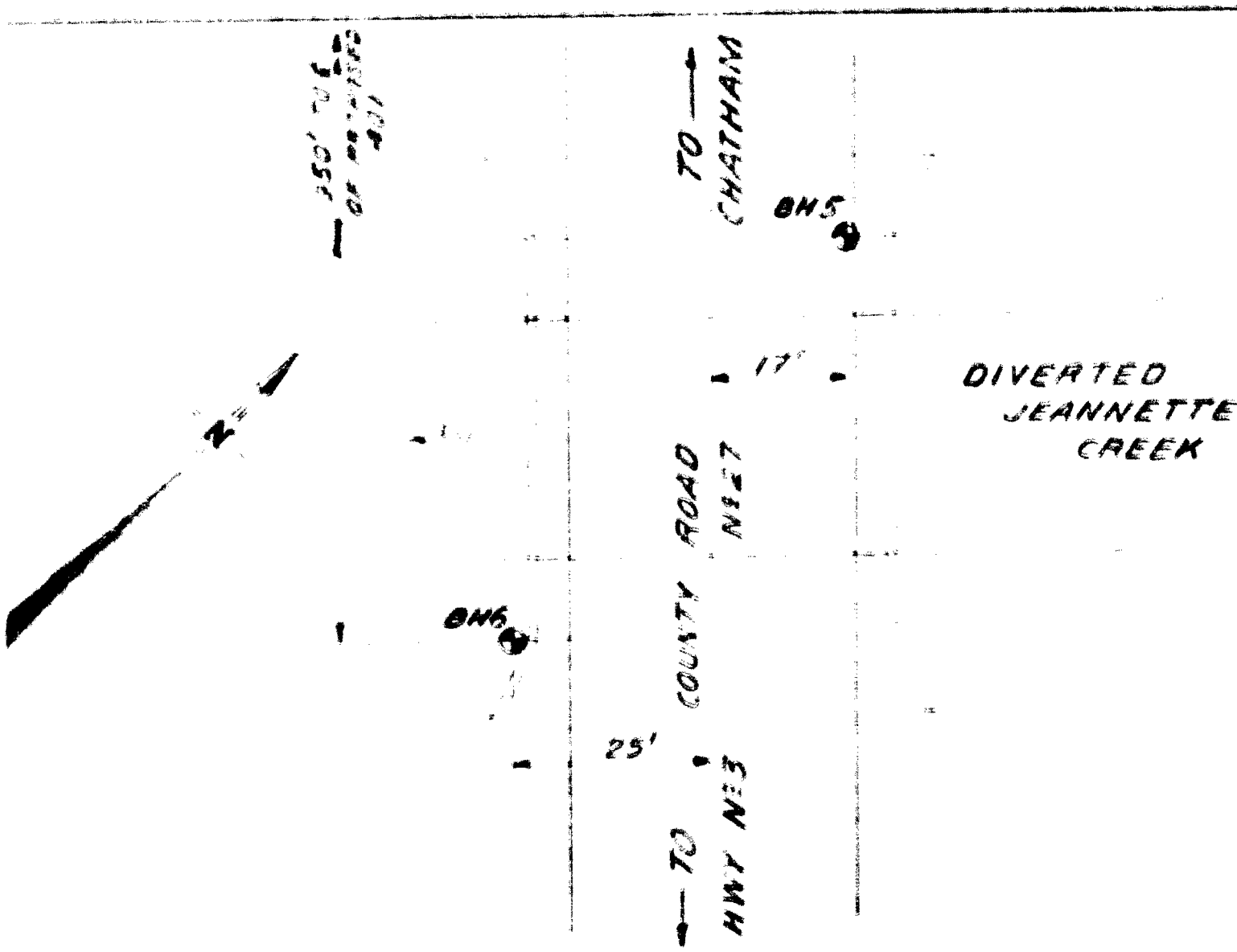
All of the laboratory and field vane measurements are recorded in the borehole logs.

## SUMMARY OF LABORATORY AND FIELD TEST RESULTS

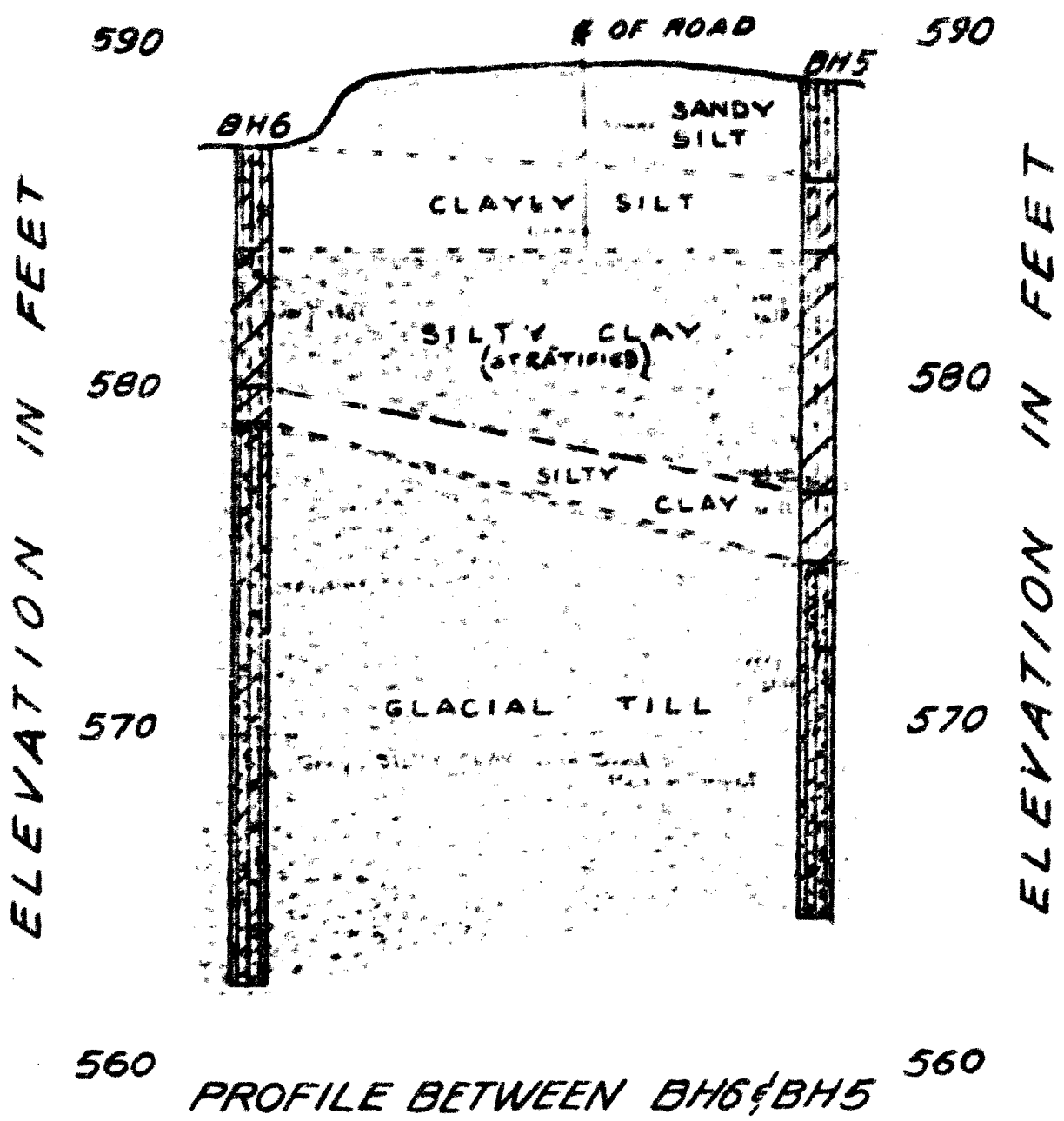
| Hole No. | Sample No. | Depth Ft. | Description | Shear Strength Field Vane psf | Shear Strength Undrained Triaxial psf* | Natural Moisture % dry wt. | Atterberg Limits PL | Atterberg Limits LL | Natural Unit Weight pcf |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 1 | 3-4½ | Mottled brown clayey silt. | | | 22.0 | 17.9 | 29.7 | |
| | | 5½ | Could not insert vane. | 2100+ | | | | | |
| | | 9 | Could not insert vane. | 2100+ | | | | | |
| | 3 | 8-9½ | Layers of clay and silt, 1/16 to 1/32 inch thick. | | | 27.5 | 18.0 | 34.3 | |
| | | 12 1/3 | | 924 | | | | | |
| | 4 | 13-14½ | Grey silty clay with fine to medium gravel sizes, slightly lensed. | | 825 | 24.6 | 16.4 | 29.5 | 125.1 |
| | | 15½ | | 965 | | | | | |
| | | 18 | Beyond vane capacity. | 2100+ | | | | | |
| | 5 | 18-19½ | Grey slightly fissured silty clay. Slightly sandy with fine to medium stones. | | 2600 | 17.8 | 15.9 | 29.6 | 131.8 |
| 6 | | 4½ | Beyond vane capacity. | 2100+ | | | | | |
| | | 8 | Beyond vane capacity. | 2100+ | | | | | |
| | | 10½ | Could not insert vane. | 2100+ | | | | | |
| | 4 | 13-14½ | Grey clayey silt with some sand and fine angular gravel. | | 3250 | 15.5 | | | 134 |
| | 5 | 18-19½ | Grey silty clay with sand and fine to med. subangular gravel. | | 2300 | 18.2 | | | 136 |

LEGEND * - Tested at overburden pressure. PL - Plastic limit. LL - Liquid limit.

Table 1




## LOCATIONS OF BOREHOLES




PROFILE BETWEEN BH6 & BH5
SCALES: HORIZONTAL 1 IN = 20 FT
VERTICAL 1 IN = 5 FT

PROPOSED JEANNETTE CREEK STREAM DIVERSION
JOB Nº 420 DWG Nº 1 OCT. 8, 1959
William A Trow & Associates

PROJECT NO. J420 DRAWING NO. 2

# WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Drive - W.P. 20-60
LOCATION Bloomfield Rd., 1450 Ft. S. of proposed Hwy 401.
HOLE LOCATION See drawing 1.
HOLE ELEVATION AND DATUM 589.0 - C.L. of Road opposite Hole No. 6 = 589.5
BOREHOLE NO. 5
FIELD SUPERVISOR
DRILLER
PREP.

LEGEND
1" DIA. SPLIT TUBE
3" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
CASING
3" SHELBY
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

| SYMBOL | DESCRIPTION | ELEV. FEET | DEPTH FEET |
|---|---|---|---|
| | | 589.0 | 0 |
| | Brown sandy silt - loose. | 586.0 | |
| | Mottled clayey silt - loose. | 584.0 | |
| | Stratified silt-clay. Layers 1/32 to 1/16 inch thick. Very stiff to 10 feet. | 577.0 | 10 |
| | Grey silty clay - medium stiff. | 575.0 | |
| | Glacial till. Grey silty clay with sand to medium gravel sizes. | | 20 |
| | End of Hole. | 564.5 | |

Notes: 1) Continuous flight auger equipment for 3½" diam. holes.
2) Hole backfilled to full depth.
3) Energy of 350 ft.lbs used to drive samplers.
4) Could not push in tube at 5½', 9' and 14'.
5) Hole remained dry to full depth for 24 hour period after completion.

STRENGTH AND PENETRATION RESISTANCE
S.P.T. Strength P.S.F. 1000 2000
BLOWS/FT. 10 20 30 40

CONSISTENCY
MOIST. CONTENT - % DRY WT. 20 30 40

| SAMPLE | NATURAL UNIT WT. P.C.F. |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 pushed | 125.1 |
| 5 | 131.8 |
| 6 | |

PROJECT NO. J420

DRAWING NO. 3

## WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Bridge - W.P. 90-80

LOCATION Bloomfield Rd., 1000 ft. S. of proposed Hwy 401.

HOLE LOCATION See drawing 1

HOLE ELEVATION AND DATUM 587.2 - C.L. of Road opposite Hole No. 6 = 589.5

BOREHOLE NO. 6

FIELD SUPERVISOR

DRILLER

PREP.

LEGEND

- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION [Qu]
- VANE TEST [C] AND SENSITIVITY [S]
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

| SYMBOL | DESCRIPTION | ELEV. FEET | DEPTH FEET |
|---|---|---|---|
| | | 587.2 | 0 |
| CH | Loose brown clayey silt, slightly organic. | | |
| | Stratified silt-clay. Layers 1/32 to 1/16" thick, sand lenses noted, very stiff at first. | 584.2 | |
| | Grey silty clay, very stiff. | 580.2 | |
| | Glacial till. Grey silty clay with sand to medium gravel sizes, very stiff. | 579.2 | 10 |
| | | | 20 |
| | End of hole. | 562.7 | |

STRENGTH AND PENETRATION RESISTANCE

Shear Strength P.S.F. 1000 2000

BLOWS/FT. 10 20 30 40

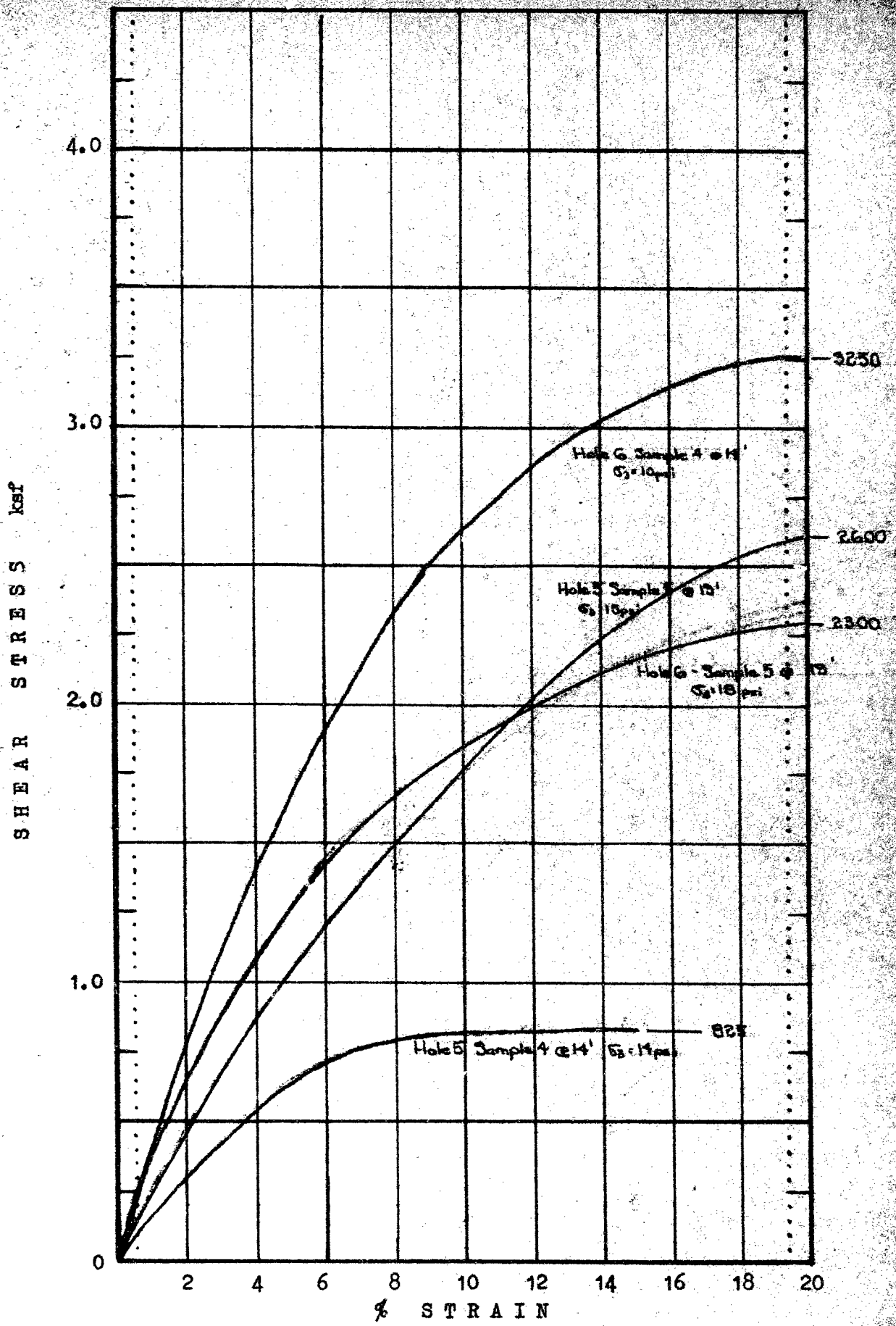
CONSISTENCY

MOIST. CONTENT - % DRY WT. 20 30 40

SAMPLE

NATURAL UNIT WT. P.C.F.

Notes: 1), 2) and 3) as in hole 5.
4) Could not push in vane at 4½ and 10½ feet.
Beyond vane capacity at 8 ft.
5) Hole remained dry to full depth for at least 6 hours after completion.




TRIAXIAL TEST RESULTS ON SAMPLES FROM HOLES No. 5 AND 6

Jeannette Creek
Upstream of County Road 27

Location of Proposed Bridge -
Jeannette Creek to be Diverted
Drill on Hole 6 - Spoil from Hole 5 on Right
Looking North

Jeannette Creek
Upstream of County Road 27

Location of Proposed Bridge -
Jeannette Creek to be Diverted
Drill on Hole 6 - Spoil from Hole 5 on Right
Looking North