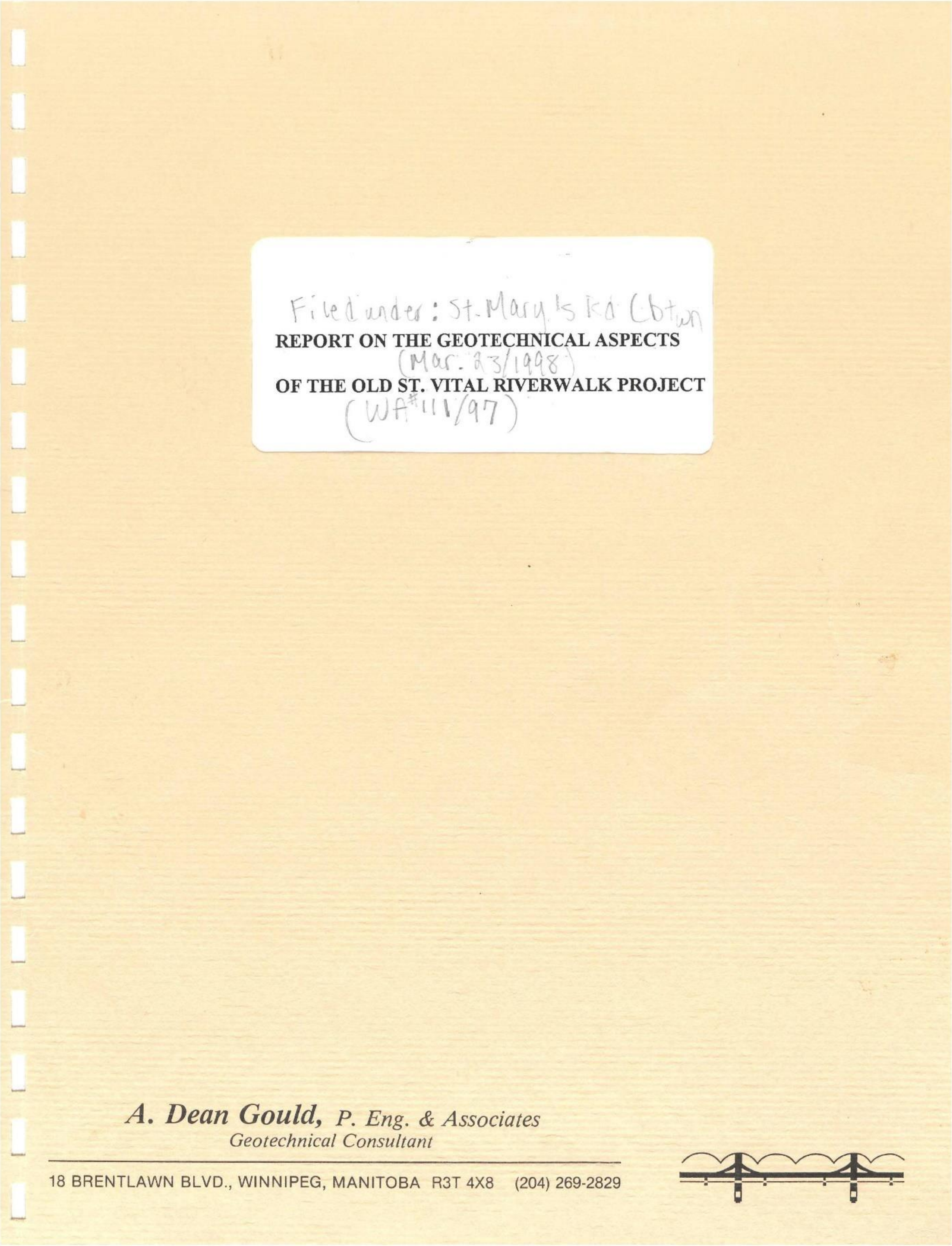
APPENDIX ‘A’

Report on the Geotechnical Aspects of the Old St. Vital Riverwalk Project

APPENDIX 'A' – REPORT ON THE GEOTECHNICAL ASPECTS OF THE OLD ST. VITAL RIVERWALK PROJECT



Filed under: St. Mary's Rd (btwn

REPORT ON THE GEOTECHNICAL ASPECTS

(Mar. 23/1998)

OF THE OLD ST. VITAL RIVERWALK PROJECT

(WA# 111/97)

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HILDERMAN THOMAS, FRANK, CRAM

Filed under: St. Mary's Rd (btwn Vivian & Harrowby)

REPORT ON THE GEOTECHNICAL ASPECTS

(Mar. 23/1998)

OF THE OLD ST. VITAL RIVERWALK PROJECT

(WA#111/97)

W/A: 111/97

THE CITY OF WINNIPEG
WATERWAYS SECTION
MAR 27 1998
RECEIVED

FILE NO. 7016

DATE; MARCH 23, 1998

PREPARED BY; A. DEAN GOULD P.ENG

GEOTECHNICAL CONSULTANT

PROVINCE OF MANITOBA
24/3/98
A. D.
GOULD
REGISTERED ENGINEER

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APPENDIX

1. Terms of Reference

In accordance with the May 12 , 1997 offer of service proposal to Hilderman, Crosby, Thomas, Cram the writer, a Geotechnical Consultant was authorized to address the Geotechnical issues of the Old St. Vital Riverwalk project and assist Dillon Consulting in the structural design. The work was to include;

- Review of historical Geotechnical Studies and Reports
- Assistance with the structural design of the project elements including the walkway, interpretive outlook and pathways
- Preparation of a report to the Waterways Section of the Department of Planning addressing the Geotechnical issues.

2. Background

The St. Vital Site is well known for riverbank instability and has been the subject of many academic, City of Winnipeg and Geotechnical community studies. These studies have involved extensive drilling, sampling, movement monitoring and more recently ground water impact studies on these same movements. A partial listing of the studies are as follows;

1960	Baracos; "The stability of riverbanks in the metropolitan Winnipeg Area" Proc. 14th Canadian Soil Mechanics Conf.
1967	Winnipeg Geotechnical Group; "Report on Activities of Case History Subgroup"

1972	City of Winnipeg Transportation Division Ripley Klohn and Leonoff; “Report on Riverbank Stability St. Mary’s Road”
1978	Baracos; “Effects of River Levels, Ground water and Other Seasonal Changes on Riverbanks in Winnipeg” 31st Canadian Geotechnical Conference
1994	City of Winnipeg - Rivers and Streams Authority KGS, UofM, R&S; “Role of Ground water in Riverbank Stability”

These studies have provided a wealth of information on soil profile, riverbank movement, insitu and laboratory soil strength parameters, piezometric pressures, river levels and ground water impacts. All have resulted in the conclusion that the St. Vital riverbank is currently in a marginally stable condition (Factor of Safety against Sliding 1.0) and that movement occurs along a non circular surface parallel to the glacial till strata at or about elevation 215.4. The movement plane as determined through slope indicator installations (1969) extends from the Red River channel to a surface scarp which is located 40 metres from the Normal Summer waters edge (Ripley, Klohn and Leonoff 1972). The riverbank movement rates can be during periods of the year as high as 0.7 mm /day on a riverbank slope which is currently at approximately 9H:1V. Movement is normally concentrated within the summer - winter period coinciding with Red River drawdown periods. Stabilization measures to limit movement have been undertaken in the Mager Drive area (1997) and earlier in the Lyndal Drive riverbank. These stabilization measures both include the construction of shear keys which extend from winter water level some 6 metres to the glacial till surface. These have been installed into the lower riverbank and have proven very costly. Stabilization of the riverbank at the Old St Vital Riverwalk project area is considered at this time uneconomical, consequently design approaches to the proposed Riverwalk structural units are to take a "passive" approach where movement can be accepted rather that the "active" approach where movement must be resisted.

3. Proposed Works

The proposed works as shown on the Hilderman, Crosby, Thomas, Cram drawings are to consist of the widening of the sidewalk along the west side of St Mary's Road and the construction of a projected outlook equipped with a steel arch, lighting standards and railings. The proposed elevation of the outlook is 230. The 160 year Flood Level at this location is 230.64 or top of riverbank at street level. Currently a timber pile wall exists along the west edge of the sidewalk which was constructed in 1973. The timber piles are 40 feet (12.2 metres) in length and are spaced at 1'-6" (0.46m) c-c. The tips of the piles terminate at elevation 219 some 3 metres above the glacial till surface, consequently are not considered as end bearing.

4. Impact on Riverbank Stability

The attached riverbank cross section has been developed from a survey performed by Bastin and Shepherd, Manitoba Land Surveyors on June 30, 1997. It reflects current topography and the position of the Retaining wall throughout the entire riverbank area.

Analysis of the riverbank stability using the following soil strength parameters has been performed by the writer. The non circular failure surface shown, reflects the soil profile and slope indicator data by Ripley Klohn and Leonoff of 1972.

Effective Soil Strength Parameters re; Janzen 1971 and based upon Direct Shear testing are;.

Brown Clay	Angle of Internal friction (res) = 13.0 degrees
	Cohesion = 3.4 kPa
Grey Clay	Angle of Internal Friction (res) = 8.0
	Cohesion = 3.4 kPa

Applying piezometric pressures in the analysis from the 1994 City of Winnipeg Rivers and Streams Report on "Role of Ground water in Riverbank Stability" the Computed Factors of Safety against sliding are;

At NWWL = 1. 01

From these calculations and those of previous investigators it is evident that current conditions are similar to those analysed earlier and a marginal state of stability exists. The retaining wall serves to support the St. Mary's road grade and sidewalk but does little to offer stabilization. The proposed project will not influence either negatively or positively the present condition of stability.

Inspection of the wall on March 23, 1998 indicated lateral movement had occured through the winter of 1997/98 resulting a 50mm displacement between the sidewalk and the road pavement.

5. Geotechnical Design Approach

To accept riverbank movement in the design of structural works, we propose to utilize the St. Mary's pavement as an anchor and support the sidewalk and observation area on existing and new cast in place concrete pilings which have an allowance for movement of up to 700 mm. We propose;

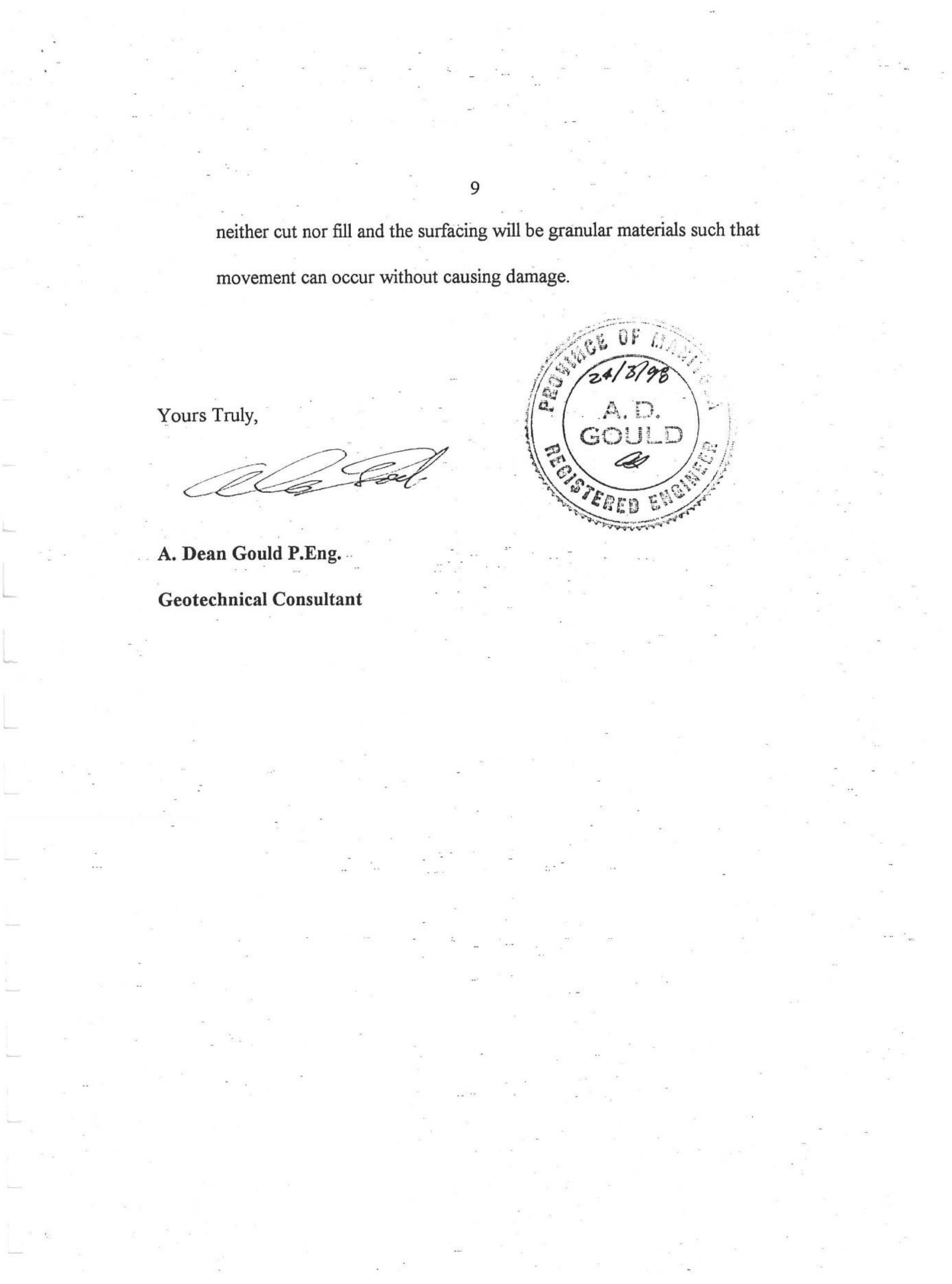
A. New cast in place concrete pile foundations are proposed for the structural concrete observation deck. Cast in place pilings are recommended over prebored driven pilings since driving vibration may cause further destabilization of the riverbank. The piles should be end bearing on the dense glacial till at or near Elevation 214.5 The allowable end bearing capacity of the glacial till should be 574 kPa. It is recognized that the deck loading will have a high component of live loading produced by snow clearing equipment. Since this loading will occur infrequently during frozen soil conditions, the allowable end bearing capacity which includes a Factor of Safety of 3 against punching failure, may be exceeded for short duration at the discretion of the designer.

B. A slip joint between the deck and the top of pile should be provided to allow pile movement with respect to the deck structural components. The end bearing piles will arrest vertical movement, however lateral movement can be anticipated consequently a slip joint of Teflon or other materials will allow movement equal to 75% of the pile diameter. Since riverbanks are known to creep at a rate of approximately 15-20 mm/year, a 400mm diameter pile would provide sufficient lateral movement for approximately 15-20 years before additional corbal would be required.

C. The deck will be tied into the St. Mary’s pavement slab such that the pavement slab will provide anchorage to lateral movement. The strength and durability of the slab/deck connection must be carefully considered. Vertical movement that may occur of the pavement resulting from continued riverbank creep should be repaired through concrete underslab grouting rather than asphalt overlays. During construction of the deck close examination of the west edge of the St. Mary’s pavement should be made and any void, grouted or filled with concrete.

E. During construction, no fill, or materail storage should be permitted on the riverbank.

F. The proposed walkway leading to and along the lower slope involve



neither cut nor fill and the surfacing will be granular materials such that movement can occur without causing damage.

24/3/98
A. D.
GOULD

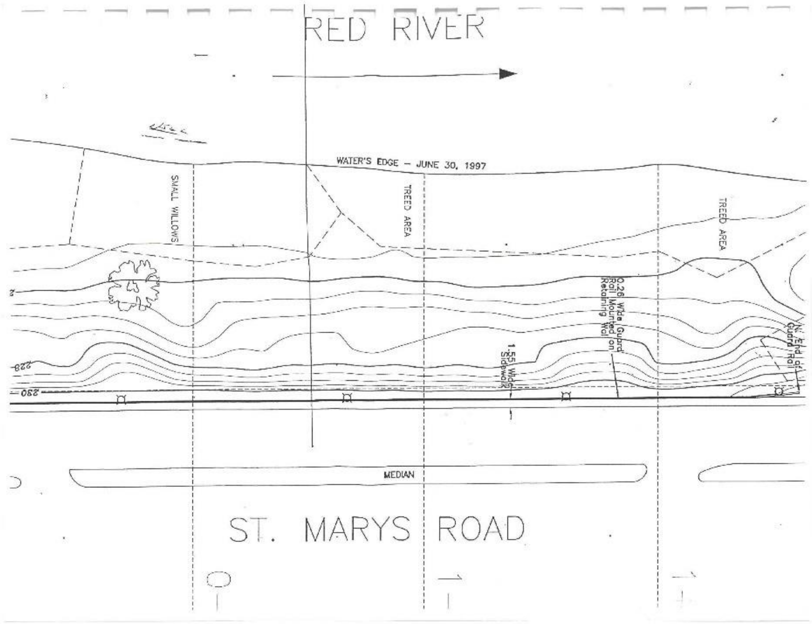
Yours Truly,

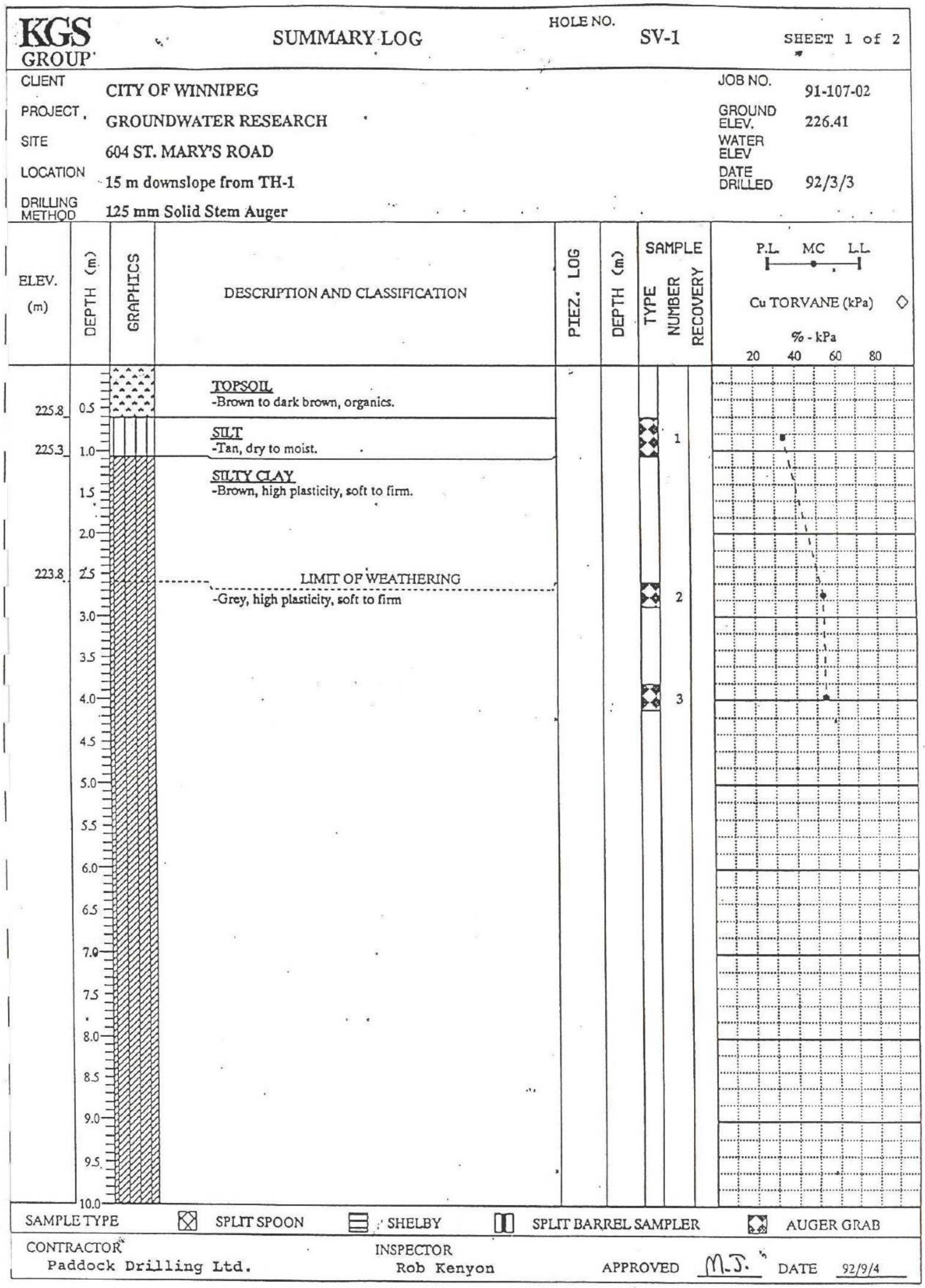
A. Dean Gould P.Eng.

Geotechnical Consultant

APPENDIX

- Location Plan of Project
- Soil Logs
- Riverbank Profile


RED RIVER
WATER'S EDGE – JUNE 30, 1997
SMALL WILLOWS
TREED AREA
TREED AREA
0.26 Wide Guard Rail Mounted on Retaining Wall
1.55 Wide Sidewalk
N. End of Guard Rail
228
230
MEDIAN
ST. MARYS ROAD



KGS GROUP

SUMMARY LOG

HOLE NO. SV-1

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG	JOB NO.	91-107-02
PROJECT	GROUNDWATER RESEARCH	GROUND ELEV.	226.41
SITE	604 ST. MARY'S ROAD	WATER ELEV	
LOCATION	15 m downslope from TH-1	DATE DRILLED	92/3/3
DRILLING METHOD	125 mm Solid Stem Auger		

ELEV. (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION
	0.0	**TOPSOIL** -Brown to dark brown, organics.
225.8	0.5	**SILT** -Tan, dry to moist.
225.3	1.0	**SILTY CLAY** -Brown, high plasticity, soft to firm.
223.8	2.5	LIMIT OF WEATHERING -Grey, high plasticity, soft to firm

SAMPLE: 1, 2, 3

P.L. MC L.L.

Cu TORVANE (kPa) ◇

% - kPa

20 40 60 80

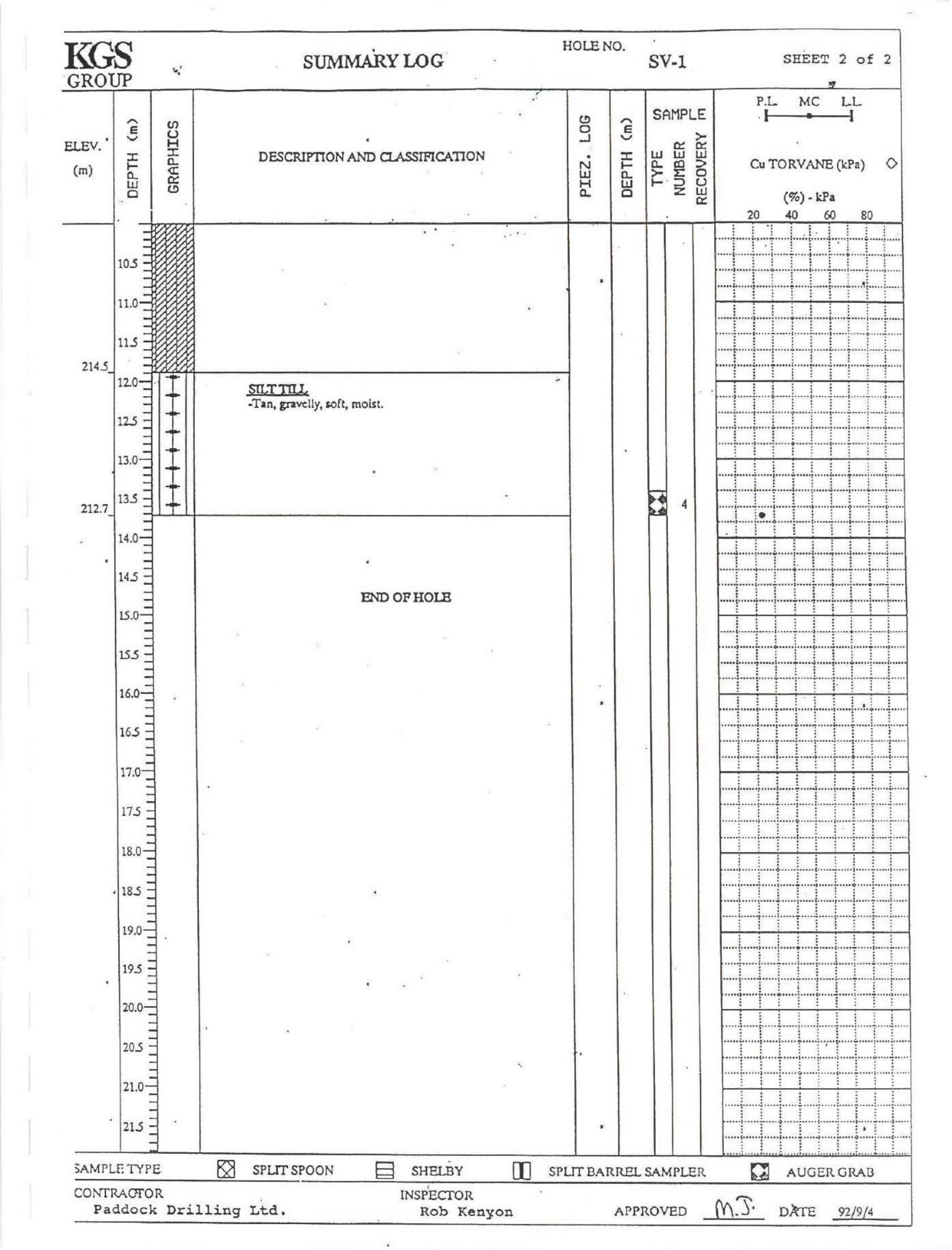
SAMPLE TYPE ⊠ SPLIT SPOON ☰ SHELBY ▯▯ SPLIT BARREL SAMPLER ⊠ AUGER GRAB

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR Rob Kenyon

APPROVED M.J.

DATE 92/9/4



KGS GROUP

SUMMARY LOG

HOLE NO. SV-1

SHEET 2 of 2

ELEV. (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	SAMPLE NUMBER
214.5	12.0	**SILT TILL** -Tan, gravelly, soft, moist.		
	13.6		⊠	4
212.7	13.7	END OF HOLE		

P.L. MC L.L.

Cu TORVANE (kPa) ◇

(%) - kPa

20 40 60 80

SAMPLE TYPE ⊠ SPLIT SPOON ▤ SHELBY ◫ SPLIT BARREL SAMPLER ⊠ AUGER GRAB

CONTRACTOR
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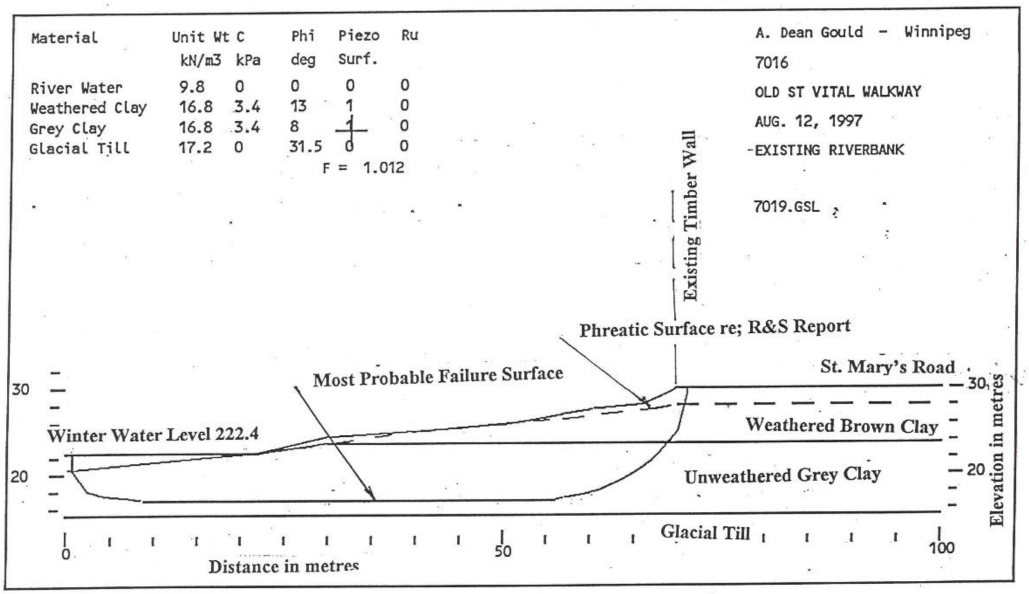

Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
River Water	9.8	0	0	0	0
Weathered Clay	16.8	3.4	13	1	0
Grey Clay	16.8	3.4	8	1	0
Glacial Till	17.2	0	31.5	0	0

F = 1.012

A. Dean Gould - Winnipeg
7016
OLD ST VITAL WALKWAY
AUG. 12, 1997
EXISTING RIVERBANK

7019.GSL

Note; Add 200 to elevations shown for Geodetic Datum

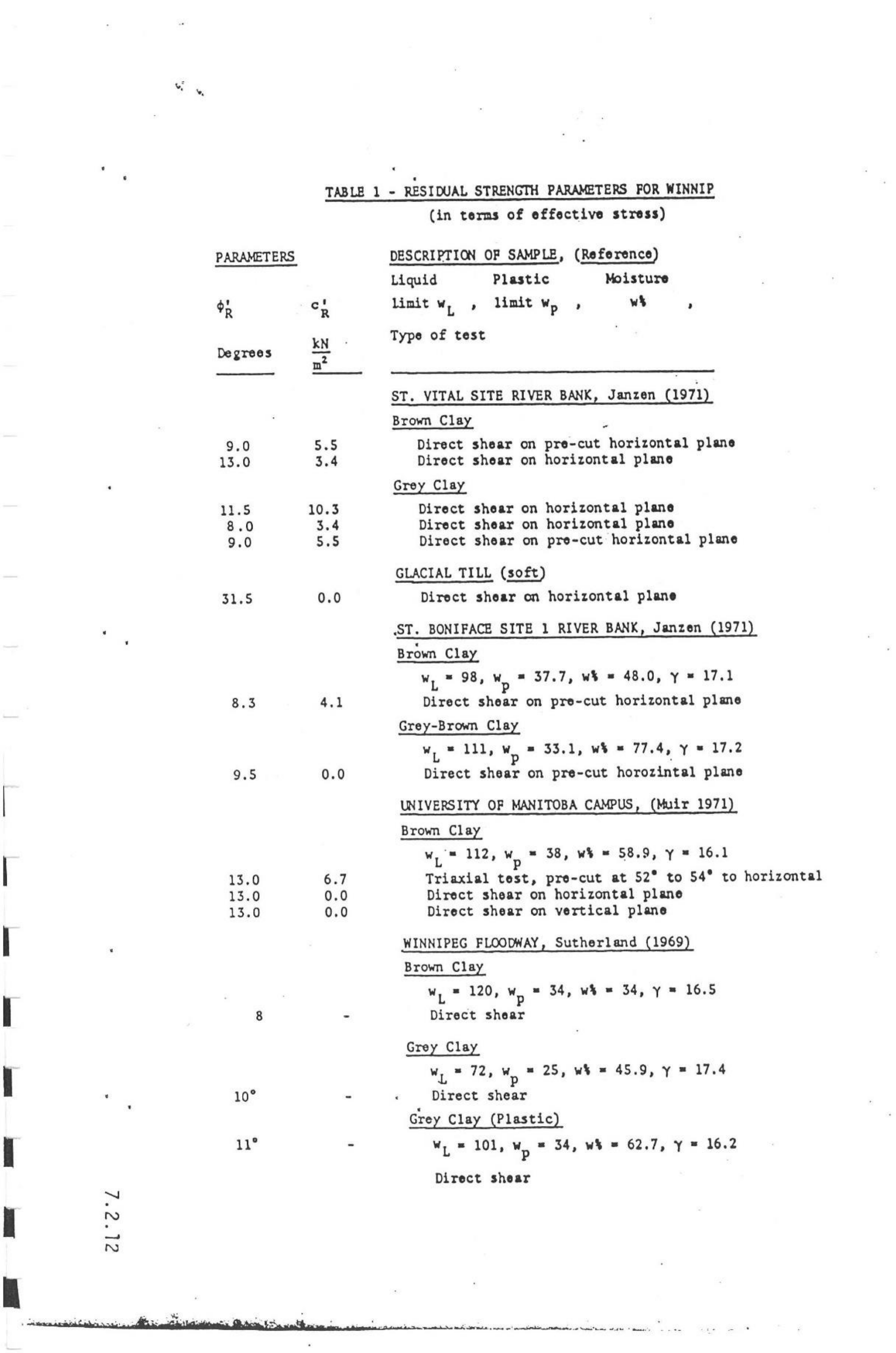

TABLE 1 - RESIDUAL STRENGTH PARAMETERS FOR WINNIP

(in terms of effective stress)

PARAMETERS ϕ'_R Degrees	c'_R $\frac{kN}{m^2}$	DESCRIPTION OF SAMPLE, (Reference) Liquid limit w_L, Plastic limit w_p, Moisture w%, Type of test
		ST. VITAL SITE RIVER BANK, Janzen (1971)
		Brown Clay
9.0	5.5	Direct shear on pre-cut horizontal plane
13.0	3.4	Direct shear on horizontal plane
		Grey Clay
11.5	10.3	Direct shear on horizontal plane
8.0	3.4	Direct shear on horizontal plane
9.0	5.5	Direct shear on pre-cut horizontal plane
		GLACIAL TILL (soft)
31.5	0.0	Direct shear on horizontal plane
		ST. BONIFACE SITE 1 RIVER BANK, Janzen (1971)
		Brown Clay
		w_L = 98, w_p = 37.7, w% = 48.0, γ = 17.1
8.3	4.1	Direct shear on pre-cut horizontal plane
		Grey-Brown Clay
		w_L = 111, w_p = 33.1, w% = 77.4, γ = 17.2
9.5	0.0	Direct shear on pre-cut horozintal plane
		UNIVERSITY OF MANITOBA CAMPUS, (Muir 1971)
		Brown Clay
		w_L = 112, w_p = 38, w% = 58.9, γ = 16.1
13.0	6.7	Triaxial test, pre-cut at 52° to 54° to horizontal
13.0	0.0	Direct shear on horizontal plane
13.0	0.0	Direct shear on vertical plane
		WINNIPEG FLOODWAY, Sutherland (1969)
		Brown Clay
		w_L = 120, w_p = 34, w% = 34, γ = 16.5
8	-	Direct shear
		Grey Clay
		w_L = 72, w_p = 25, w% = 45.9, γ = 17.4
10°	-	Direct shear
		Grey Clay (Plastic)
11°	-	w_L = 101, w_p = 34, w% = 62.7, γ = 16.2 Direct shear

7.2.12

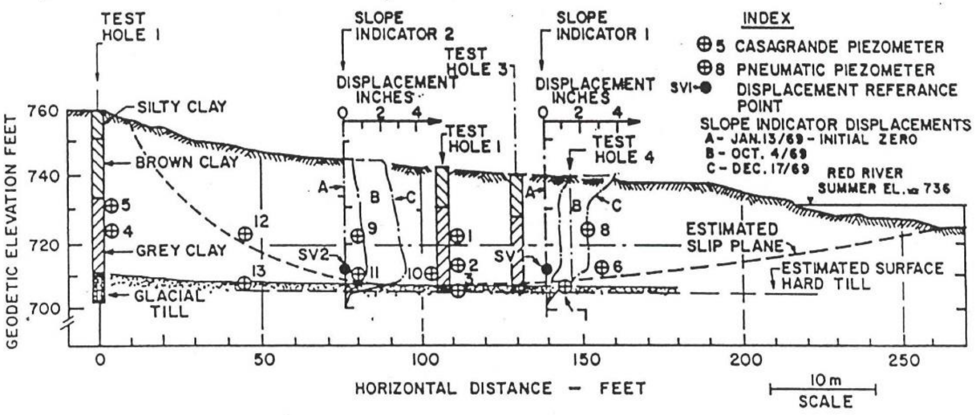

FIGURE 1 — ST. VITAL SITE, RIVER BANK CROSS-SECTION, LOCATIONS OF PIEZOMETERS, SLOPE INDICATORS, TEST HOLES AND REFERENCE POINTS. TYPICAL SLOPE INDICATOR HORIZONTAL DISPLACEMENTS, ESTIMATED SLIP PLANE

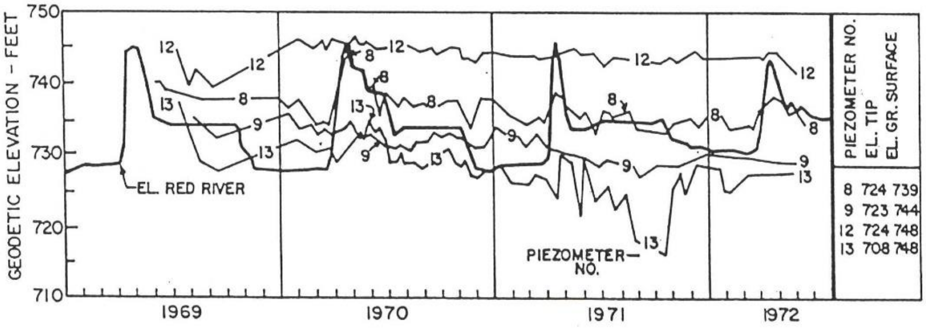

FIGURE 2 - ST. VITAL SITE - RIVER BANK SLIDE PIEZOMETRIC ELEVATIONS FOR SELECTED PIEZOMETERS. ELEVATION RED RIVER

7.2.14