

TJ/PEDOCAN LAND CONSULTANTS

GEOLOGY OF THE COTEAU BAY
IRRIGATION PROJECT

Report 0124-002 November 23, 1989

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000

E. A. Christiansen Consulting Ltd.

CONSULTING GEOLOGIST

BOX 3087
SASKATOON, SASKATCHEWAN, CANADA
S7K 3S9

PHONE 374-6700

November 24, 1989

TJ/Pedocan Land Consultants
700 Hall Street
Outlook, Saskatchewan
S0L 2N0

Attention: Mr. Len Knapik, P.Ag.

Dear Mr. Knapik:

Enclosed are five copies of Report 0124-002 on the "Geology
of the Coteau Bay Irrigation Project."

Sincerely yours,

E.A. Christiansen, P.Geol., P.Eng.

INTRODUCTION

The purpose of this investigation is to provide a subsurface geological framework for the study of suitability of soils for irrigation being conducted by TJ/Pedocan Land Consultants in the Coteau Bay area. E.A. Christiansen Consulting Ltd. was commissioned to drawing six cross sections showing the stratigraphy of the drift and bedrock deposits (Drawing 0124-002-01 to 07) using existing information and to propose locations and depths of testholes to calibrate the geological information. It was agreed with TJ/Pedocan Land Consultants that such a testhole drilling program and installation of deeper piezometers should await the procurement and assessment of results of their piezometer program. It was further understood that the study of the surficial deposits is the responsibility of TJ/Pedocan Land Consultants. The new stratigraphic information generated by this firm is included in the present report.

Geological logs and groundwater analyses (Appendix A) used in this study were provided by TJ/Pedocan Land Consultants, Saskatchewan Research Council, and Saskatchewan Water Corporation. Geological and pedological maps and reports (Christiansen and Meneley, 1971; E.A. Christiansen Consulting Ltd. 1984, 1987; Ellis et al. 1968; Sawatzky, 1967) were also used in this study.

GEOLOGY

Stratigraphy

Both bedrock and drift were studied in this investigation. Where the bedrock sediments remain at their original elevation, the Judith River Formation is the base of exploration (Drawing 0124-002-02). Where the bedrock sediments were collapsed, on the other hand, the Ardkenneth Member of the Bearpaw Formation (Drawings 0124-002-02 to 06) is taken as the base of exploration.

The Judith River Formation, which ranges in thickness from 100 to 250 feet, is composed of interbedded sand, silt, clay, and coal. This formation is potentially an aquifer, particularly where it occurs at its original elevation. The inventory by TJ/Pedocan Land Consultants did not encounter any wells in this formation.

The Bearpaw Formation in the Coteau Bay area is up to 950 feet thick and is composed of interbedded sand and clay members. The Outlook and Ardkenneth Members represent deltaic sands and silts, whereas the intertonguing members are composed of marine silts and clays. For the purpose of this report, discussion of the bedrock sediments in the Bearpaw Formation will be restricted to the Ardkenneth and Snakebite Members.

The Ardkenneth Member is the most extensive bedrock aquifer in the Coteau Bay area. The member is about 100 feet thick and is composed of fine to medium, gray, noncalcareous, "salt and pepper" sand which becomes finer grained and siltier with depth.

The Snakebite Member is thickest in the collapsed areas where it was protected from erosion. The member, which is up to 450 feet thick in the Coteau Bay area, is composed of gray, noncalcareous, marine silts and clays.

Drift in the Coteau Bay area includes silt, sand and gravel of the Empress Group, tills, glaciolacustrine silts, deltaic sands, and alluvium (Drawings 0124-002-02 to 07). Drift ranges from 10 to 266 feet (Drawing 0124-002-07, logs 62, 27). Tills range in thickness from 266 in log 27 to zero in the South Saskatchewan River Valley. Because of the paucity of testhole information, little is known about the till and intertill stratigraphy. Glaciolacustrine and deltaic deposits for the most part are restricted to below an elevation of about 1875 feet above sea level adjacent to the South Saskatchewan River Valley. The glaciolacustrine silts are commonly less than 10 feet thick. The thickness of the deltaic sands, however, is not known. Alluvial sands occur in the bottom of the South Saskatchewan River Valley where they attain a thickness of about 100 feet.

Structure

The structure shown by the composite seismic lines of Sawatzky (1967), exhibits uplands and depressions (Drawing 0124-002-01; T.25, R.8; T.27, R.9). The depressions are thought to represent collapse structures resulting from the dissolution of Devonian salt. The upland areas, in most cases, probably represent "salt hills" where little salt was removed by dissolution. The structural upland northwest of Birsay may be related to cryptovolcanic activity which is thought to have formed the Elbow structure (DeMille, 1960).

Groundwater

From the inventory of well information obtained by TJ/Pedocan Land Consultants, electrical conductivity, chloride, and SAR values were selected (Appendix A) and plotted in the cross sections (Drawings 0124-002-02 to 07). In the Coteau Bay area, wells are in sands in the Ardkenneth Member and in sands and gravels in drift. Although the Ardkenneth Member is the most extensive aquifer in the Coteau Bay area, 75 percent of the wells are in sands and gravel between till and bedrock, between tills, or in surficial deposits.

Waters from three deep wells in the Ardkenneth Member (Appendix A, 24, 26, 41) have an electrical conductivity of 3.9 ± 0.4 mS/cm and an SAR of 72.4 ± 9.0 . Waters from three

shallow wells in the Ardkenneth Member (Appendix A, 3, 6, 53), on the other hand, have an electrical conductivity of 1.3 ± 0.6 mS/cm and an SAR of 1.9 ± 1.3 . Waters from 16 wells less than 125 feet deep in drift have an electrical conductivity of 2.0 ± 1.3 mS/cm and an SAR of 1.4 ± 1.3 . One well (Appendix A, 60) in the base of the drift has an elevated electrical conductivity (2.8 mS/cm) and SAR (8.1).

Water from deeper wells in the Ardkenneth Member can be distinguished readily from drift water by an elevated SAR resulting from a higher sodium and lower calcium and magnesium content. Water from the shallow wells in the Ardkenneth Member, however, have an electric conductivity and SAR similar to drift water suggesting that the bedrock water in the Ardkenneth Member has been replaced by drift water.

SOIL SALINITY

Although there is a paucity of potentiometric measurements in the Coteau Bay area, particularly in the vicinity of Dunblane, it appears that the Ardkenneth Member is not a contributor to soil salinization except in the Anerley Valley. This postulation could be verified by installing a piezometer in the Ardkenneth Member between Logs 57 and 10 (Drawing 0124-002-05) where the aquifer occurs at the shallowest depth in the Dunblane area.

By elimination, it appears that soil salinization in the Coteau Bay area is the result of artesian conditions in the Empress Group, intertill sands and gravels, and/or subglacial valleys. Empress Group sands and gravels occur in Log 16 (Drawing 0124-002-06) and may be the cause of soil salinity in the lowlands surrounding the Archer Ridge upland (Drawing 0124-002-01, T.25, R.8). The occurrence of intertill sands and gravels have not been verified. If the Empress Group or intertill deposits extend from the uplands to the west eastward to the South Saskatchewan River Valley, they have the potential to cause salinity in the Dunblane plains. Subglacial valleys are very common in the Coteau Bay area and, according to Mr. Len Knapik (personal communication), salinization is associated with these valleys. Christiansen (1987) demonstrated that the sediment becomes coarser grained with depth in the Verendrye Valley which sets up the model for artesian conditions in the valleys in the Coteau Bay area.

LITERATURE CITED

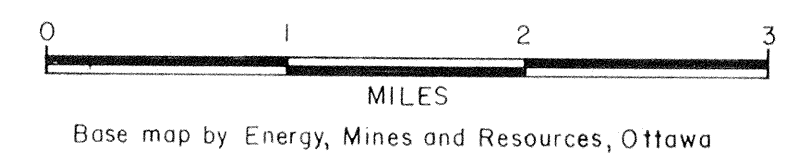
- Christiansen, E.A. 1987. Verendrye valley and the Glidden esker, Saskatchewan: subglacial and ice-walled features in southwestern Saskatchewan, Canada. Canadian Journal of Earth Sciences, V. 24, pp. 170-176.
- Christiansen, E.A. and Meneley, W.A. 1971. Geology and groundwater resources of the Rosetown area (72-0), Saskatchewan. Saskatchewan Research Council, Geology Division, Map No. 14.
- DeMille, G. 1960. The Elbow structure of south-central Saskatchewan. Journal of the Alberta society of petroleum geologists, V. 8, pp. 154-162.

- E.A. Christiansen Consulting Ltd. 1984. Geology of the main canals in the Outlook area. Consulting Report 0101-001 for Saskatchewan Water Corporation.
- E.A. Christiansen Consulting Ltd. 1987. Geology of the Outlook irrigation project. Consulting Report 0117-001 for Saskatchewan Institute of Pedology.
- Ellis, J.G., Acton, D.F. and Moss, H.C. 1968. The soils of the Rosetown map area. Saskatchewan Institute of Pedology, Publication 53, Extension Publication 202.
- Sawatzky, H.B. 1967. Composite seismic map, Saskatoon area, Saskatchewan. Saskatchewan Department of Mineral Resources, Drawing No. 4.
- TJ/Pedocan Land Consultants, 1989. Coteau Bay irrigation project, detailed soil survey and evaluation for sprinkler irrigation. Final Technical Report (in preparation).

APPENDIX A. INDEX OF CROSS SECTION LOGS, WELLS, AND
WATER ANALYSES, COTEAU BAY IRRIGATION PROJECT.

INFORMATION SHEET OF THE COTEAU BAY IRRIGATION PROJECT

DRAWING 0124-002-01



TESTHOLES

- ① Electric logs, cutting samples, and cores
- ② Electric logs and cutting samples
- ③ Electric and driller's logs
- ④ Electric and/or gamma-ray logs
- ⑤ Augerhole logs
- ⑥ Cutting samples

WELLS AND PIEZOMETERS

- ① Electric logs, cutting samples, and cores
- ② Electric logs and cutting samples
- ③ Electric and driller's logs
- ④ Electric and/or gamma-ray logs
- ⑤ Augerhole logs
- ⑥ Cutting samples
- ⑦ Well inventories

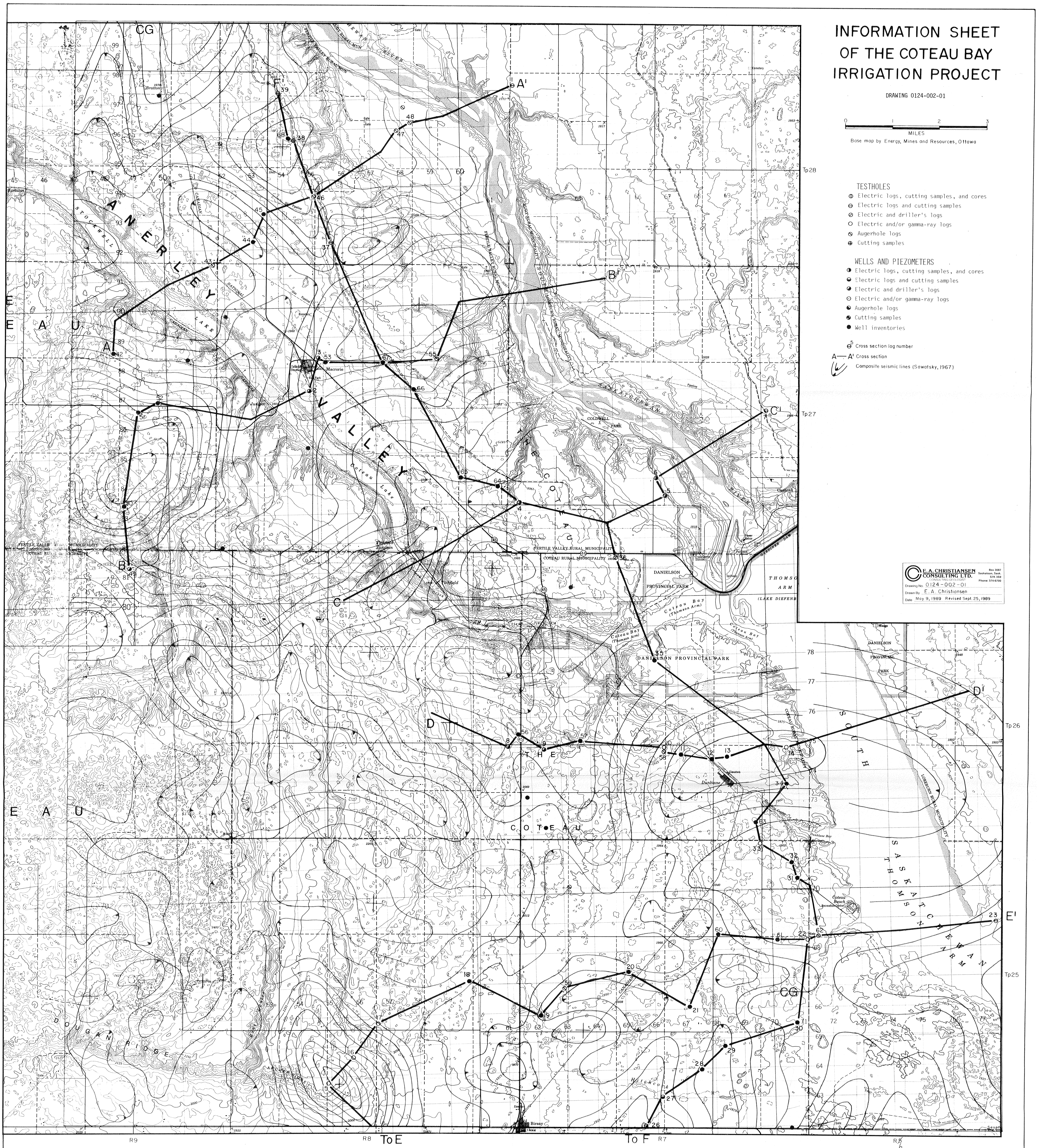
⑧ Cross section log number

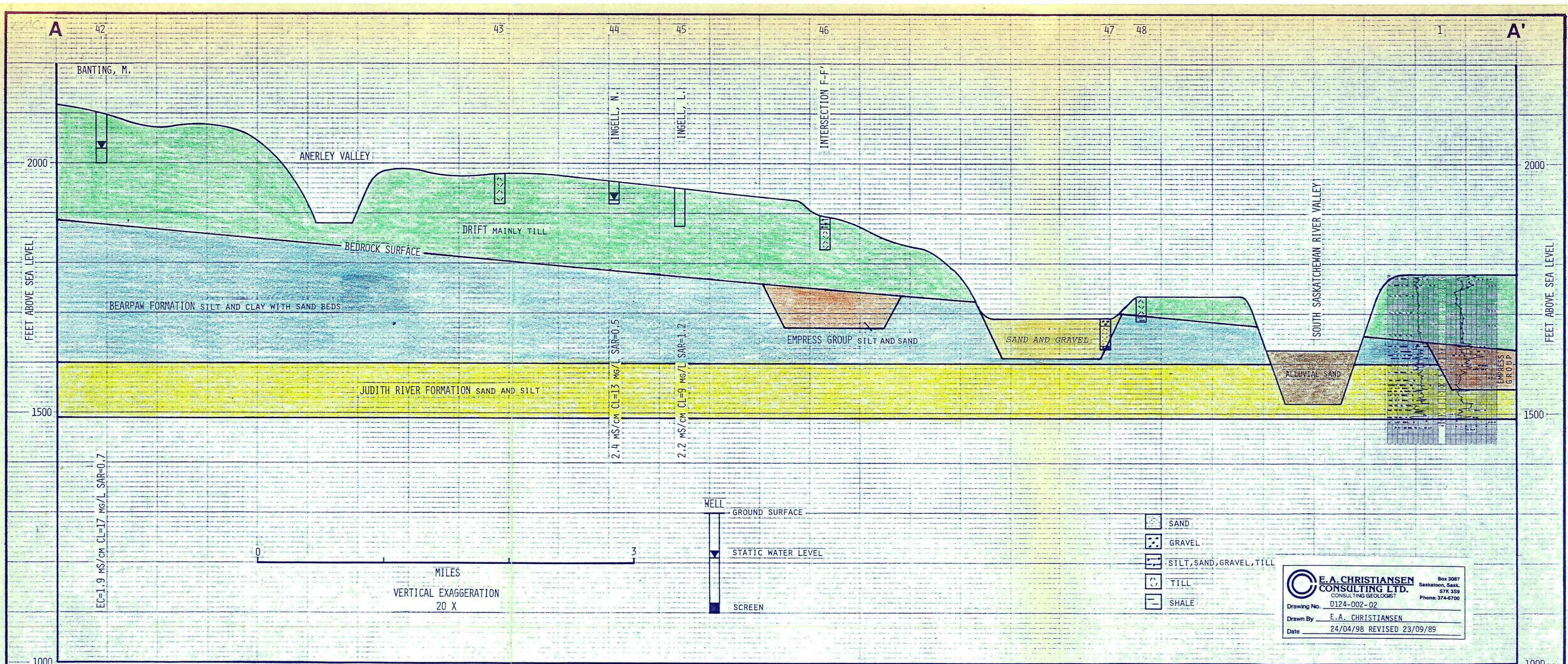
A-A' Cross section

↖ Composite seismic lines (Sawatsky, 1967)

**E.A. CHRISTIANSEN
CONSULTING LTD.**
Drawing No. 0124-002-01
Drawn By E.A. Christiansen
Date May 9, 1989 Revised Sept 25, 1989

Box 3087
Saskatoon, Sask.
S7N 3S5
Phone 374-6700





**DRAWING 0124-002-02. CROSS SECTION A - A',
COTEAU BAY IRRIGATION PROJECT**

INTERPRETATION NOT VERIFIED BY TEST DRILLING

STRUCTURE PARTLY FROM COMPOSITE SEISMIC MAP

EXCEPT AT TESTHOLE SITES WHERE GEOLOGIC LOGS
ARE AVAILABLE, GEOLOGIC CONTACTS ARE
INFERRED AND REPRESENT GEOLOGIC MODELS THAT
ARE BELIEVED TO BEST FIT THE INFORMATION.

**E.A. CHRISTIANSEN
CONSULTING LTD.**
CONSULTING GEOLOGIST
Box 3087
Saskatoon, Sask.
S7K 3S9
Phone: 374-6700

Drawing No. 0124-002-02
Drawn By E.A. CHRISTIANSEN
Date 24/04/98 REVISED 23/09/89

B

49

50

51

52

2

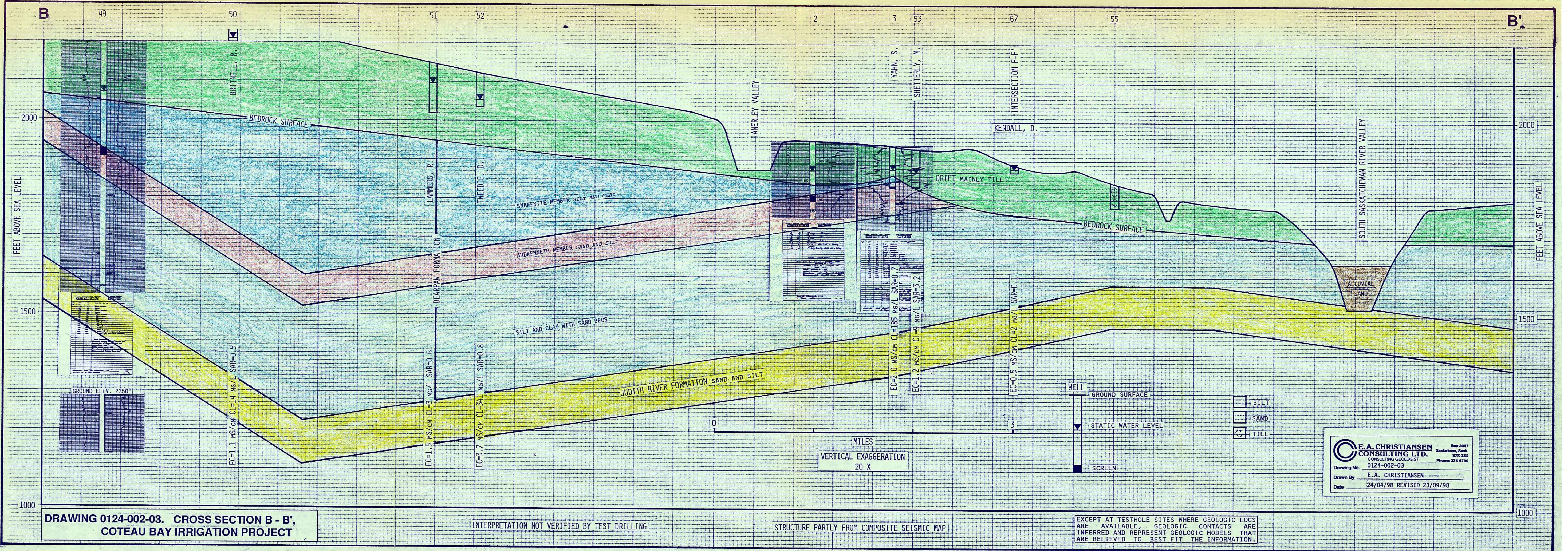
3

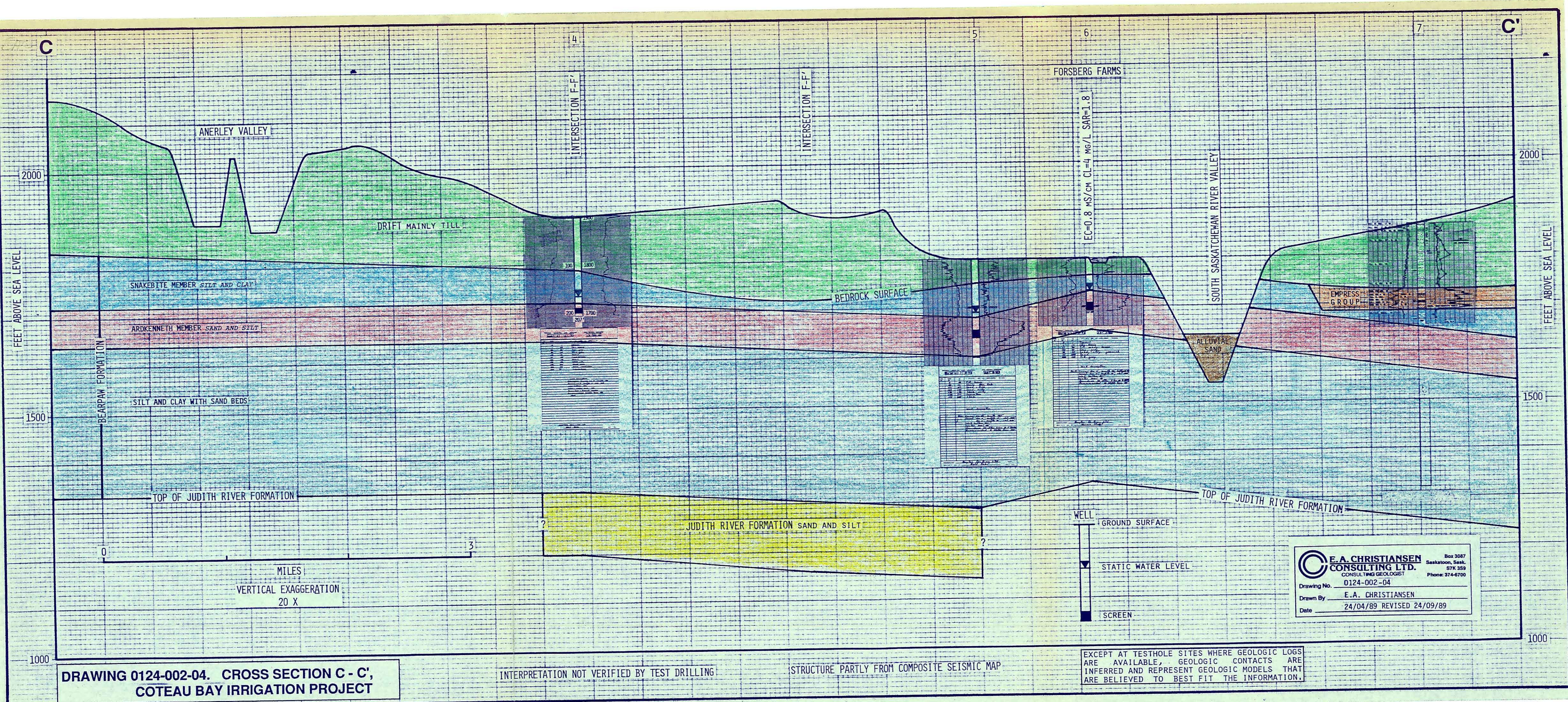
53

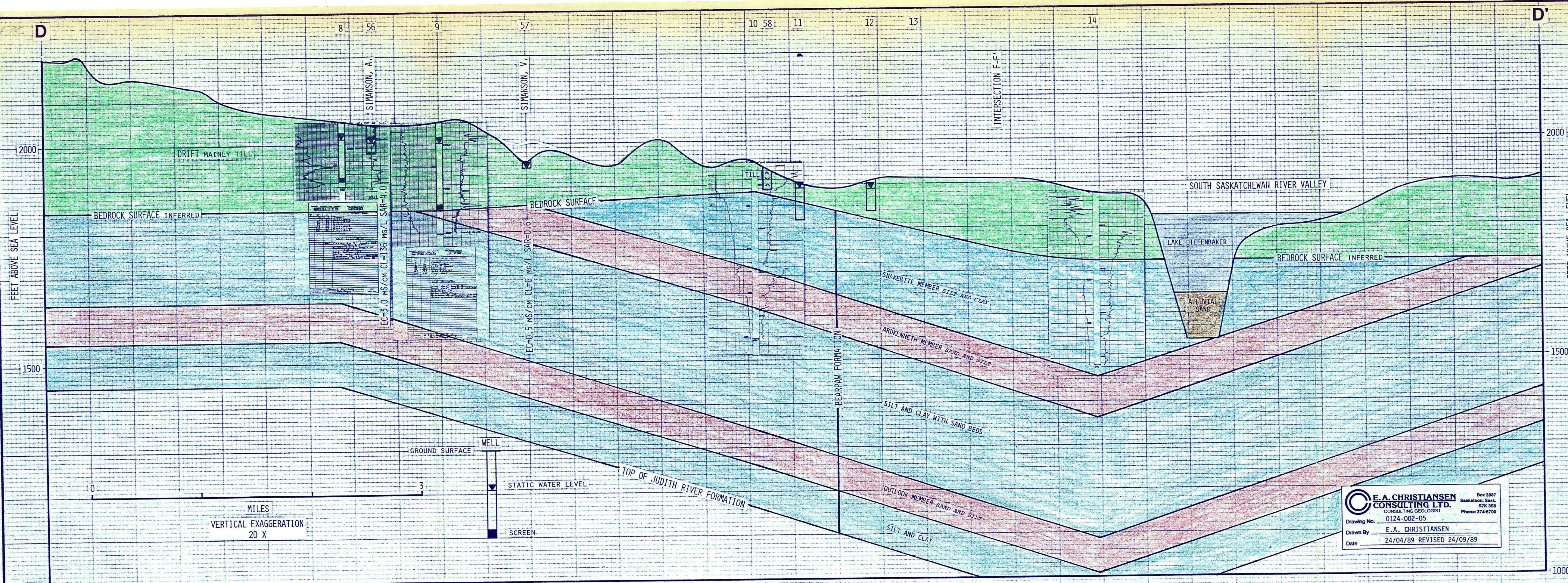
67

55

B'







**DRAWING 0124-002-05. CROSS SECTION D - D',
COTEAU BAY IRRIGATION PROJECT**

EXCEPT AT TESTHOLE SITES WHERE GEOLOGIC LOGS
ARE AVAILABLE, GEOLOGIC CONTACTS ARE
INFERRED AND REPRESENT GEOLOGIC MODELS THAT
ARE BELIEVED TO BEST FIT THE INFORMATION.

INTERPRETATION NOT VERIFIED BY TEST DRILLING

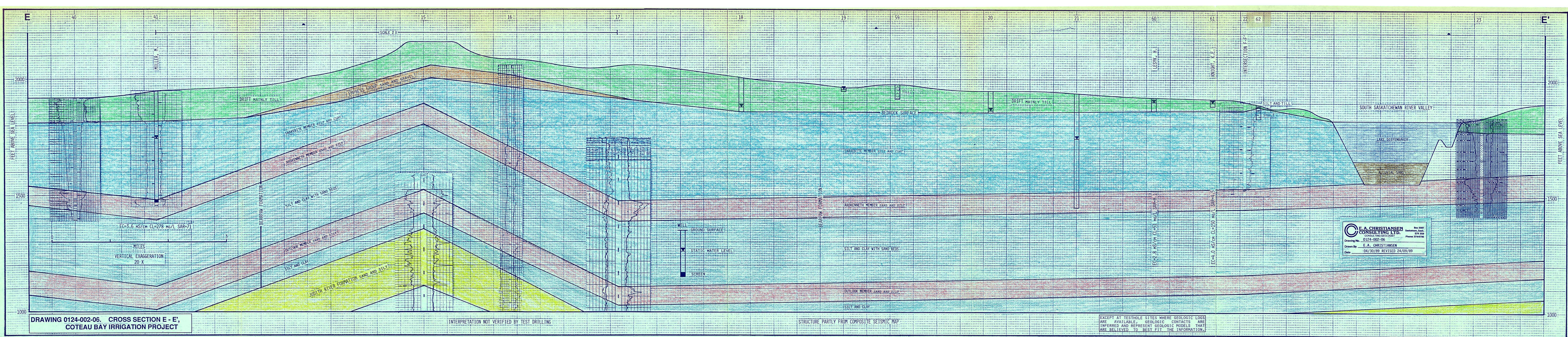
STRUCTURE PARTLY FROM COMPOSITE SEISMIC MAP

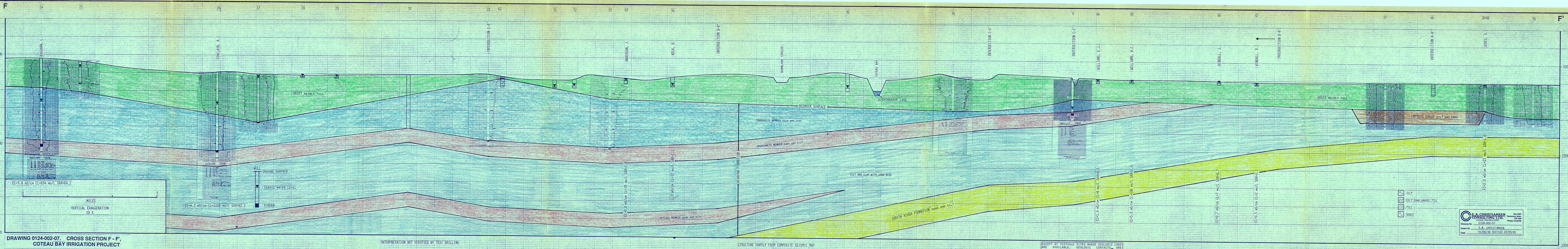


**E.A. CHRISTIANSEN
CONSULTING LTD.**
CONSULTING GEOLOGIST
Box 3087
Saskatoon, Sask.
S7N 3S9
Phone: 374-6700

Drawing No. 0124-002-05
Drawn By E.A. CHRISTIANSEN
Date 24/04/89 REVISED 24/09/89

1000





DRAWING 0124-002-07. CROSS SECTION F - F', COTEAU BAY IRRIGATION PROJECT

EXCEPT AT TESTHOLE SITES WHERE GEOLOGIC LOGS ARE AVAILABLE, GEOLOGIC CONTACTS ARE INFERRED AND REPRESENT GEOLOGIC MODELS THAT ARE BELIEVED TO BEST FIT THE INFORMATION.

E.A. CHRISTIANSEN CONSULTING LTD.
Drawing No. 0124-002-07
Drawn By E.A. CHRISTIANSEN
Date 01/05/89 REVISED 24/09/89

Site 3947 Saskatoon, Sask. S7N 3S9 Phone 374-7100