

E.K. SAUER CONSULTING LTD.

GEOLOGY OF THE SASKATOON CHEMICALS LTD.
COOLING TOWER SITE

Report 0156-004

October 26, 1997



E. A. Christiansen Consulting Ltd.

CONSULTING GEOLOGIST

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E.K. Sauer Consulting Ltd.
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S7N 3R2

Attention: Dr. E.K. Sauer

Dear Karl:

Enclosed is a copy of letter report 0156-004 on the "Geology of the Saskatoon Chemicals Ltd. Cooling Tower site". If you have any queries, please contact me.

Sincerely yours,

E.A. Christiansen, P. Eng., P.GeoL.

INTRODUCTION

E.A. Christiansen Consulting Ltd. was commissioned by E.K. Sauer Consulting Ltd. to determine the stratigraphy of borehole SH-06 (Drawings 0156-004-01, 02) and to construct two cross sections, one across the northwest side of the south Saskatchewan River valley (A-A', Drawing 0156-004-03) and another along the top of the valley side (B-B', Drawing 0156-004-04). Cross section B-B' includes two inclinometers (SI-01, SI-02), one piezometer (P-01), and one testhole (SH-06) in the Cooling Tower site which is the focus of this investigation.

This study was conducted within the geological framework provided by Christiansen (1995). The present study includes: (1) examination of cutting samples provided by E.K. Sauer Consulting Ltd. from borehole SH-06 (Appendix A), (2) selection of till samples for carbonate analyses (Table 1, Appendix B) to aid in the identification of tills, and (3) examination of Atterberg limits provided by E.K. Sauer Consulting Ltd. (Table 2).

STRATIGRAPHY

Bedrock and glacial deposits were encountered during the drilling of borehole SH-06 (Appendix A, Drawings 0156-004-03, 04). The bedrock sediments include the Judith River and Bearpaw formations, and the glacial deposits include the Empress, Sutherland, and Saskatoon groups (Fig. 1).

Judith River Formation

In borehole SH-06 (Appendix A; Drawings 0156-004-03, 04), the Judith River Formation is composed of about 10 m of noncalcareous, deltaic sand and silt and white calcareous sandstone beds. In borehole SH-01, about 27 m of this formation was penetrated.

Bearpaw Formation

The Bearpaw Formation is composed of 18 to 23 m of marine, noncalcareous, gray silty clay. The contact between the Judith River and Bearpaw formations is

Table 1. Carbonate content of tills in borehole SH-06.

STRATIGRAPHIC UNIT	N	\bar{X}	SD
Battleford Formation	3	35.00	1.25
Floral Formation, lower till	5	35.64	1.69
Warman Formation	2	18.90	2.30
Dundurn Formation, upper till	5	33.18	3.80
Dundurn Formation, lower till	8	24.48	2.03

Table 2. Atterberg limits of tills

STRATIGRAPHIC UNIT	BOREHOLE	N	\bar{X} W ₁	SD	\bar{X} W _p	SD	\bar{X} I _p	SD
Warman Formation	SI-01	4	47.70	1.61	16.33	0.52	31.37	1.50
Dundurn Formation, upper till	SI-02	4	37.18	0.76	13.50	0.14	23.68	0.83

TIME UNITS		STRATIGRAPHIC UNITS			
		GROUP	FORMATION	DEPOSIT	
QUATERNARY	PLEISTOCENE	SASKATOON		13 Glaciolacustrine silt and clay	
			12 Battleford	Till	
			Floral	11 Upper till, sand, + gravel	
				10 Silt and clay	
				9 Sand and gravel	
				8 Riddell Mbr. sand	
				7 Lower till, sand, + gravel	
		SUTHERLAND	6 Warman	Till	
			Dundurn	5 Upper till	
				4 Lower till	
		3 EMPRESS		Sand and gravel (Glacial)	
CRETACEOUS		MONTANA	2 Bearpaw	Silt and clay	
			1 Judith River	Sand and silt	

Figure 1. Stratigraphic chart. Pleistocene nomenclature from Christiansen (1992).

conformable and represents a structure marker horizon for this investigation.

Empress Group

The Empress Group is composed of 7 m of sand and gravel between the Bearpaw and Dundurn formations (Fig. 1). The deposit occurs only in borehole SH-01 (Drawing 0156-004-04). The contact between the Empress Group and the Bearpaw Formation is an erosional unconformity.

Dundurn Formation

The Dundurn Formation is composed of lower and upper units. The lower unit is composed of 20 to 25 m of gray and dark gray till which has a mean carbonate content of $24.48 \pm 2.03 \text{ mL CO}_2/\text{g}$ in borehole SH-06 (Table 1). The contact between the Dundurn Formation and Empress Group and Bearpaw formation is non-conformable. The upper unit is composed of 11 to 16 m of gray till, the upper 1 to 3 m of which is mottled with olive till. In borehole SH-06, the upper till has a mean carbonate content of $33.18 \pm 3.80 \text{ mL CO}_2/\text{g}$ (Table 1) which is significantly different from the lower till in the Dundurn Formation. The contact between the lower and upper tills of the Dundurn Formation is nonconformable.

Warman Formation

The Warman Formation is between the Dundurn Formation of the Sutherland Group and the Floral Formation of the Saskatoon Group (Fig. 1). The Warman Formation is composed of less than 1 to 6 m of clayey, gypsiferous, gray and mottled till. The till has a mean carbonate content of 18.90 ± 2.30 which is significantly lower than both the underlying Dundurn Formation and the overlying lower till of the Floral Formation (Table 1). The mean liquid limit of 47.70 ± 1.61 is significantly lower than 37.18 ± 0.76 for the upper till of the Dundurn Formation (Table 2). The high liquid limit and low electrical resistance (Drawing 0156-004-04) of the Warman Formation confirms the clayey description of the samples in the geological logs.

The contact between the upper till of the Dundurn Formation and the Warman Formation is nonconformable.

Floral Formation

The Floral Formation is composed in ascending order of a lower till unit, Riddell Member, a sand and gravel unit and silt and clay unit comprising the Sutherland valley fill (Drawing 0156-004-03), and an upper till unit. The lower till unit is composed of less than 1 to 12 m of interbedded sandy till and sand and gravel. The Riddell Member is composed of less than 1 to 10 m of sand and gravel which is dry at the Cooling Tower site (Drawing 0156-004-04, P-01). The sand and gravel and silt and clay units are restricted to the Sutherland valley and are less than 1 to 5 m and less than 1 to 16 m thick, respectively. The upper till unit is composed of 3 to 5 m of sandy till which is hard, jointed, and stained and sand and gravel. The contacts between Dundurn Formation and the lower till unit of the Floral Formation and between the Riddell Member and the upper till of the Floral Formation are nonconformable.

Battleford Formation

the Battleford Formation is composed of 1 to 4m of soft, massive, unstained till. The contact between the Floral and Battleford Formations is nonconformable.

Glaciolacustrine silt and clay

A thin, discontinuous veneer of glaciolacustrine silt and clay, less than 1 to 1.5 m, covers the Saskatoon Chemicals Ltd. site. The contact between the Battleford Formation and the glaciolacustrine silt and clay is conformable.

STRUCTURE

The contact between the Judith River and Bearpaw formations represents a structure marker horizon. The elevations of the marker horizon at SH-01 and SH-06 are 411 and 413 m , respectively suggesting that there is little structure at the Saskatoon Chemicals Ltd. site.

REFERENCES CITED

- Christiansen, E.A. 1992. Pleistocene stratigraphy of the Saskatoon area, Saskatchewan, Canada: an update. Canadian Journal of Earth Sciences. 18: 1767-1778.
- Christiansen, E.A. 1995. Geology of the Saskatoon Chemicals Ltd. site. E.A. Christiansen Consulting Ltd. Report 0156-002.

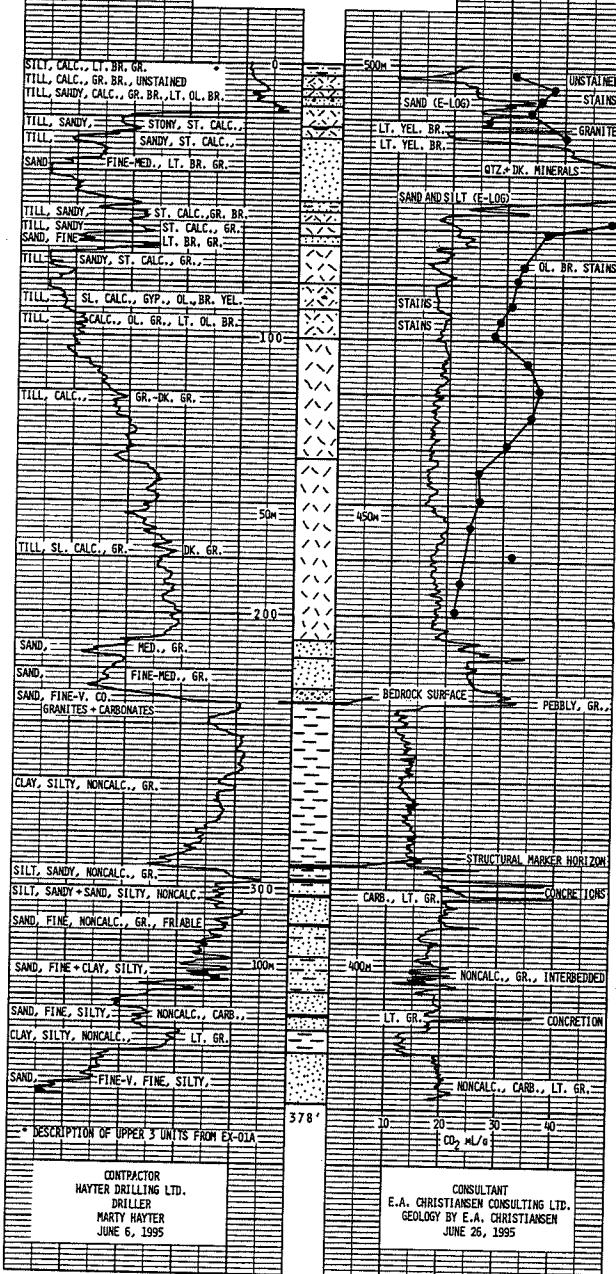
SCL 73B/02 1995
SASKATOON SH-01
NE-13-23-37-05-W3
13:389367E/5784335N
TESTHOLE

EL E V A T I O N 499.84 M

SURVEY

SP COND MUD 840 MICROSIEMENS/CM AT 25° C
SP COND WATER 460 MICROSIEMENS/CM AT 25° C

SP 10 MV R 20 OHMS



SCL 73B/02 1995
SASKATOON SH-03
SW-04-26-37-05-W3
13:389202E/5784633N
TESTHOLE

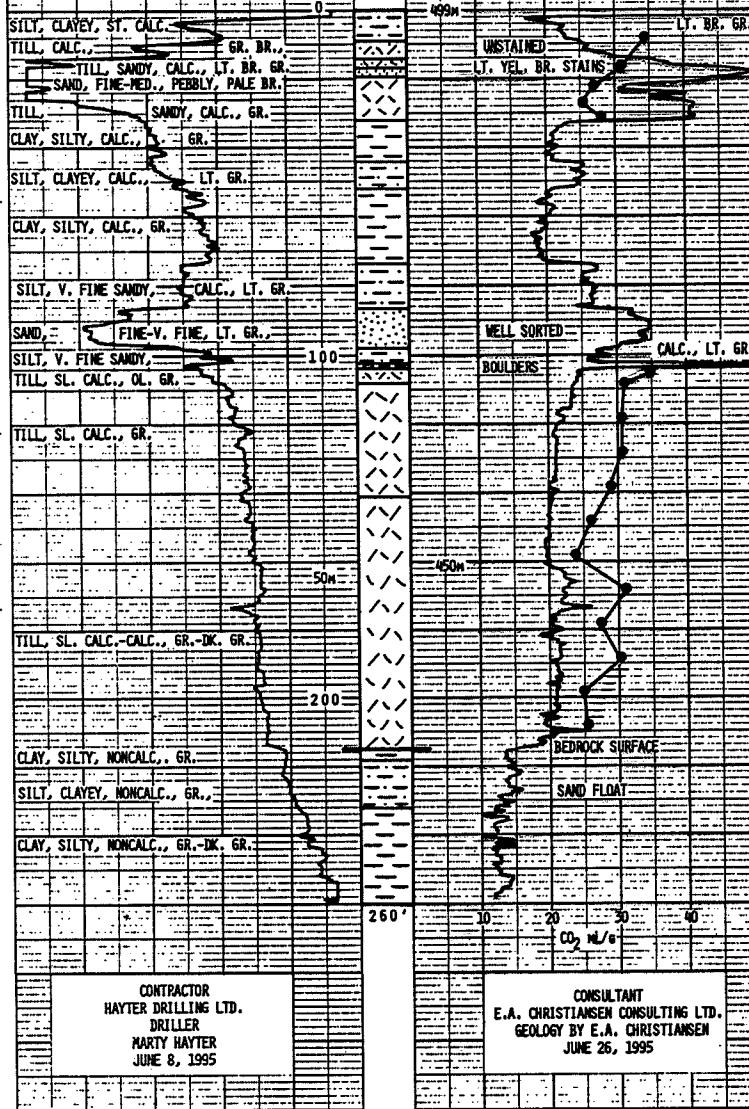
ELEVATION 498.93 M

SURVEY.

SP COND MUD NOT AVAILABLE

SP COND WATER NOT AVAILABLE

SP 10 MV R 20 OHMS



SCL 73B/02 1995
 SASKATOON SH-04
 NW-13-23-37-05-W3
 13:389278E/5784528N
 TESTHOLE

ELEVATION 500.44 M

SURVEY

SP COND MUD 3400 MICROSIEMENS/CM AT 25° C

SP COND WATER 500 MICROSIEMENS/CM AT 25° C

SP MV R 20 OHMS

UNABLE TO MEASURE SPONTANEOUS POTENTIAL (SP) BECAUSE OF HIGH VOLTAGE IN GROUND.

CLAY, SILTY, CALC., LT. BR. GR.
 TILL, CALC., LT. GR., UNSTAINED

TILL, SANDY, CALC., LT. BR. GR..

SAND, FINE-CO., PEBBLY, LT. YEL. BR.

CLAY + SILT, CALC., CARB., GR.

TILL, SANDY, CALC., LT. YEL. BR.

TILL, CALC., GR.+OL., MOTTLED

TILL, CALC., GR.-

TILL, CALC., LT. YEL. BR., DK. YEL. BR.

TILL, CALC., GR., PALE OL. STAINS

TILL, CALC. GR.

TILL, CLAYEY, SL. CALC., OL. GR.+OL..

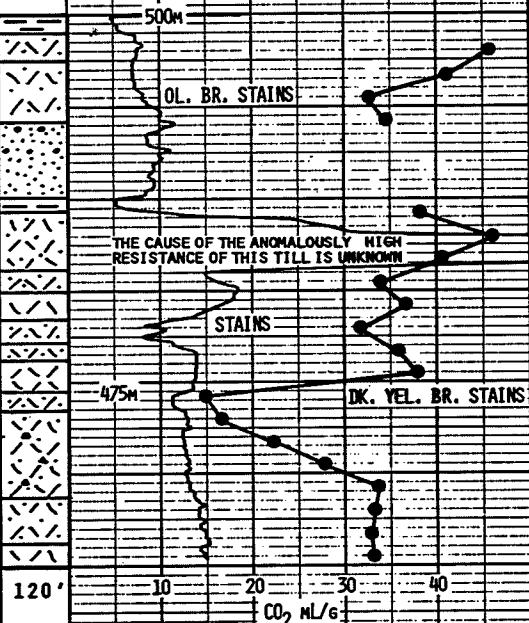
TILL, CALC., GYP., OL.+GR., MOTTLED

TILL, CALC., GR.+OL., MOTTLED

TILL, CALC., GR.-

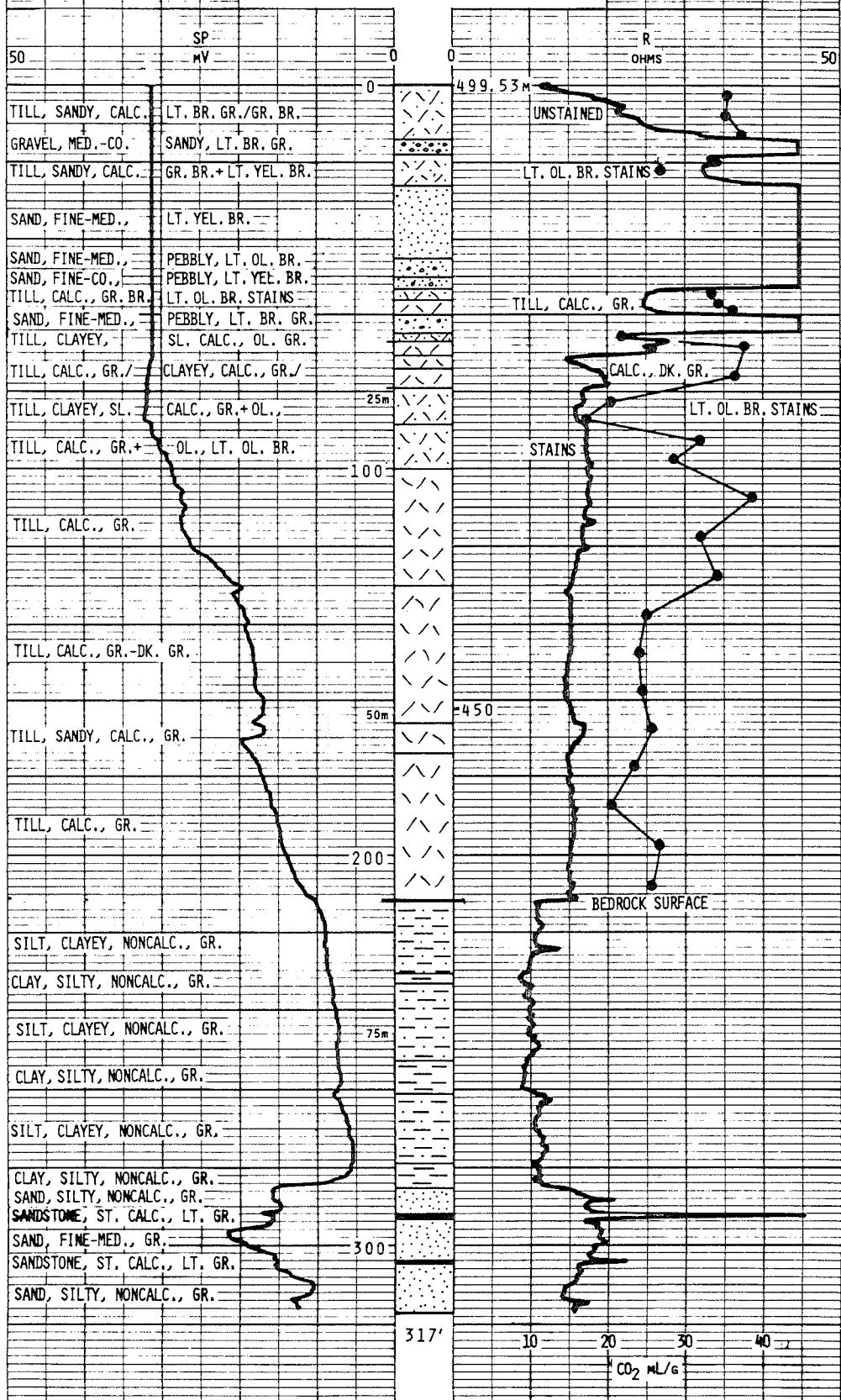
CONTRACTOR
 HAYTER DRILLING LTD.
 DRILLER
 MARTY HAYTER
 JUNE 8, 1995

THE LOW RESISTANCE OF THE SAND IS THE RESULT OF THE ANOMALOUSLY HIGH CONDUCTIVITY OF ITS WATER (SENTARD)



CONSULTANT
 E.A. CHRISTIANSEN CONSULTING LTD.
 GEOLOGY BY E.A. CHRISTIANSEN
 JUNE 26, 1995

SCL 73-B/02 1997
 SASKATOON SH-06
 NE-13-23-37-05-W3
 13:38943 1E/5784397N
 TESTHOLE



SCL 73-B/02 1997
SASKATOON SI-01
NE-13-23-37-05-W3
13:389445E/5784406N
INCLINOMETER

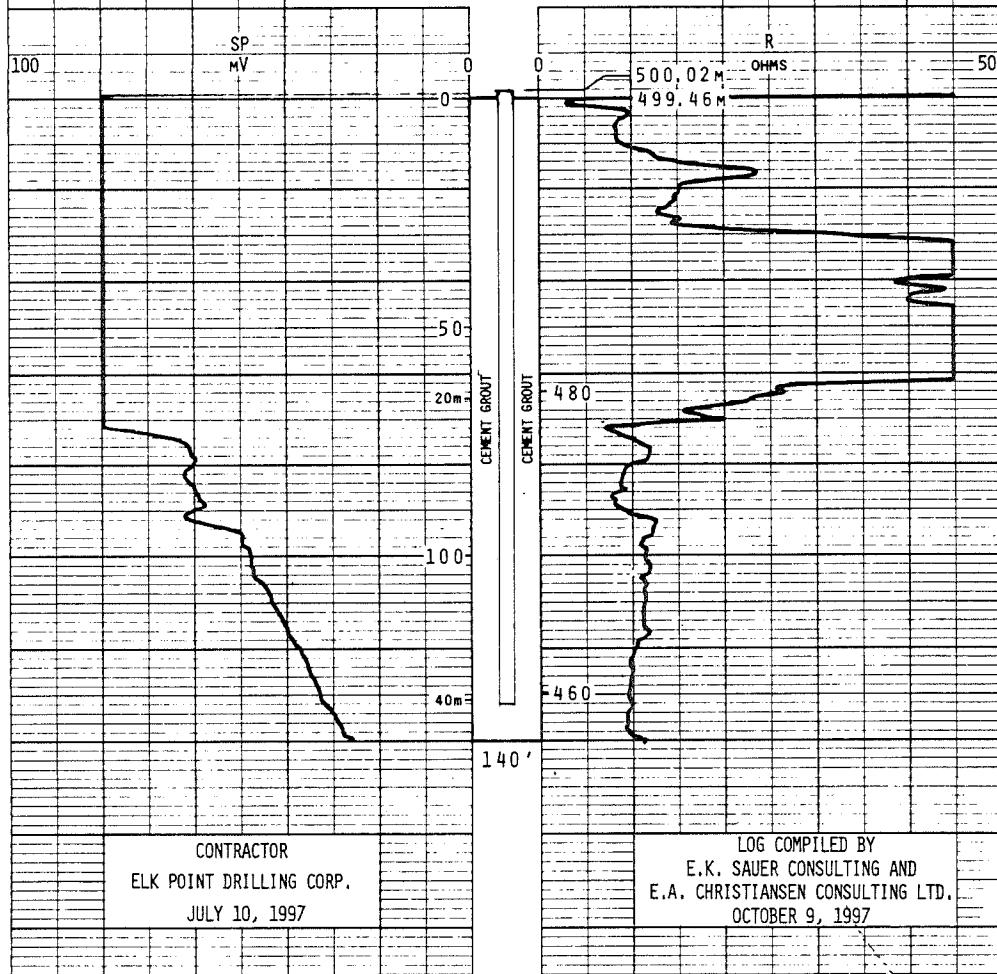
ELEVATION 499.46 M

SURVEY

SP COND MUD 1000 MICROSIEMENS/CM AT 25° C

SP COND WATER 420 MICROSIEMENS/CM AT 25° C

SP 20 MV R 10 OHMS



SCL 73-B/02 1997
SASKATOON SI-02
NE-13-23-37-05-W3
13:389416E/5784382N
INCLINOMETER

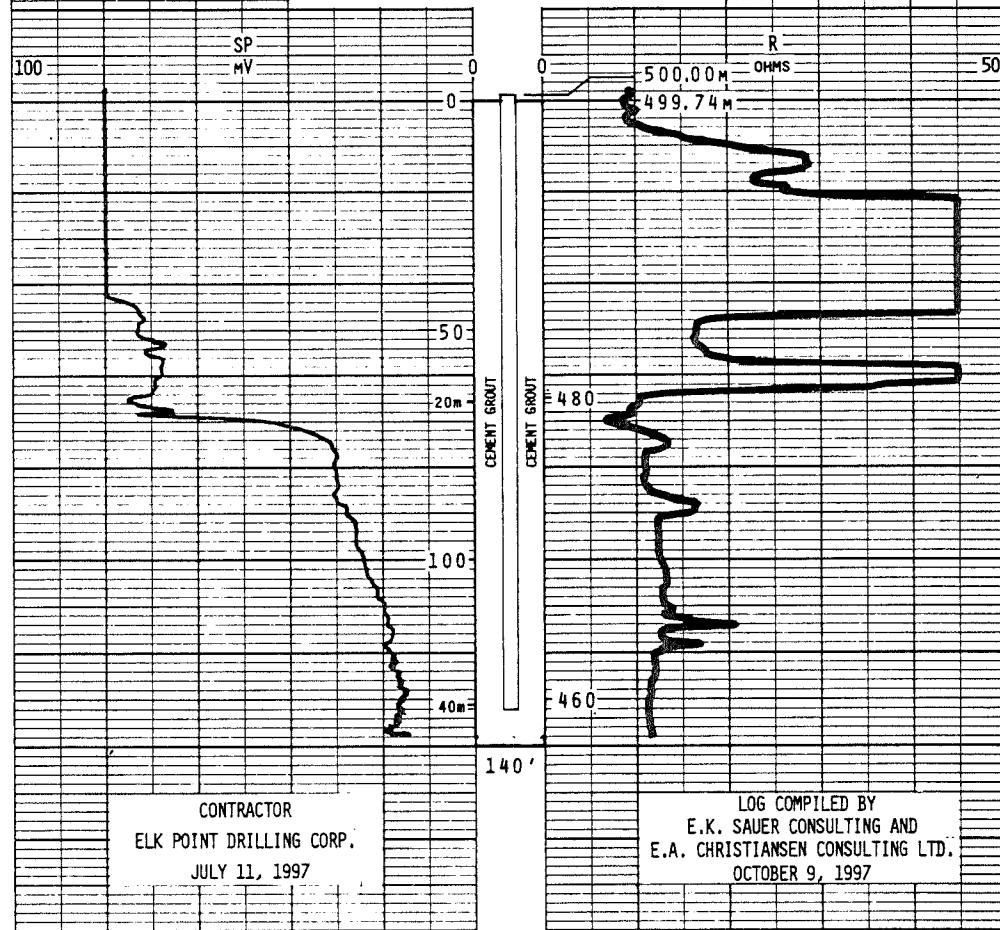
ELEVATION 499.74 M

SURVEY

SP COND MUD 2400 MICROSIEMENS/CM AT 25° C

SP COND WATER 420 MICROSIEMENS/CM AT 25° C

SP 20 MV R 10 OHMS



SCL 73-B/02 1997
SASKATOON P-01
NE-13-23-37-05-W3
13:389425E/5784395N
PEIZOMETER

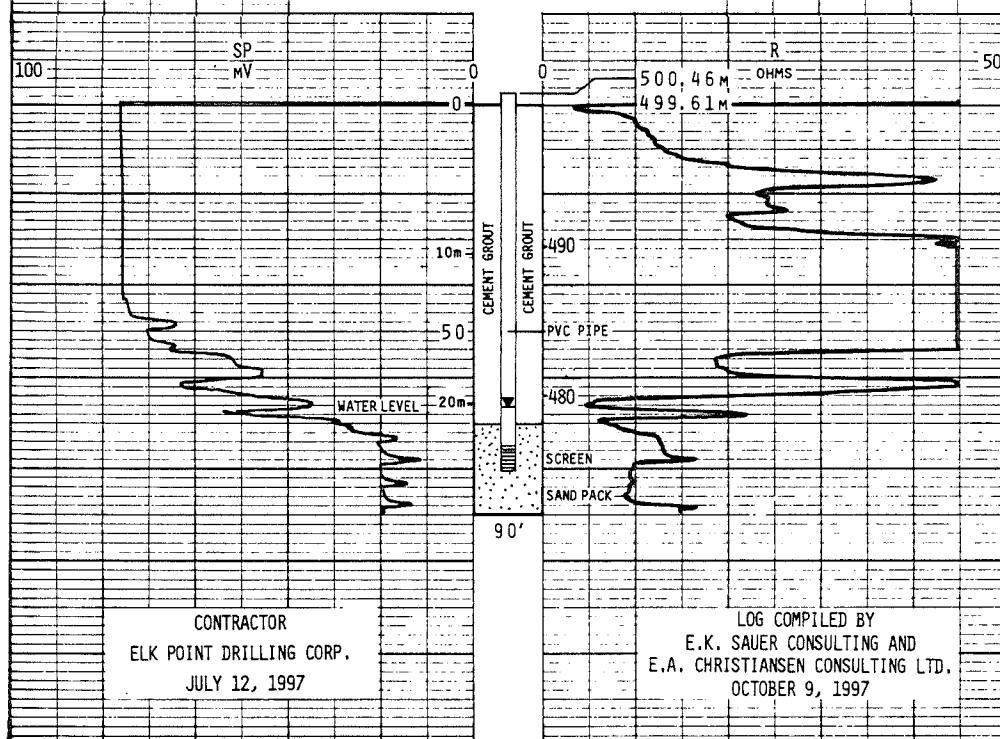
ELEVATION 499.61 M

SURVEY.

SP COND MUD

SP COND WATER 420 MICROSIEMENS/CM AT 25° C

SP 20 MV. R 10 OHMS



Summary of Survey Results For Saskatoon Chemicals Survey

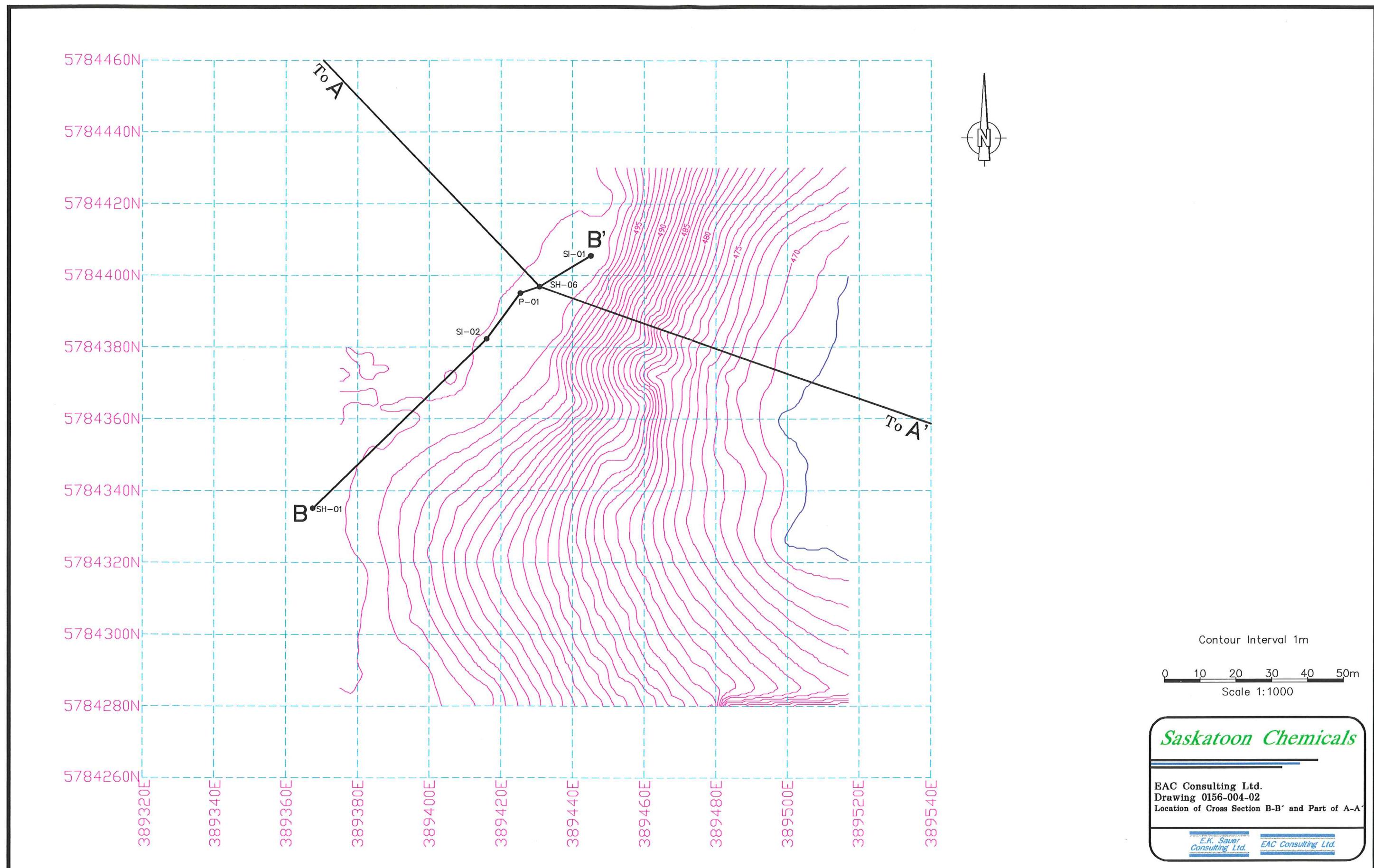
Surveyed by: M.D. Haug and Associates

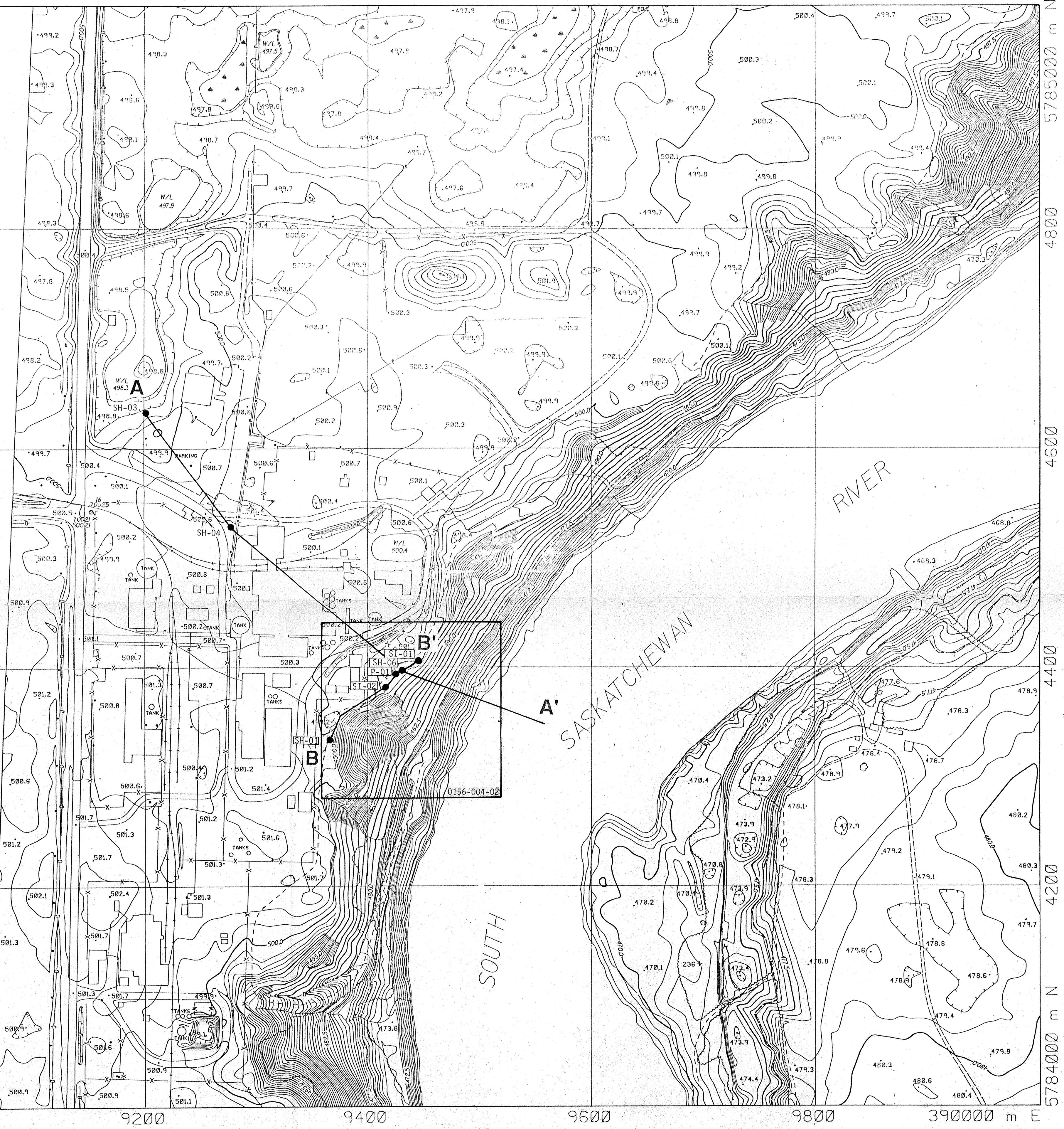
Instrument: Jeffrey Stoicescu / Len Frass

Prism: Len Frass / Jeffrey Stoicescu

Aug-13-97 11:44

<u>Shot I.D. Number</u>	<u>Northing</u>	<u>Easting</u>	<u>Elevation</u>	<u>Shot Type</u>
<u>TIE-IN SHOTS</u>				
SI - SC06	5784405.560	389444.936	500.02	SLOPE INCLINOMETER 1
SI - SC06 (GROUND)	5784405.441	389445.029	499.46	GROUND ELEV. OF SI1
NEW PEIZ.	5784394.937	389425.318	500.46	MWNEW
NEW PEIZ. (GROUND)	5784394.736	389425.337	499.61	MWGROUN
SI - SC07	5784382.155	389415.863	500.00	SLOPE INCLINOMETER 2
SI - SC07 (GROUND)	5784382.147	389415.923	499.74	GROUND ELEV. OF SI2
<u>CROSS-SECTION SHOTS</u>				
1007	5784420.071	389432.169	500.50	FENCE
1008	5784415.743	389437.101	499.97	TOPOG
1009	5784412.654	389440.137	499.66	TOPOG
1010	5784407.414	389445.118	499.41	TOPOG
1011	5784403.143	389448.907	499.20	TOPOG
1012	5784400.311	389448.455	498.07	TOPOG
1013	5784398.674	389449.708	496.28	TOPOG
1014	5784397.375	389451.225	494.63	TOPOG
1015	5784396.233	389452.450	493.29	TOPOG
1016	5784394.452	389454.304	491.40	TOPOG
1017	5784392.718	389455.942	489.62	TOPOG
1018	5784391.060	389456.976	488.09	TOPOG
1019	5784390.596	389457.578	487.28	TOPOG
1020	5784390.173	389458.026	487.15	TOPOG
1021	5784389.871	389459.601	486.03	TOPOG
1022	5784388.478	389461.205	484.21	TOPOG





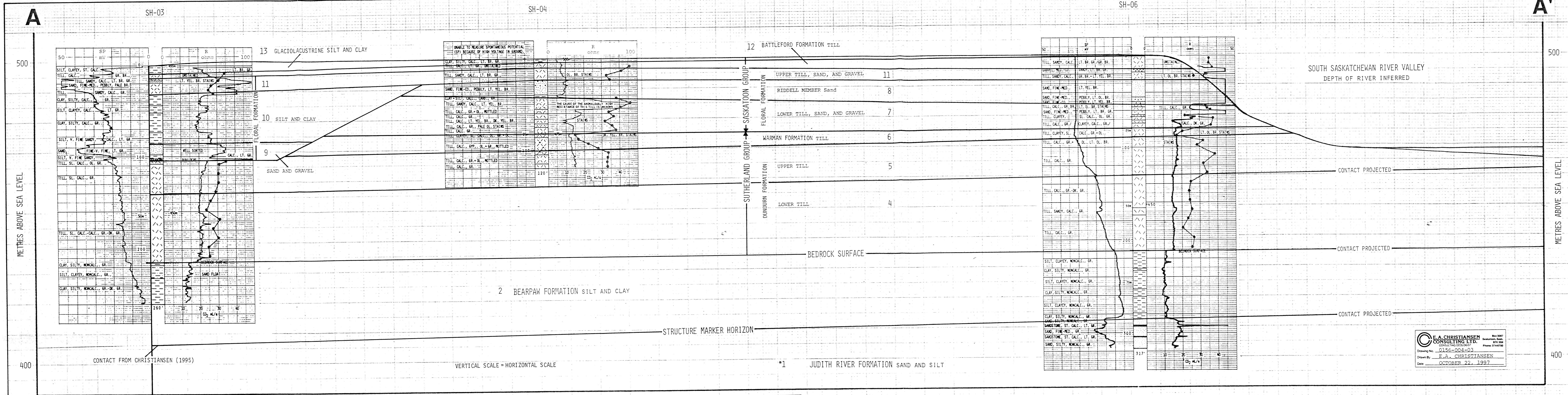
M e c h a n i s m

DRAWING 0156-004-01. LOCATION OF DRAWING 0156-004-02 AND
CROSS SECTIONS A-A' AND B-B'.

SCALE 1:2000

SCALE 1:2000

	E.A. CHRISTIANSEN	Box 3087 Baskett, Sask. S7K 3S9
CONSULTING LTD.		Phone: 374-6700
CONSULTING GEOLOGIST		
Drawing No.	0156-004-01	
Drawn By	E.A. CHRISTIANSEN	
Date	OCTOBER 23, 1997	



DRAWING 0156-004-03. STRUCTURE CROSS SECTION A-A' ACROSS THE NORTH-WEST SIDE OF THE SOUTH SASKATCHEWAN RIVER VALLEY.

LIMITATION
ES WHERE GEOLOGIC LOGS ARE AVAILABLE,
RE INFERRED AND REPRESENT GEOLOGIC
IEVED TO BEST FIT THE INFORMATION.

E FIGURE 1 FOR INDEX 0

E.A. CHRISTIANSEN
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Box 3087
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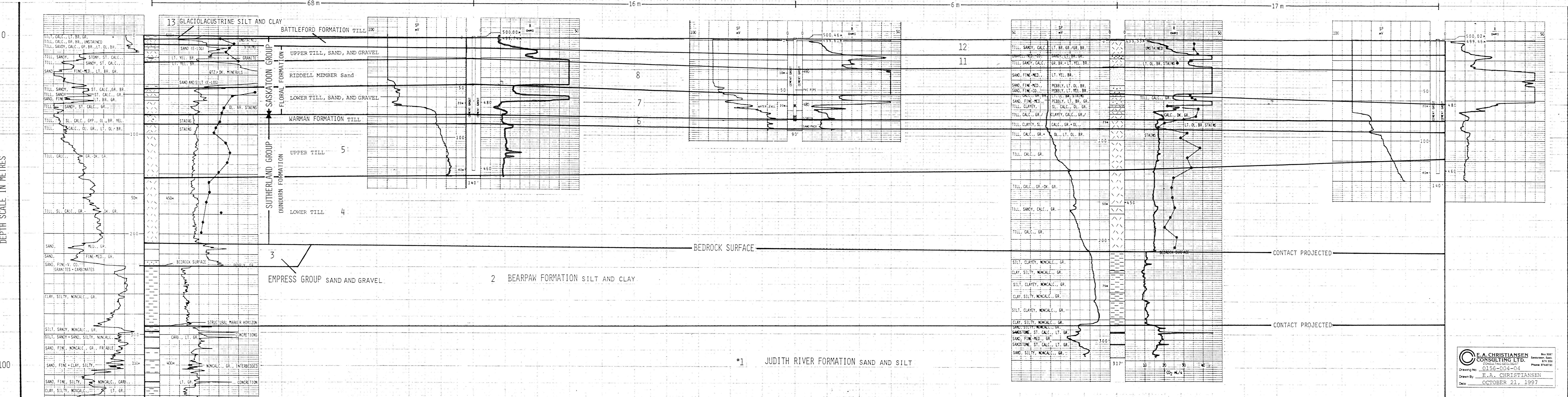
1

1920-1921

— 1 —

卷之三

B



DRAWING 0156-004-04. STRATIGRAPHIC CROSS SECTION B-B' ALONG NORTHWEST
SIDE OF THE SOUTH SASKATCHEWAN RIVER VALLEY.

OF SI-01, SI-02, AND P-01 BASED ON E-LOGS ONLY

10. *Leucosia* *leucostoma* *leucostoma* *leucostoma* *leucostoma* *leucostoma* *leucostoma*

OR INDEX OF STR

DEPTH SCALE IN METRES