

CONTENTS

MILROFF RCE  
MOBILE TEL

739<sub>2</sub>



QUINTETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

### LOCATION PLAN

FIG. 1

- LEGEND**
- EXISTING ROTARY DRILL HOLE
  - EXISTING DIAMOND DRILL HOLE
  - ⊕ PROPOSED ROTARY DRILL HOLE
  - ⊕ PROPOSED DIAMOND DRILL HOLE
  - ▲ EXISTING PHOTO OR SURVEY CONTROL POINT
  - ▲ PROPOSED PHOTO OR SURVEY CONTROL POINT
  - EXISTING ACCESS ROAD
  - PROPOSED ACCESS ROAD
  - OVERLAND CONVEYOR
  - POWER LINE
  - TRANSMISSION LINE

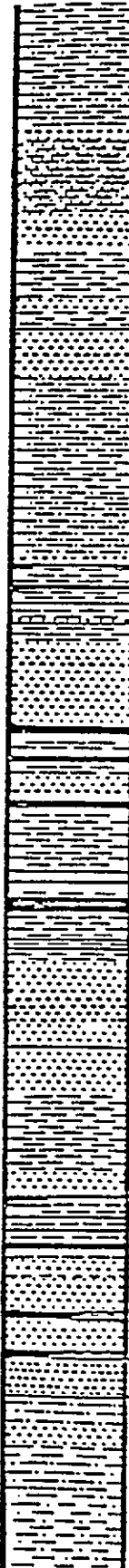
SCALE 1:20,000

|                        |             |               |               |
|------------------------|-------------|---------------|---------------|
| Project Manager        |             | TRANSFER AREA |               |
| QUINTETTE COAL LIMITED |             | TRANSFER AREA |               |
| DENISON MINES LIMITED  |             | TRANSFER AREA |               |
| COAL DIVISION          |             | TRANSFER AREA |               |
| Scale                  | 1:20,000    | Drawing No.   | 87-903-26-001 |
| Category               | EXPLORATION | Rev.          | 0             |

LOWER CRETACEOUS

FORT ST. JOHN GROUP

|                                     |                                     |
|-------------------------------------|-------------------------------------|
| SHAFTESBURY FORMATION<br>(82 m)     |                                     |
| Gates Member<br>(262-274 m)         | Boulder Creek Member<br>(122-140 m) |
| Hulcross Member<br>(75-105 m)       |                                     |
| MOOSEBAR FORMATION<br>(120 - 215 m) |                                     |
| GETHING FORMATION<br>(100 - 200 m)  |                                     |
| CADOMIN 15-45m                      |                                     |
| MINNES GROUP<br>(~ 2100 m)          |                                     |



|   |                     |  |
|---|---------------------|--|
| Interbedded gray shale and mudstone.                                    |                     |  |
| Sandstone, conglomerate and shale with carbonaceous materials.          |                     |  |
| Marine shale with sideritic concretions and mudstones.                  |                     |  |
| A,B,C   | Upper Gates Member  | Cyclic alternation of interbedded gray shale and coarse to fine grain sandstone, conglomerate and coal |
| Babcock Member  |                     |  |
| D,E,F   | Middle Gates Member |  |
| G/I,J,K   |                     |  |
| Torrens Member  |                     |  |
| Marine shale with sideritic concretions; glauconitic sandstone at base. |                     |  |
| Bird, Skeeter-Chamberlain Middle Coal Zone                              |                     |  |
| Basal Conglomerate.   |                     |  |
| Siltstones, shales, some sandstone and coaly shale.                     |                     |  |

FIG. 2

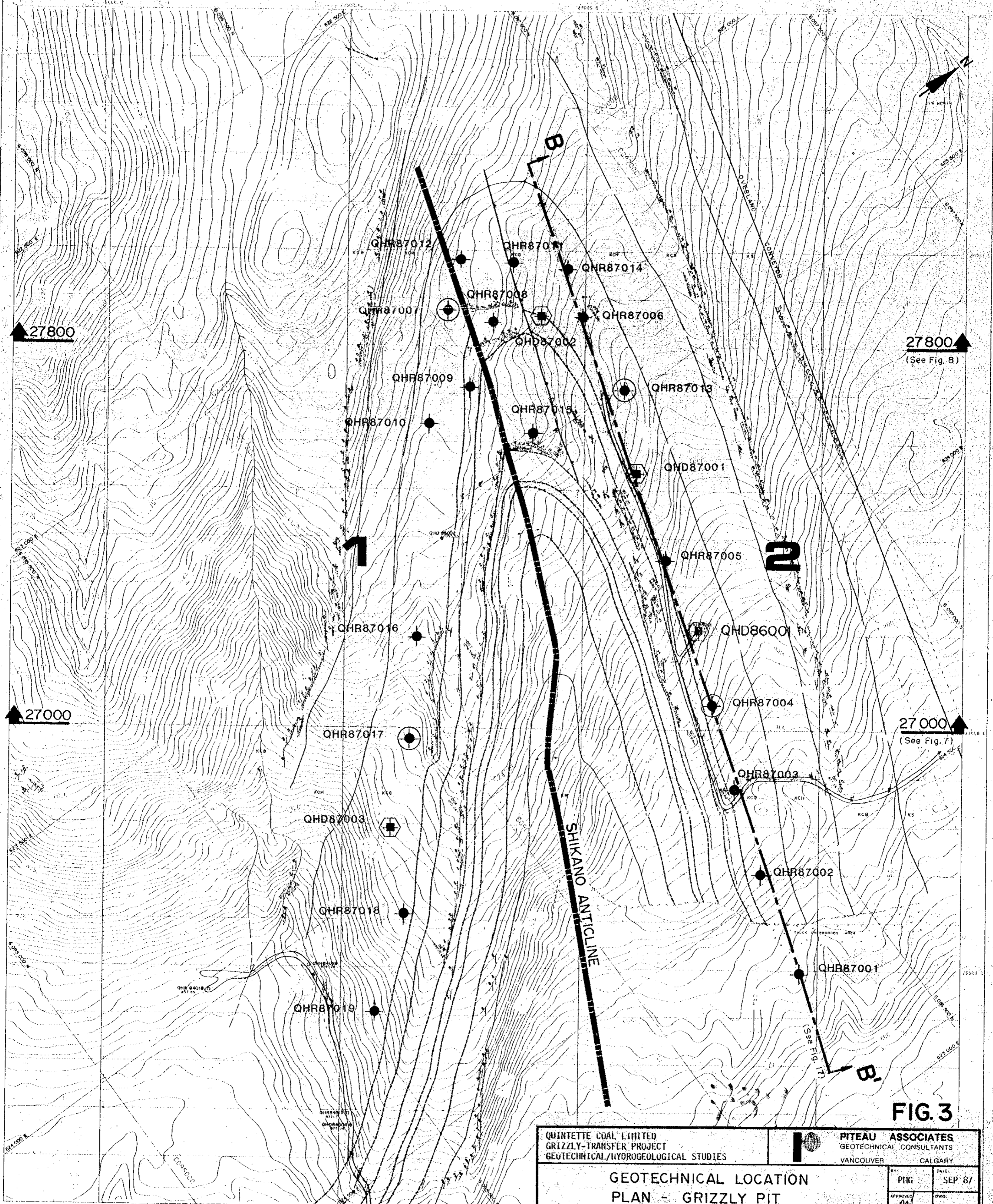
QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU & ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

GENERAL STRATIGRAPHIC COLUMN ( After QUINETTE COAL LTD., 1981)

|                    |          |
|--------------------|----------|
| BY:                | DATE:    |
| PMH                | AUG 87   |
| APPROVED:          | DWG:     |
| <i>[Signature]</i> | 339-GT-2 |



**FIG. 3**

|  |  |  |  |
|--|--|--|--|
| QUINTETTE COAL LIMITED<br>GRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES |  | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY |  |
| <b>GEOTECHNICAL LOCATION<br/>PLAN - GRIZZLY PIT</b>  |  | BY: PHG<br>DATE: SEP 87  | APPROVED: [Signature]<br>DWO: 339-47-3 |

**LEGEND**

- 1** STRUCTURAL DOMAIN
- 1** STRUCTURAL DOMAIN BOUNDARY
- ◆ QHR87018 ROTARY DRILLHOLE
- ◆ QHD87007 DIAMOND DRILLHOLE
- ◆ QHD87004 ROTARY DRILLHOLE WITH PIEZOMETERS
- ◆ QHD86006 DIAMOND DRILLHOLE WITH PIEZOMETERS
- ◆ QHD87003 GEOTECHNICALLY LOGGED DIAMOND DRILLHOLE
- ▲ 27 000 GEOTECHNICAL CROSS SECTION
- B** HYDROGEOLOGICAL LONGITUDINAL CROSS SECTION

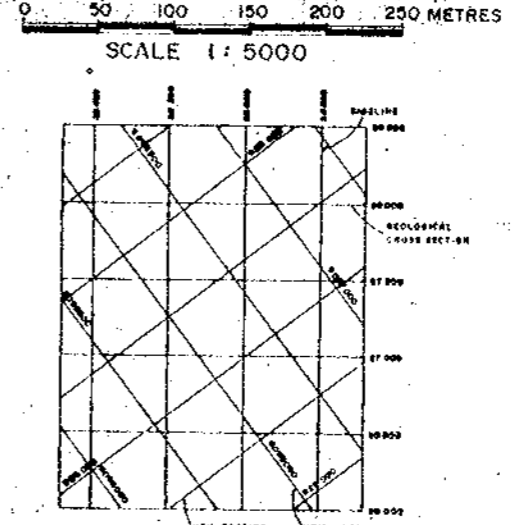
**LEGEND**

**GEOLOGIC FORMATIONS**

- [KS] SHAFTSBURY
- [KCB] BOULDER CREEK
- [KCH] HULLCROSS
- [KCG] GATES
- [KCM] MOOSEBAR
- [KQ] GETHING
- [KCU] CADOMIN

**LEGEND**

- TREELINE
- ROADS
- TRENCH
- ROTARY DRILL HOLE
- ◆ DIAMOND DRILL HOLE
- THRUST FAULT
- ANTICLINE
- SYNCLINE
- GEOLOGIC CONTACT
- COAL BEAM OUTCROP



|      |             |    |         |          |
|------|-------------|----|---------|----------|
| DATE | DESCRIPTION | BY | CHECKED | APP. NO. |
|      |             |    |         |          |
|      |             |    |         |          |
|      |             |    |         |          |

QUINTETTE COAL LIMITED  
 GRIZZLY AREA  
 GEOLOGY

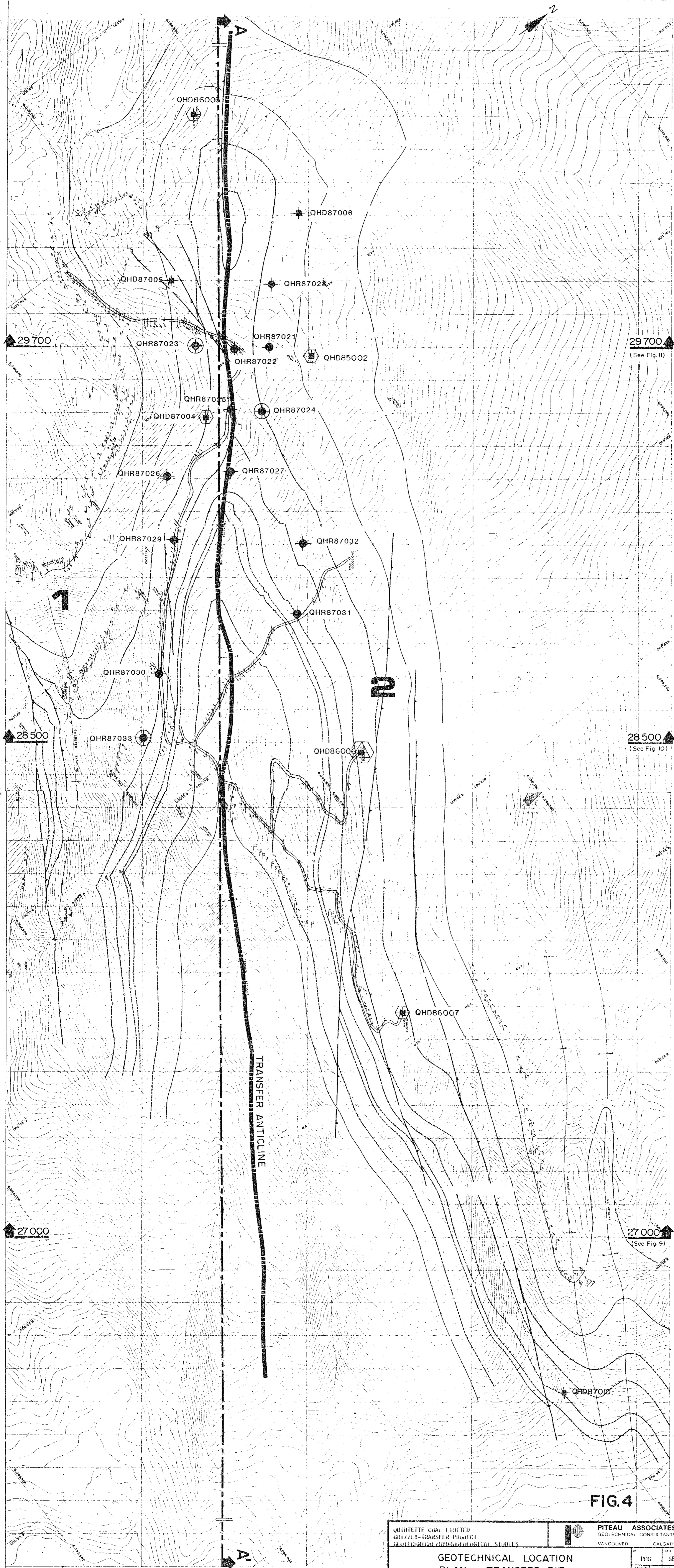


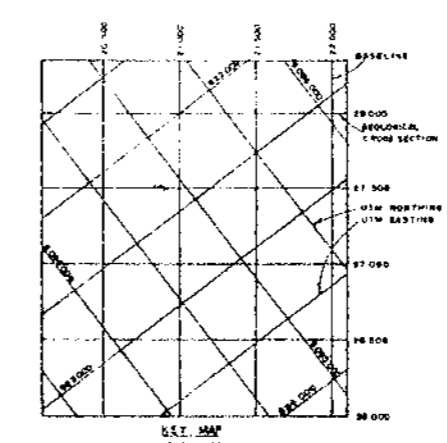
FIG. 4

|   |  |
|---|--|
| QUIHETTE COAL LIMITED<br>BRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL / HYDROGEOLOGICAL STUDIES | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY |
| <b>GEOTECHNICAL LOCATION PLAN - TRANSFER PIT</b>  |  |
| PROJECT: PIG<br>DATE: SEP 07  | SHEET: 539-47-4  |

- LEGEND**
- TREELINE
  - == ROADS
  - TRENCH
  - ROTARY DRILL HOLE
  - ⊕ DIAMOND DRILL HOLE
  - THRUST FAULT
  - ANTICLINE
  - SYNCLINE
  - GEOLOGIC CONTACT
  - COAL BEAM OUTCROP

- GEOLOGIC FORMATIONS**
- KS SHAFTSBURY
  - KCB BOULDER CREEK
  - KCC HILLCROSS
  - KCS GATES
  - KW MOOSEBAR
  - KQ GETMING
  - KCD CADOMIN

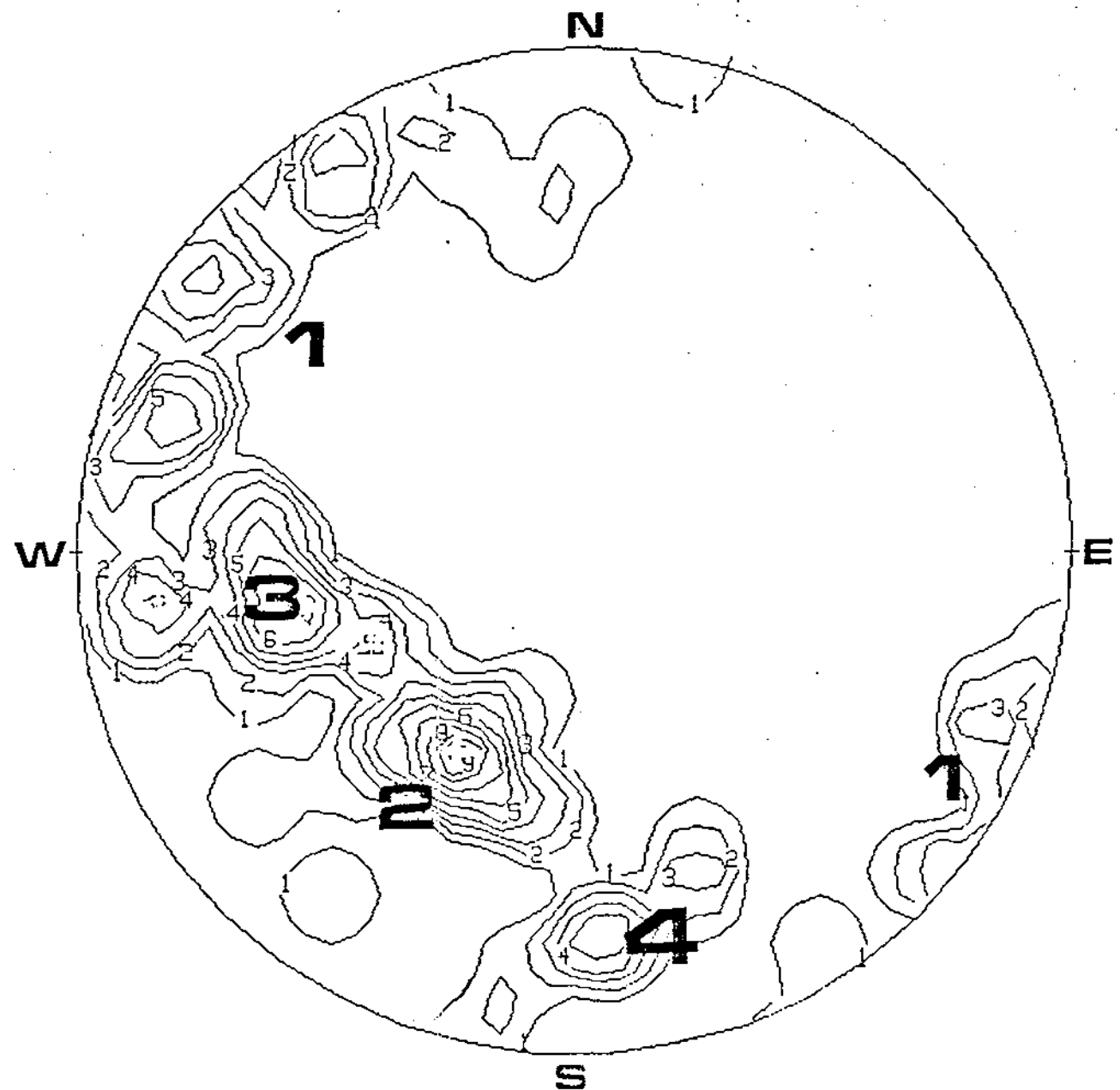
0 50 100 150 200 250 METRES  
SCALE 1:5000



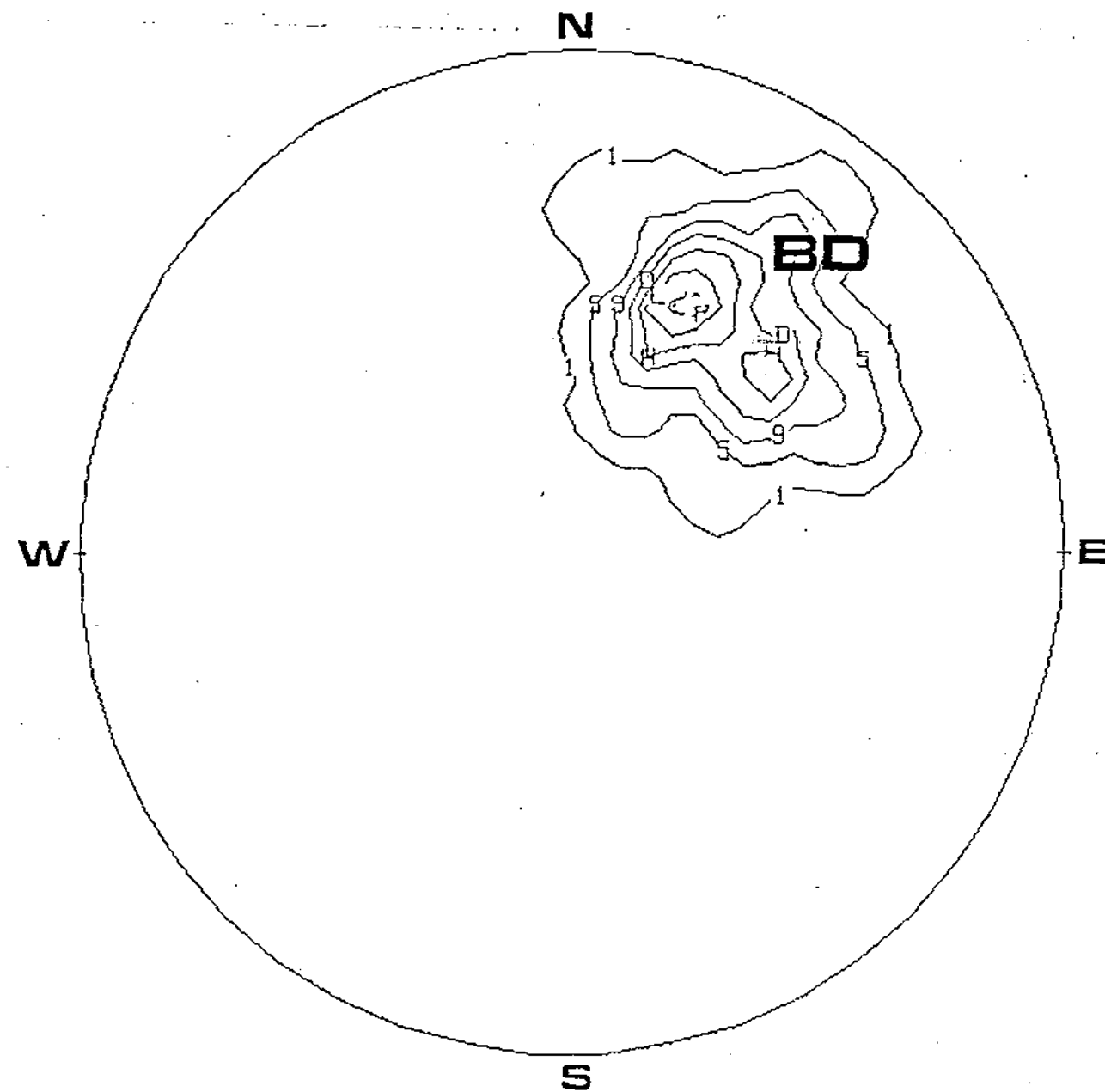
|   |                         |
|---|-------------------------|
| QUIHETTE COAL LIMITED<br>GEMSON MINES LIMITED<br>TRANSFER AREA GEOLOGY<br>SHEET 2 | 1:5000<br>87-903-20-002 |
|---|-------------------------|

NOTE: For additional Symbols see Fig. 3.

739



LOWER HEMISPHERE EQUAL AREA PROJECTION  
SHIKANO/GRIZZLY/TRANSFER JOINTS ON SW DIPPING LIMBS



LOWER HEMISPHERE EQUAL AREA PROJECTION  
SHIKANO/GRIZZLY/TRANSFER BEDDING ON SW DIPPING LIMBS

**FIG. 5**

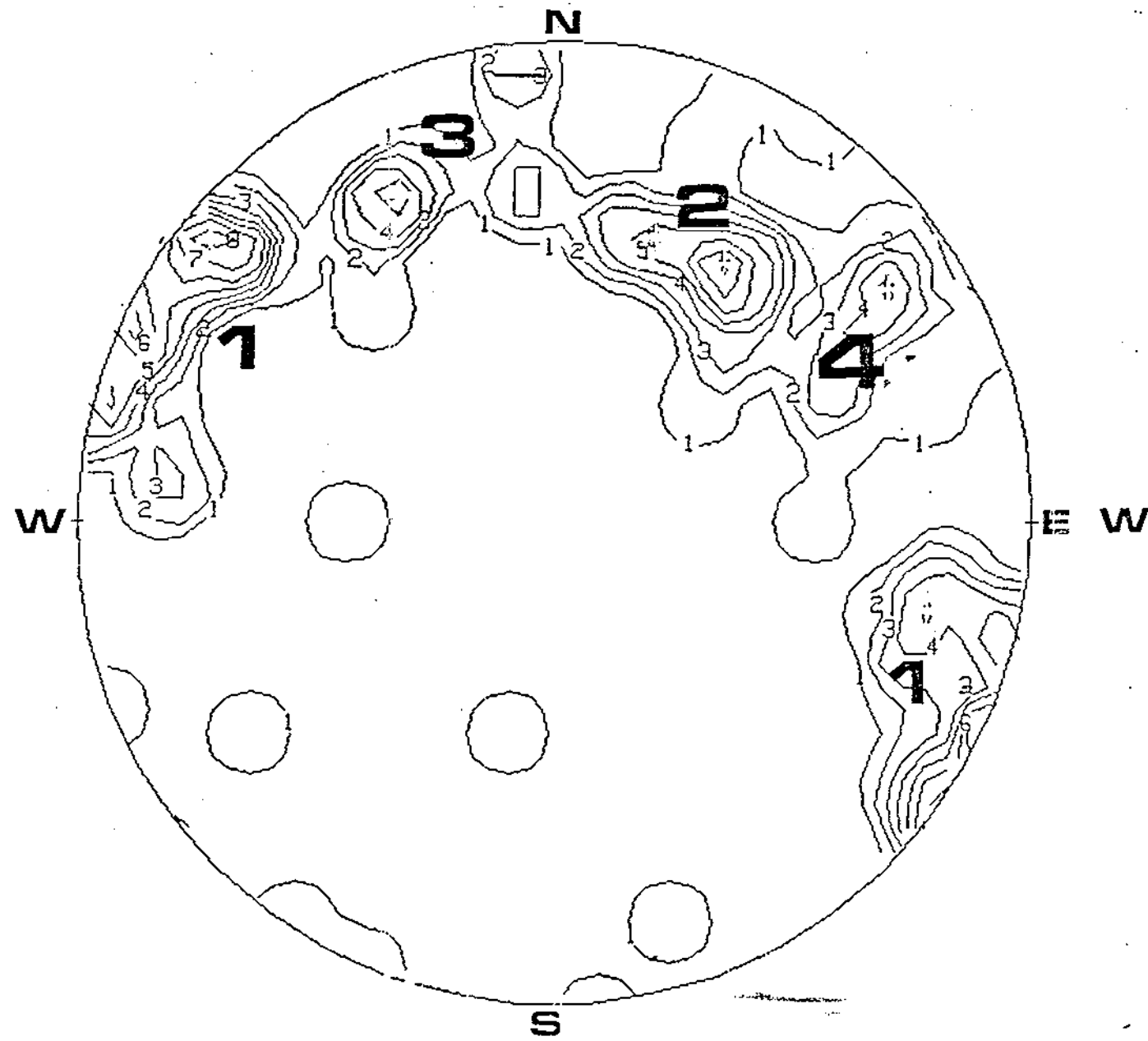
QUINTETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



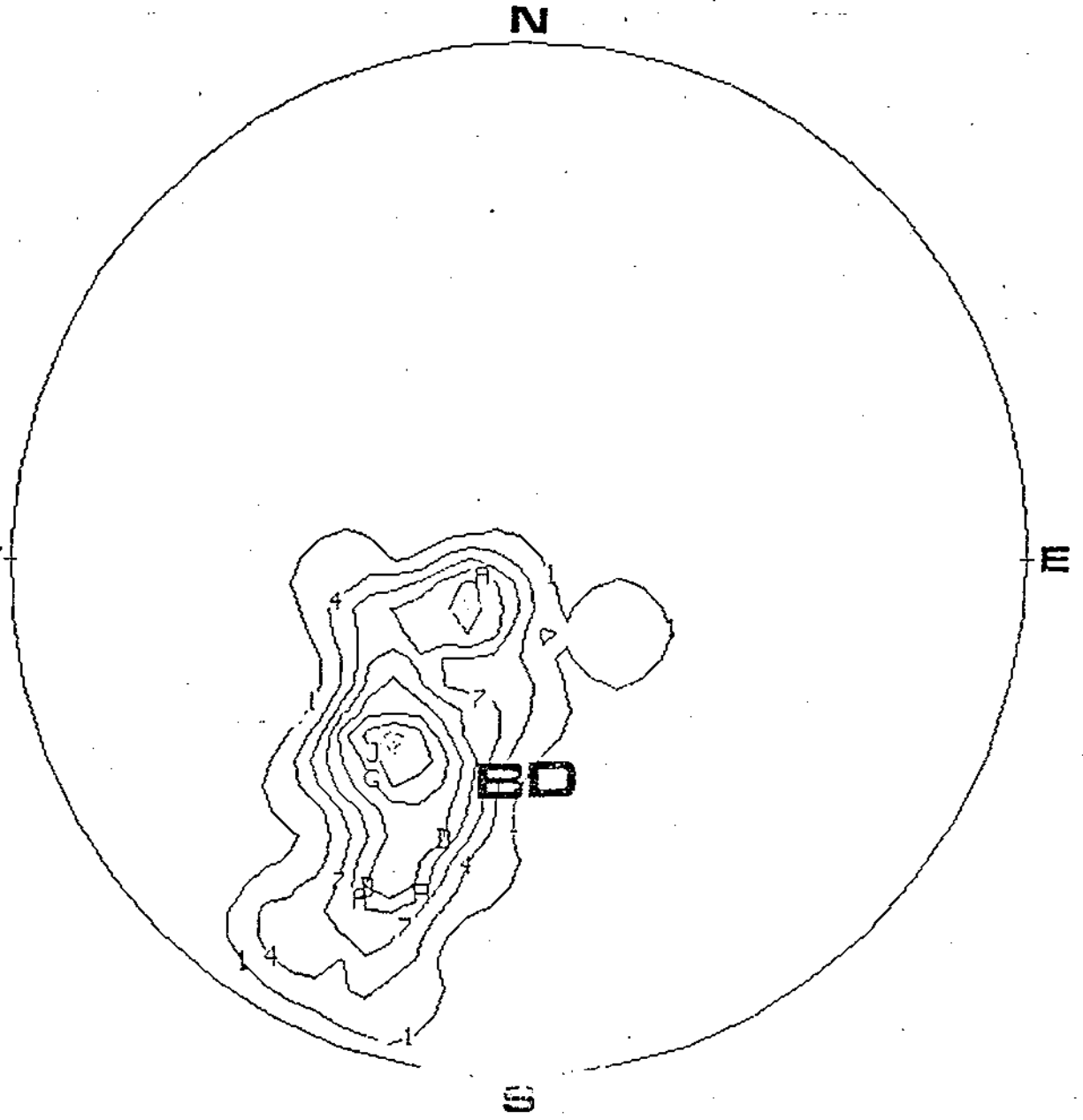
PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

BEDDING AND JOINT ORIENTATIONS IN STRUCTURAL DOMAIN 1

|                                 |                  |
|---------------------------------|------------------|
| BY:<br>PMG                      | DATE:<br>SEP 87  |
| APPROVED:<br><i>[Signature]</i> | DWO:<br>339-GT-5 |



LOWER HEMISPHERE EQUAL AREA PROJECTION  
 SHIKANO/GRIZZLY/TRANSFER JOINTS ON NE DIPPING LIMBS



LOWER HEMISPHERE EQUAL AREA PROJECTION  
 SHIKANO/GRIZZLY/TRANSFER BEDDING ON NE DIPPING LIMBS

**FIG. 6**

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

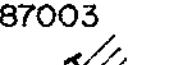
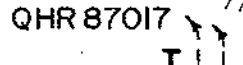

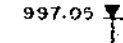


BEDDING AND JOINT ORIENTATIONS IN STRUCTURAL DOMAIN 2







|                                 |                  |
|---------------------------------|------------------|
| BY:<br>PMG                      | DATE:<br>SEP 87  |
| APPROVED:<br><i>[Signature]</i> | DWG:<br>339-GT-6 |


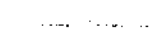



ELEVATION IN METRES

22900

**LEGEND**

-  QHD 87003  
GEOTECHNICALLY LOGGED DIAMOND DRILLHOLE ILLUSTRATING BEDDING DIP INTERPRETATION BASED ON CUMULATIVE SUMS ANALYSIS
-  QHR 87017  
ROTARY OR DIAMOND DRILLHOLE WITH PIEZOMETER INSTALLATIONS
-  LOCATION OF PIEZOMETER OR STANDPIPE TIP
-  997.05  
PIEZOMETRIC ELEVATION IN SEALED PIEZOMETER (m)
-  997.05  
WATER TABLE ELEVATION IN OPEN DRILLHOLE OR STANDPIPE (m)
-   
FLOWING HOLE OR PIEZOMETER

-  KS Shaftsbury formation
-  KCB Boulder Creek formation
-  KCH Hulcross formation
-  XCG Gates formation
-  KM Monsebar formation
-  KG Setling formation

-  D COAL SEAM
-  FORMAL CONTACT
-  FAULT
-  SYNCLINAL AXIS
-  ANTICLINAL AXIS

- NOTES:**
- See Appendix A for details of geotechnically logged Diamond Drillholes.
  - See Appendix D for details of hydrogeological installations.



|   |   |           |                  |
|---|---|-----------|------------------|
|  | <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY | BY:       | DATE:<br>SEP. 37 |
|   |   | APPROVED: | DWG:<br>333-4T-7 |

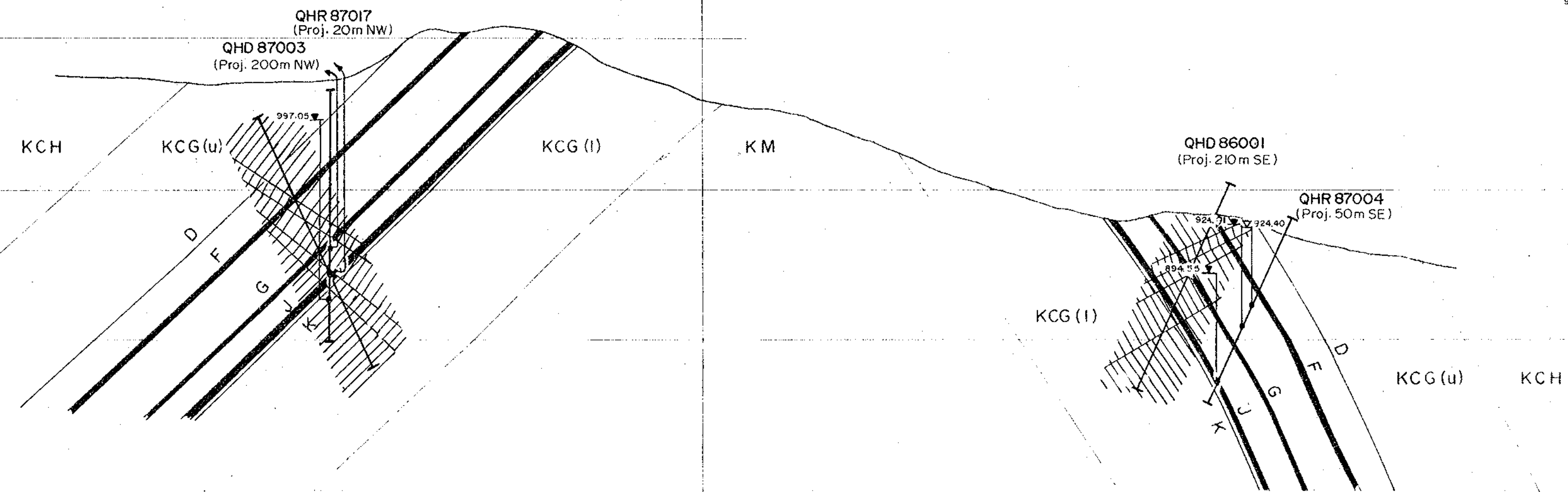
**QUINTETTE COAL LIMITED**  
Project Manager  
**DENISON MINES LIMITED**  
COAL DIVISION

Area **GRIZZLY** Category **GEOLOGY**

Drawing Title  
**GEOTECHNICAL CROSS-SECTION**  
**27 000**  
**FIG. 7**

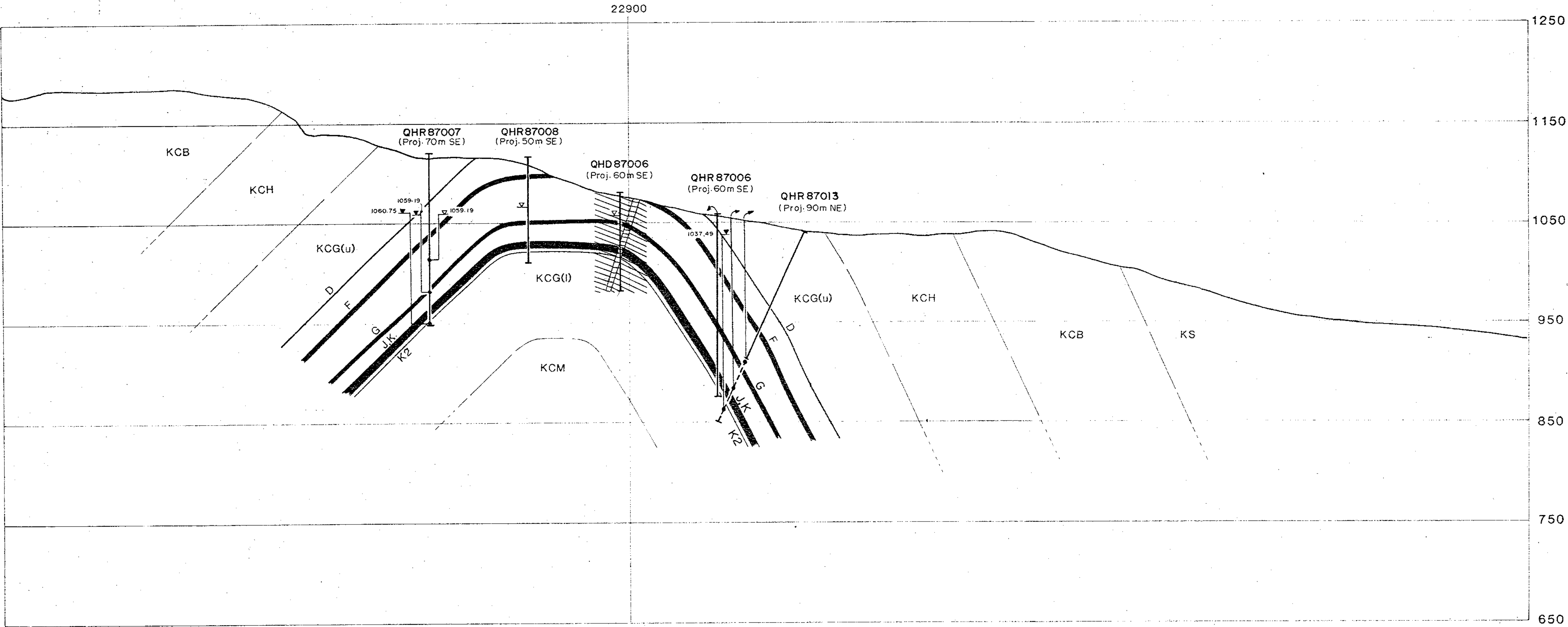
|                 |                                   |     |
|-----------------|-----------------------------------|-----|
| Scale<br>1:2500 | Drawing No. OCL<br>87-905-21-003A | Rev |
|-----------------|-----------------------------------|-----|

1250  
1150  
1050  
950  
850  
750  
650





ELEVATION IN METRES



- KS Shaftsbury formation
- KCB Boulder Creek formation
- KCH Hulcross formation
- KCG Gates formation
- KM Moosebar formation
- KG Gething formation

- D COAL SEAM
- FORMATION CONTACT
- FAULT
- SYNCLINAL AXIS
- ANTICLINAL AXIS

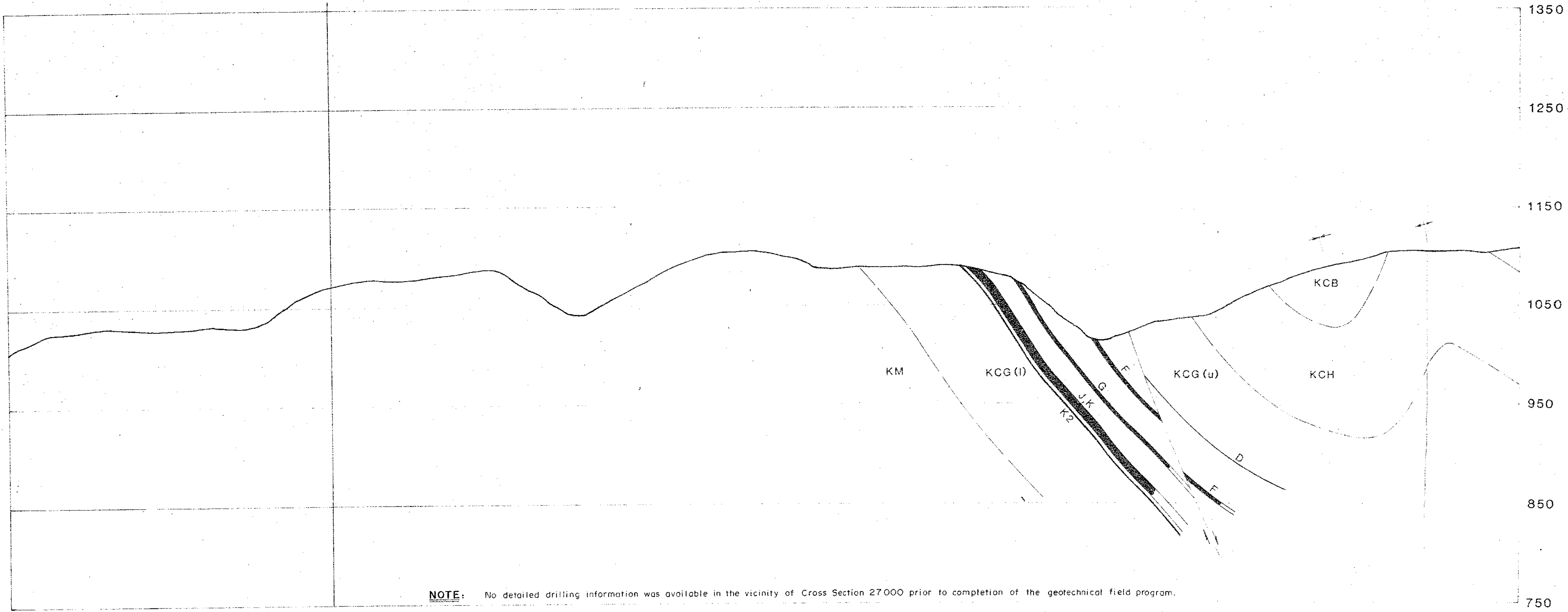
NOTE: For additional Notes and Symbols see Fig. 7.



|  |                |          |
|--|----------------|----------|
| <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER      CALGARY                   | BY:            | DATE:    |
|  | APPROVED:      | DWG:     |
| <b>QUINETTE COAL LIMITED</b><br>Project Manager<br><b>DENISON MINES LIMITED</b><br>COAL DIVISION |                |          |
| Area   | GRIZZLY        | Category |
| Drawing Title  |                | GEOLOGY  |
| <b>GEOTECHNICAL<br/>         CROSS-SECTION<br/>         27800</b>                                |                |          |
| FIG. 8   |                |          |
| Scale  | Drawing No OCL | Rev.     |
| 1:2500   | 87-905-21-004  |          |

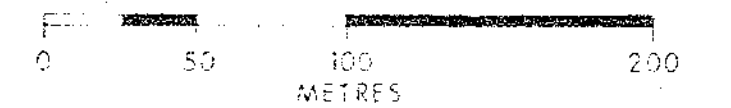
ELEVATION IN METRES

20800



- KS Shaftsbury formation
- KCB Boulder Creek formation
- KCH Hulcross formation
- KCG Gates formation
- KM Moosebar formation
- KG Gething formation

- COAL SEAM
- FORMATION CONTACT
- FAULT
- SYNCLINAL AXIS
- ANTICLINAL AXIS



|  |           |        |
|--|-----------|--------|
| <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER      CALGARY | BY:       | DATE:  |
|  | APPROVED: | DWG:   |
|  | 239-489   | CCT 87 |

**QUINTETTE COAL LIMITED**  
 Project Manager  
**DENISON MINES LIMITED**  
 COAL DIVISION

Area: **TRANSFER**      Category: **GEOLOGY**

Drawing Title  
**GEOTECHNICAL  
 CROSS-SECTION  
 27000**

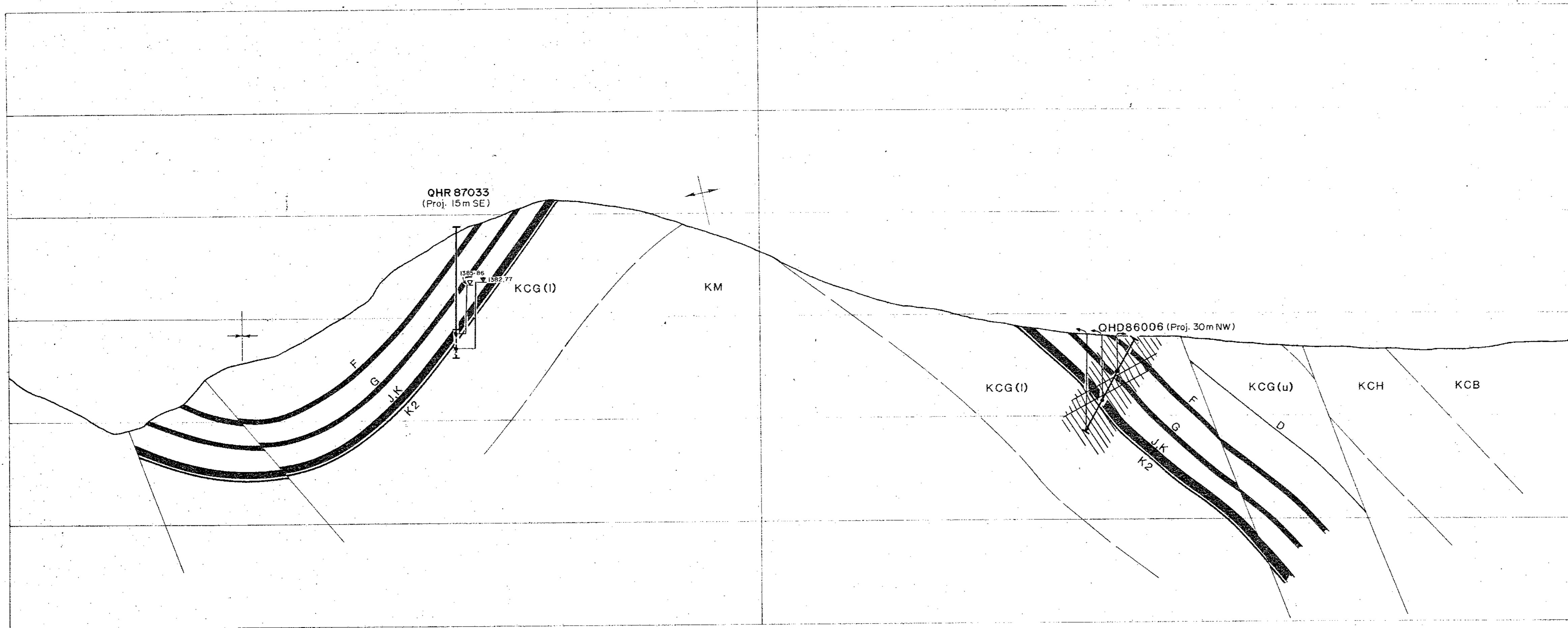
**FIG. 9**

Scale: 1:2500      Drawing No. QCL: 87-903-22-001

**NOTE:** No detailed drilling information was available in the vicinity of Cross Section 27000 prior to completion of the geotechnical field program.

ELEVATION IN METRES

20800



1650  
1550  
1450  
1350  
1250  
1150  
1050

- KS Shaftsbury formation
- KCB Boulder Creek formation
- KCH Hulcross formation
- KCG Gates formation
- KM Moosebar formation
- KG Gething formation

- COAL SEAM
- FORMATION CONTACT
- FAULT
- SYNCLINAL AXIS
- ANTICLINAL AXIS

NOTE: For additional Notes and Symbols see Fig. 7.

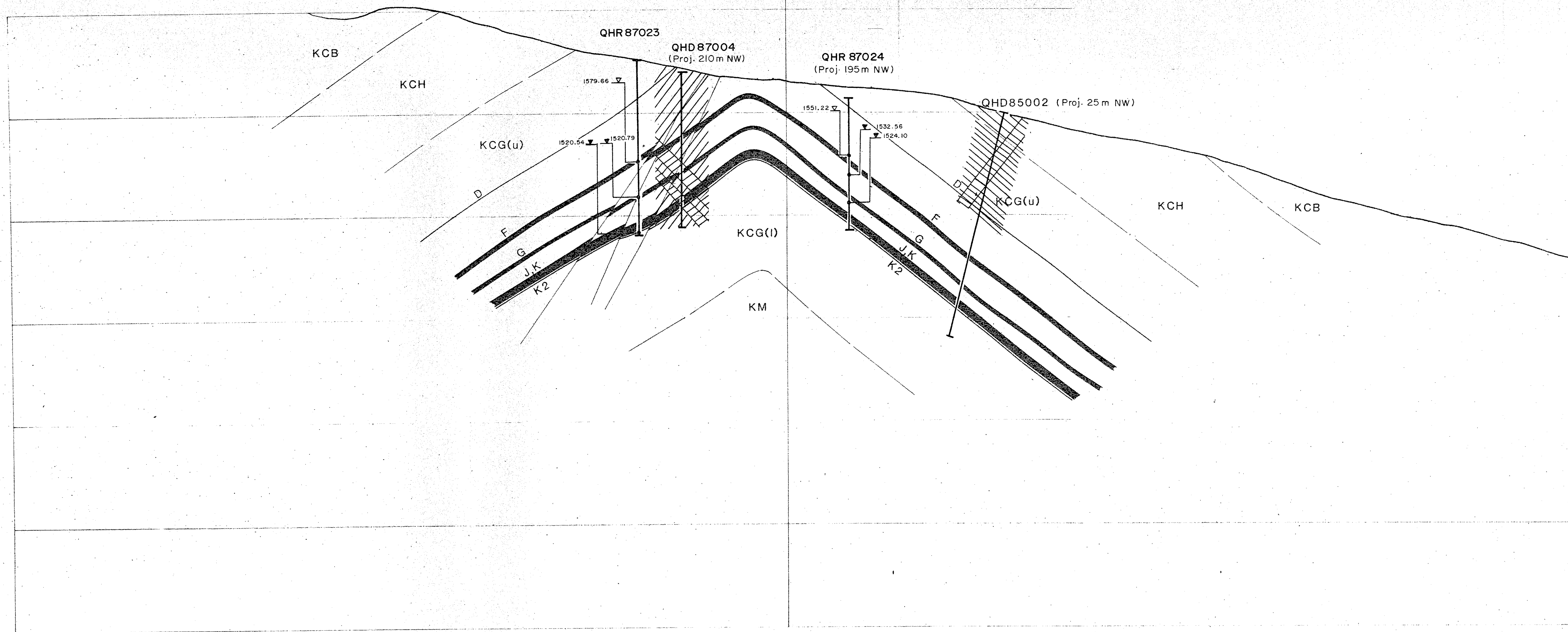


|   |                      |                     |
|---|----------------------|---------------------|
| <p><b>PITEAU ASSOCIATES</b><br/>GEOTECHNICAL CONSULTANTS<br/>VANCOUVER CALGARY</p>                          | BY:                  | DATE:               |
|   | APPROVED:            | DWG:                |
| <p><b>QUINTETTE COAL LIMITED</b><br/>Project Manager<br/><b>DENISON MINES LIMITED</b><br/>COAL DIVISION</p> |                      |                     |
| Area  | TRANSFER             | Category<br>GEOLOGY |
| <p>Drawing Title<br/><b>GEOTECHNICAL<br/>CROSS-SECTION<br/>28500</b></p>                                    |                      |                     |
| Scale   | Drawing No. QCL      | Rev.                |
| 1:2500  | <b>87-903-21-003</b> |                     |

**FIG. 10**

ELEVATION IN METRES

20800



1650  
1550  
1450  
1350  
1250  
1150  
1050

- KS Shafrsbury formation
- KCB Boulder Creek formation
- KCH Hulcross formation
- KCG Gates formation
- KM Moosebar formation
- K2 Getting formation

- COAL SEAM
- FORMATION CONTACT
- FAULT
- SYNCLINAL AXIS
- ANTICLINAL AXIS

NOTE: For additional Notes and Symbols see Fig. 7.



|   |           |           |
|---|-----------|-----------|
| <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY | BY:       | DATE:     |
|   | APPROVED: | DWG.      |
|   |           | 339-4T-11 |

**QUINETTE COAL LIMITED**  
 Project Manager  
**DENISON MINES LIMITED**  
 COAL DIVISION

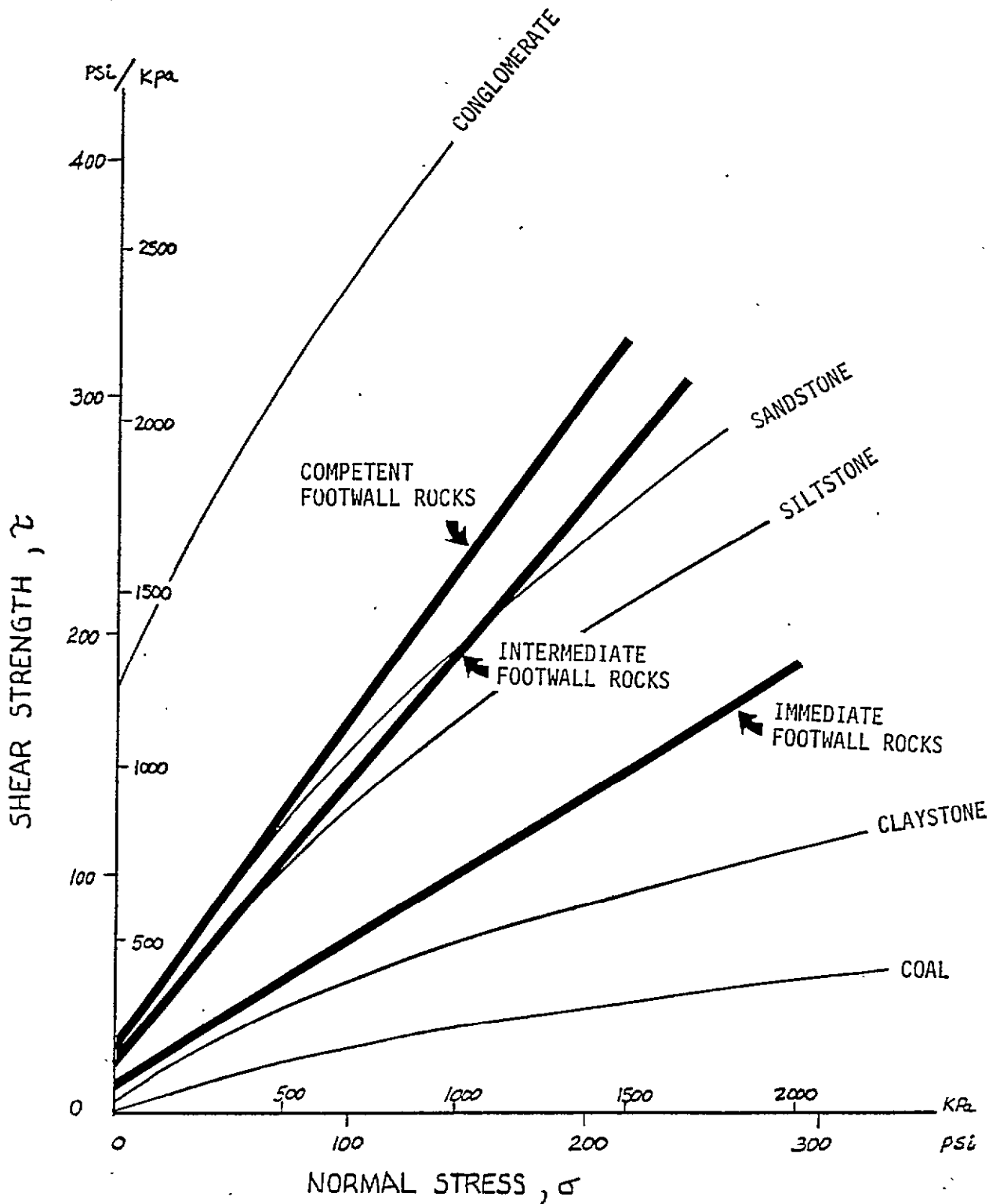
Area **TRANSFER** Category **GEOLOGY**

Drawing Title  
**GEOTECHNICAL CROSS-SECTION**

29700

**FIG. II**

|                 |                                  |      |
|-----------------|----------------------------------|------|
| Scale<br>1:2500 | Drawing No. QCL<br>87-903-21-005 | Rev. |
|-----------------|----------------------------------|------|



NOTE: Rock mass strength envelopes are based on criteria developed by Hoek and Brown (1980).

**FIG.12**

QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

MOHR ENVELOPES OF ROCK MASS SHEAR STRENGTH

|                              |                |
|------------------------------|----------------|
| BY: PMG                      | DATE: AUG '87  |
| APPROVED: <i>[Signature]</i> | DWG: 339-GT-12 |

MESA  
PIT STATUS  
APR 26, 1987

WOLVERINE

SHIKANO  
PIT STATUS  
MARCH 31, 1987

739

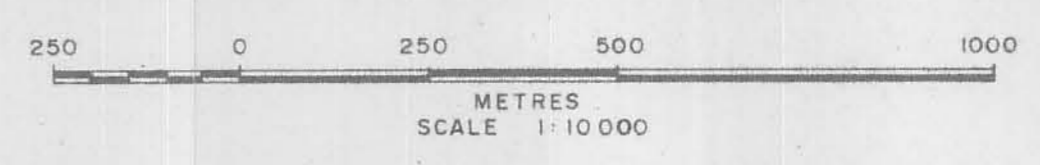
**LEGEND FOR AIRPHOTO INTERPRETATION**

|     |                             |     |                                   |
|-----|-----------------------------|-----|-----------------------------------|
| R   | BEDROCK                     | C   | COLLUVIUM (b= blanket, v= veneer) |
| Gt  | GLACIOFLUVIAL TERRACE       | SC  | SILTY COLLUVIUM                   |
| A   | ALLUVIUM                    | M   | TILL                              |
| F/O | ALLUVIUM WITH SOME ORGANICS | C/R | COLLUVIUM WITH ROCK               |
| Lt  | GLACIOLACUSTRINE TERRACE    | C   | COLLUVIUM OVER ROCK               |

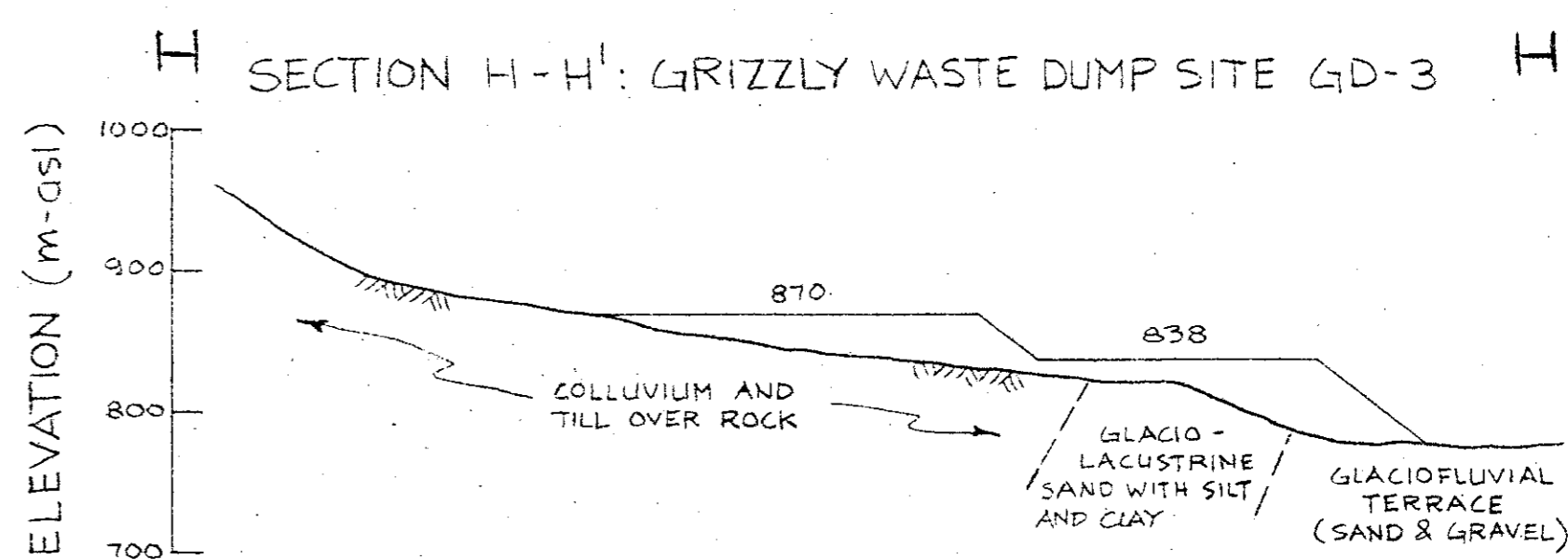
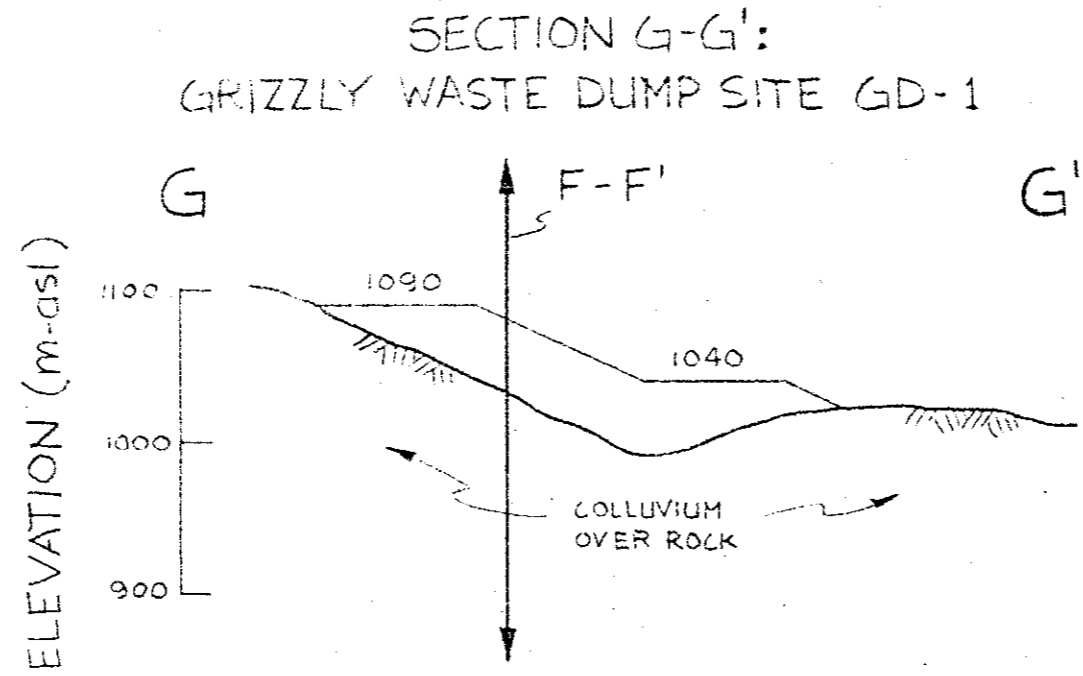
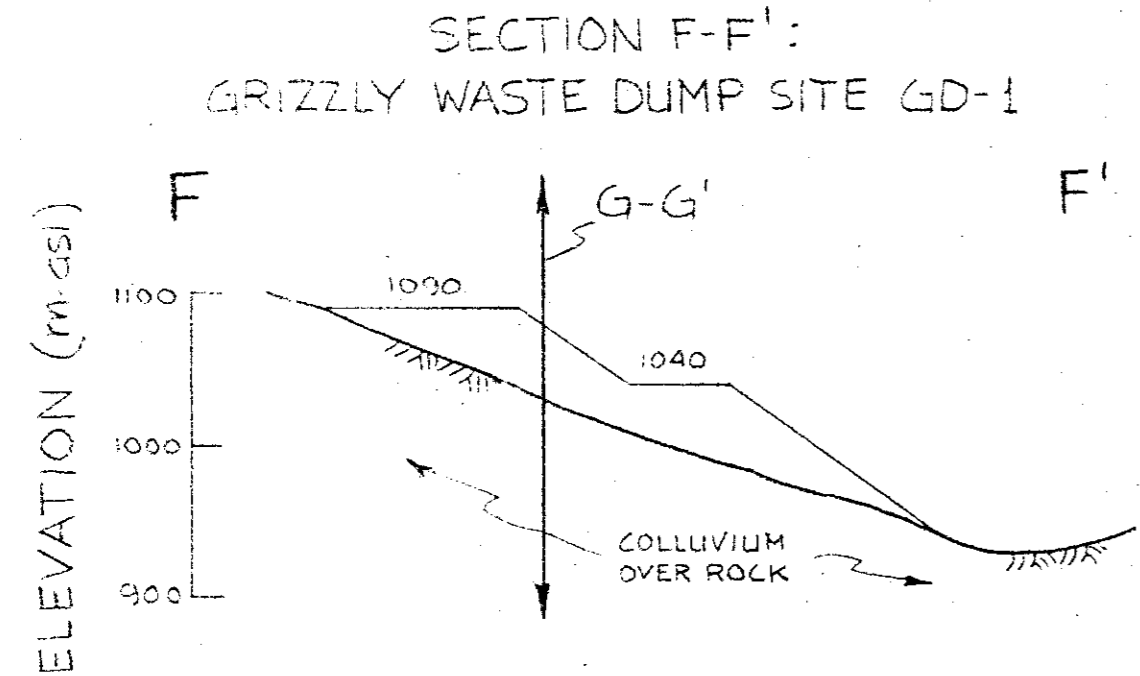
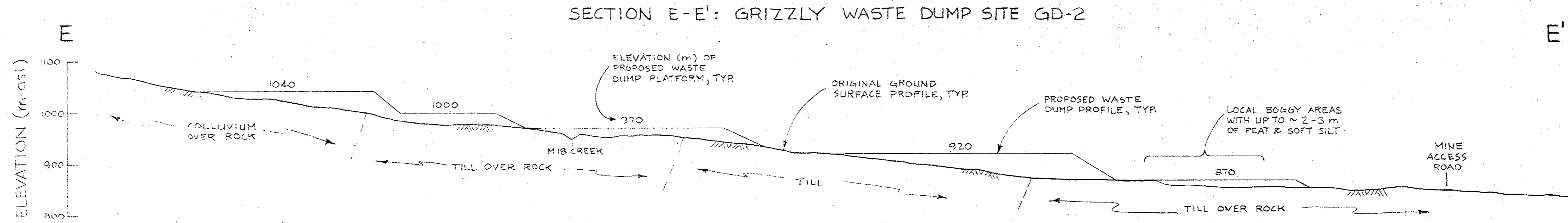
**LEGEND**

|    |                                  |     |                      |
|----|----------------------------------|-----|----------------------|
| ○  | EXISTING ROTARY DRILL HOLE       | —   | EXISTING ACCESS ROAD |
| ●  | EXISTING DIAMOND DRILL HOLE      | --- | OVERLAND CONVEYOR    |
| □  | TEST PIT                         | -P- | POWER LINE           |
| ▲  | CROSS SECTION (See Fig. 14 B 15) | -T- | TRANSMISSION LINE    |
| ▲  | WASTE DUMP LIFT                  |     |                      |
| SP | SEDIMENTATION POND SITE          |     |                      |

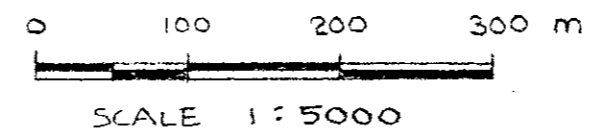
**NOTES:**  
1. Boundaries of surficial soils types based primarily on airphoto interpretation with limited ground reconnaissance and test pitting.



|   |                       |  |   |   |
|---|-----------------------|--|---|---|
| <b>QUINTETTE COAL LIMITED</b><br>Project Manager<br><b>DENISON MINES LIMITED</b><br>COAL DIVISION |                       | ORIGINAL DRAFT<br>Revision Description<br>Kiv. Des. App.<br>J.T.J.<br>G.P.S. | <b>PITEAU &amp; ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY | DATE: 04/07/87<br>APPROVED: [Signature]<br>399-6715 |
| Area: TRANSFER  | Category: EXPLORATION | Scale: 1:10,000  | Dwg No. OCL 87-903-28-001<br><b>FIG. 13</b>                                     |   |



**NOTE:**  
SEE FIG. 13 FOR LOCATION OF CROSS SECTIONS



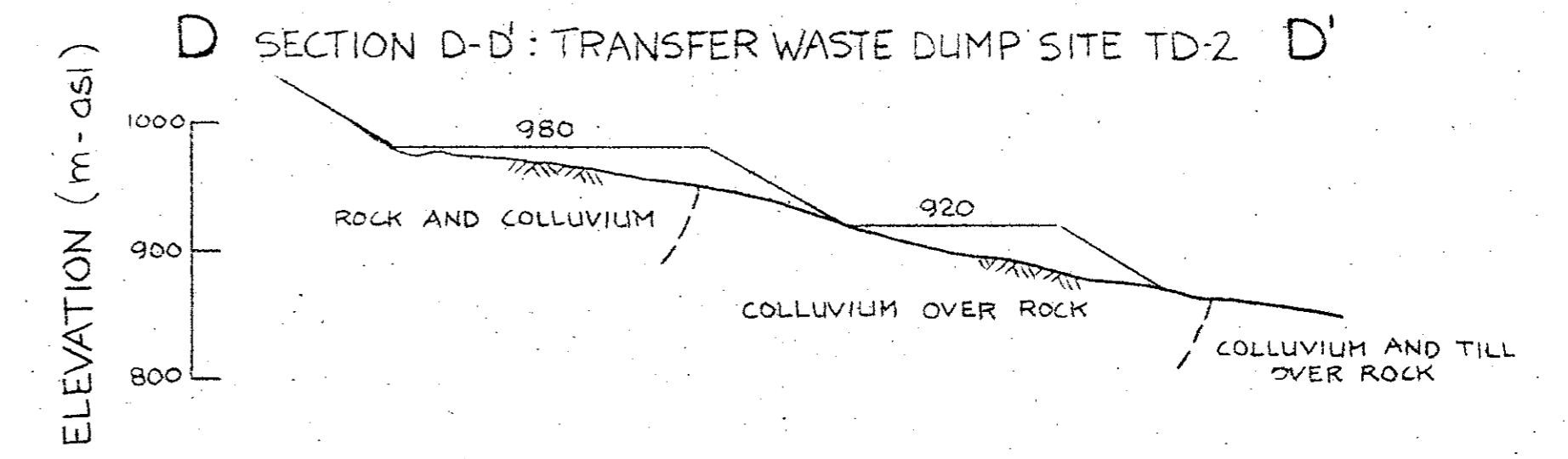
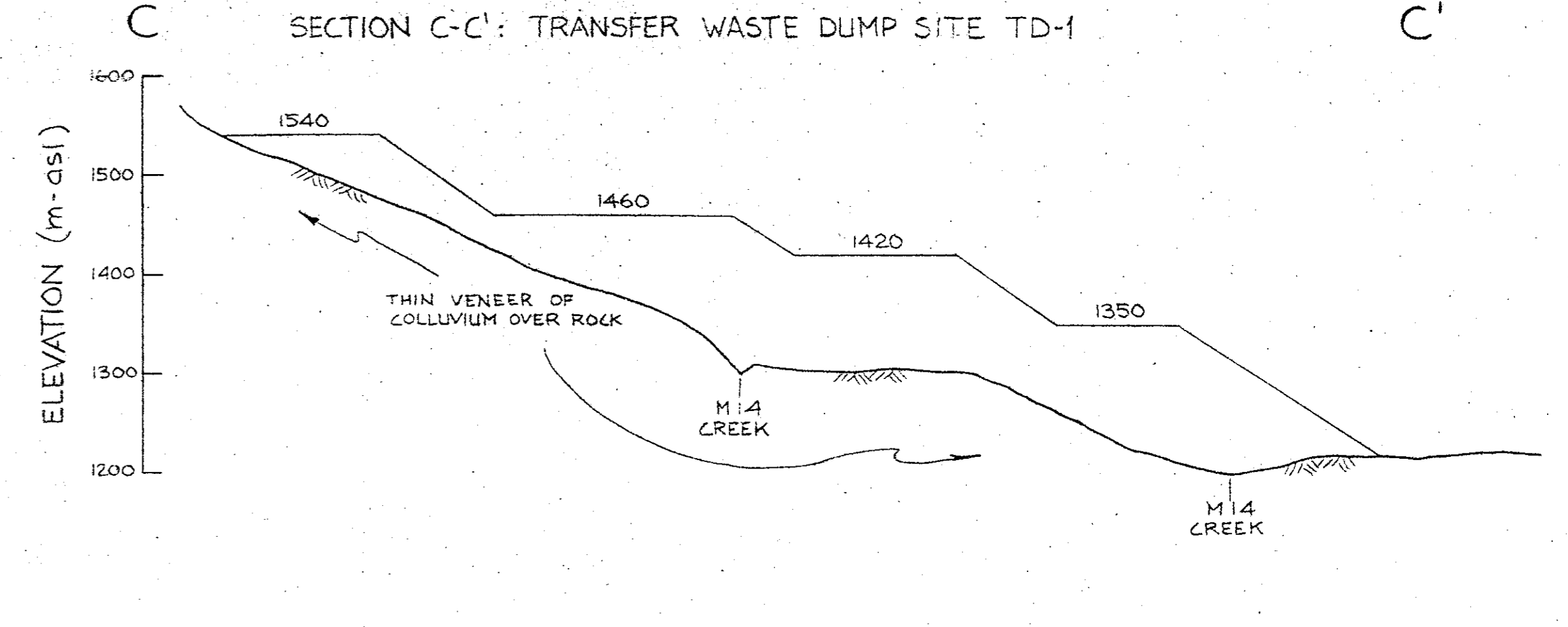
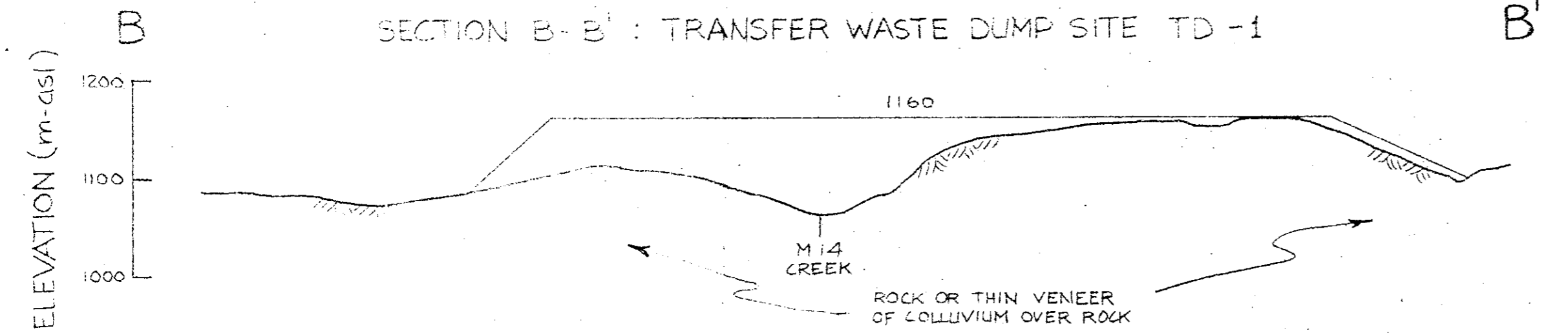
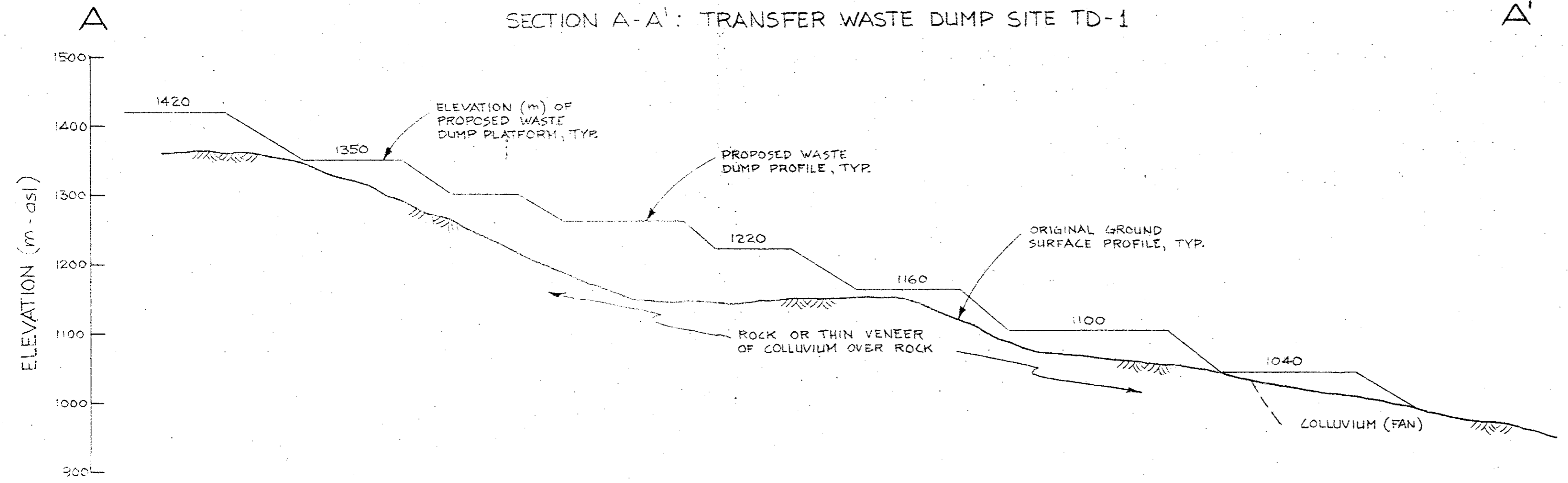
QUINTETTE COAL LIMITED  
GRIZZLY - TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

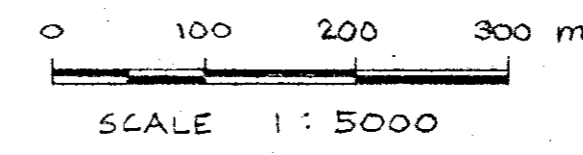
CROSS SECTIONS THROUGH PROPOSED  
GRIZZLY WASTE DUMP SITES

|                |                  |
|----------------|------------------|
| BY<br>PHH      | DATE<br>SEPT, 87 |
| APPROVED<br>BL | DWG<br>DWC       |
| <i>av.</i>     | <i>J</i>         |

**FIG. 14**



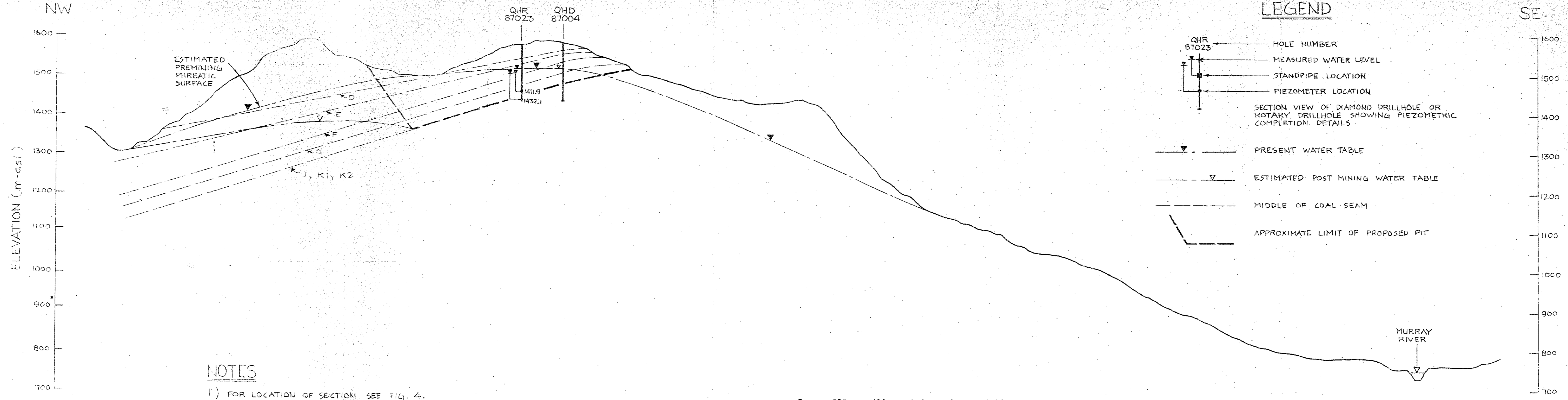
**NOTE:**  
SEE FIG. 13 FOR LOCATION OF CROSS SECTIONS



**FIG. 15**

|  |  |  |                        |
|--|--|--|------------------------|
| QUINTETTE COAL LIMITED<br>GRIZZLY - TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES |  | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY |                        |
| CROSS-SECTIONS THROUGH PROPOSED<br>TRANSFER WASTE DUMP SITES                                 |  | BY: PMH<br>APPROVED: BL  | DATE: SEPT. 87<br>DWG: |



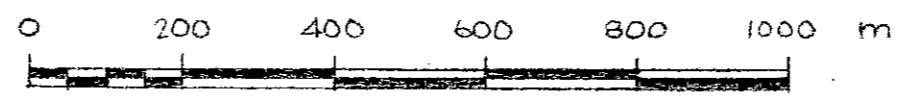


**NOTES**

- 1) FOR LOCATION OF SECTION SEE FIG. 4.
- 2) FINITE - ELEMENT MESH BASED ON THIS SECTION IS SHOWN ON FIG. 18.

**LEGEND**

- QHR 87023 ← HOLE NUMBER
- ▽ ← MEASURED WATER LEVEL
- ← STANDPIPE LOCATION
- ← PIEZOMETER LOCATION
- SECTION VIEW OF DIAMOND DRILLHOLE OR ROTARY DRILLHOLE SHOWING PIEZOMETRIC COMPLETION DETAILS
- ▽— PRESENT WATER TABLE
- - - ▽ - - - ESTIMATED POST MINING WATER TABLE
- - - MIDDLE OF COAL SEAM
- · - - APPROXIMATE LIMIT OF PROPOSED PIT



HORIZONTAL SCALE 1:10,000  
VERTICAL EXAGGERATION 2:1

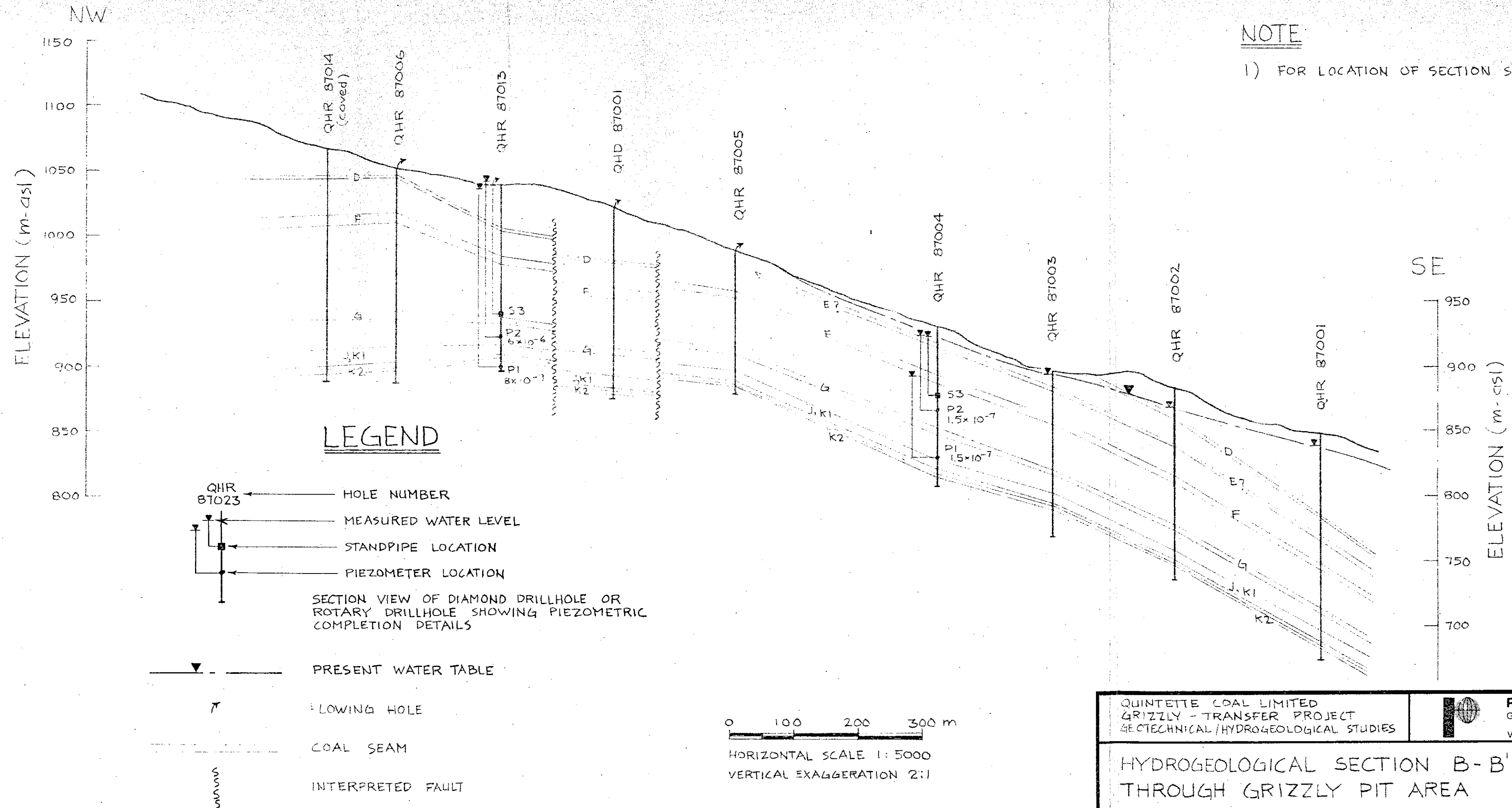
QUINETTE COAL LIMITED  
GRIZZLY - TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

HYDROGEOLOGICAL SECTION A-A'  
THROUGH TRANSFER PIT AREA

|          |                 |
|----------|-----------------|
| BY<br>AH | DATE<br>SEPT 87 |
| BL       |                 |
| APPROVED | DWG             |

**FIG.16**



**NOTE**  
 1) FOR LOCATION OF SECTION SEE FIG. 3.

**LEGEND**

- QHR 87023 ← HOLE NUMBER
- ▲ ← MEASURED WATER LEVEL
- ← STANDPIPE LOCATION
- ← PIEZOMETER LOCATION

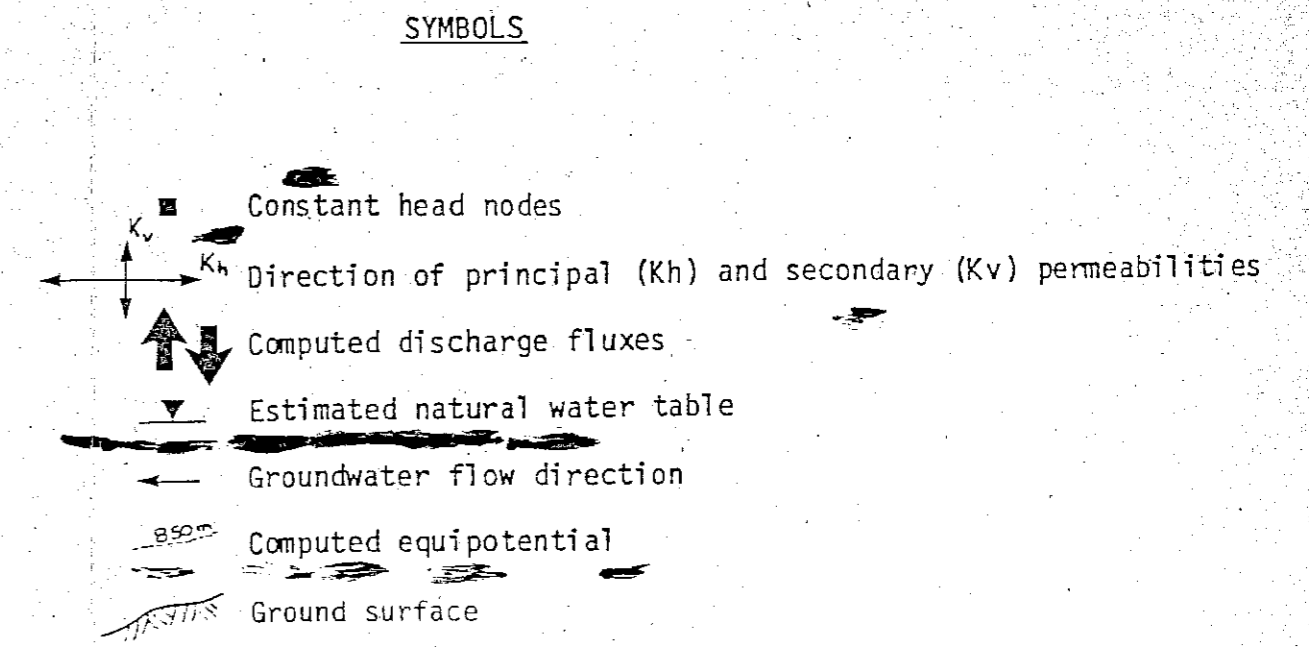
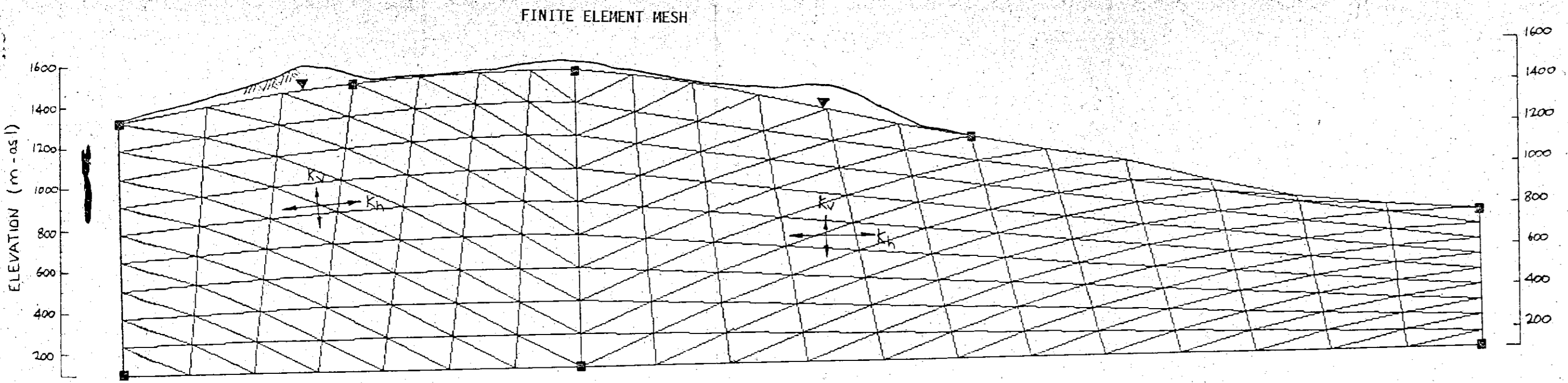
SECTION VIEW OF DIAMOND DRILLHOLE OR ROTARY DRILLHOLE SHOWING PIEZOMETRIC COMPLETION DETAILS

- ▼ ——— PRESENT WATER TABLE
- ↑ FLOWING HOLE
- COAL SEAM
- ~~~~~ INTERPRETED FAULT

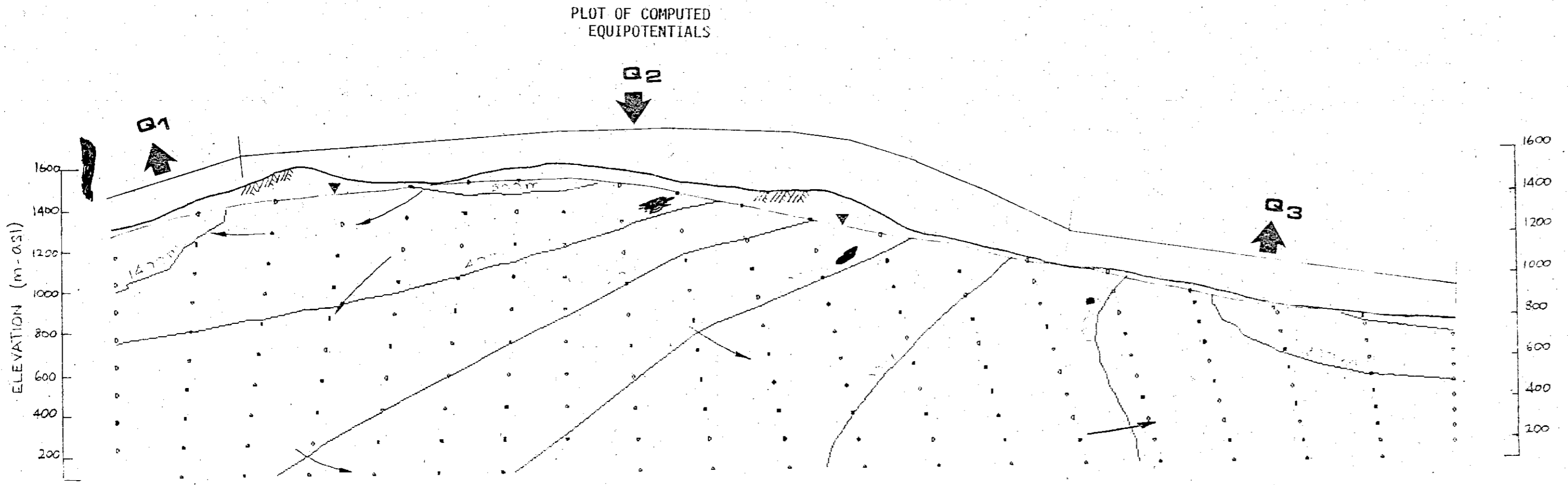
0 100 200 300 m  
 HORIZONTAL SCALE 1: 5000  
 VERTICAL EXAGGERATION 2:1

**FIG. 17**

|  |  |  |                               |
|--|--|--|-------------------------------|
| QUINTETTE COAL LIMITED<br>GRIZZLY - TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES |  | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY |                               |
| HYDROGEOLOGICAL SECTION B-B'<br>THROUGH GRIZZLY PIT AREA                                     |  | BY: AH<br>DATE: SEPT. 87   | APPROVED: [Signature]<br>DWG: |



Scale 1 cm = 200m



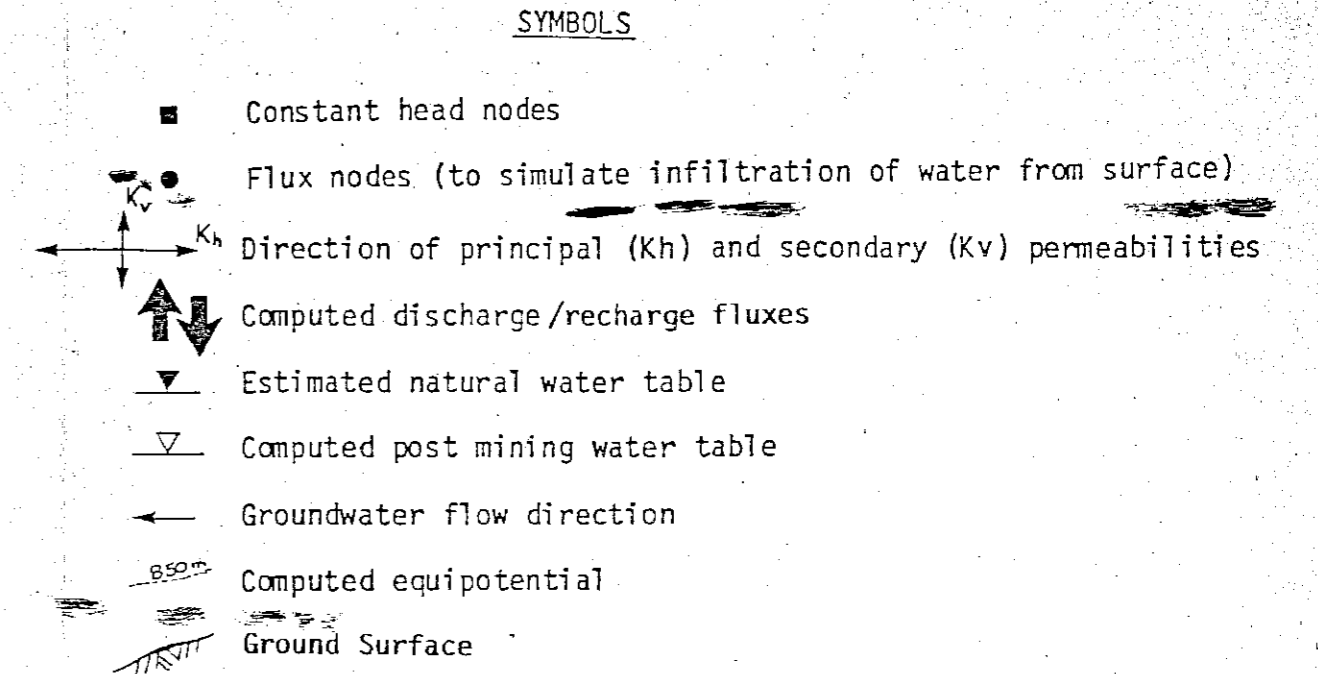
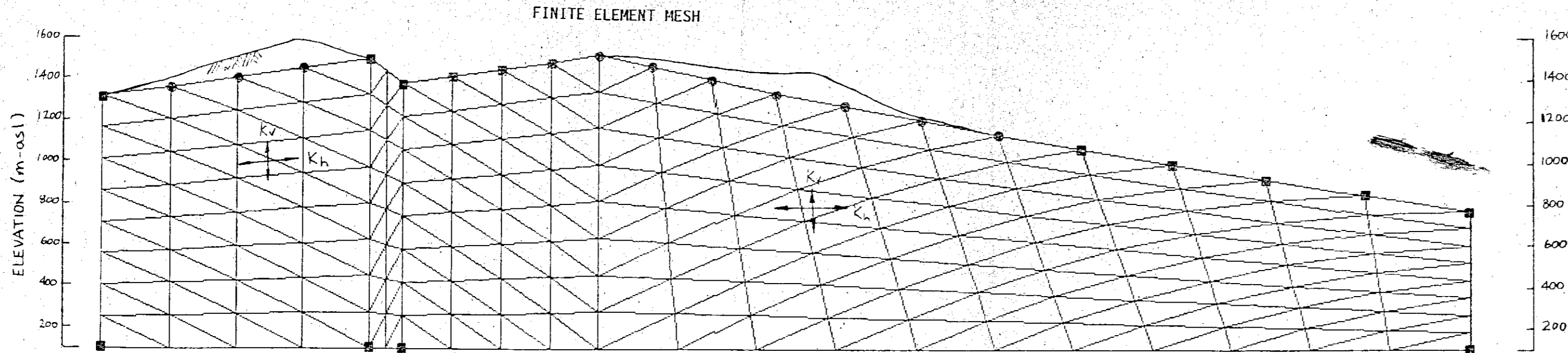
**SUMMARY OF MODELLING RESULTS**

| CASE | HYDRAULIC CONDUCTIVITY (m/s) |           | COMPUTED FLUX (L/s/m) |       |       | CALCULATED RECHARGE ( $Q_2$ )<br>BASED ON<br>10% INFILTRATION<br>OF PRECIPITATION |
|------|------------------------------|-----------|-----------------------|-------|-------|---|
|      | $K_h$                        | $K_v$     | $Q_1$                 | $Q_2$ | $Q_3$ |   |
| I    | $10^{-7}$                    | $10^{-8}$ | .002                  | .013  | .011  | .011  |
| II   | $10^{-6}$                    | $10^{-7}$ | .02                   | .13   | .11   | .011  |

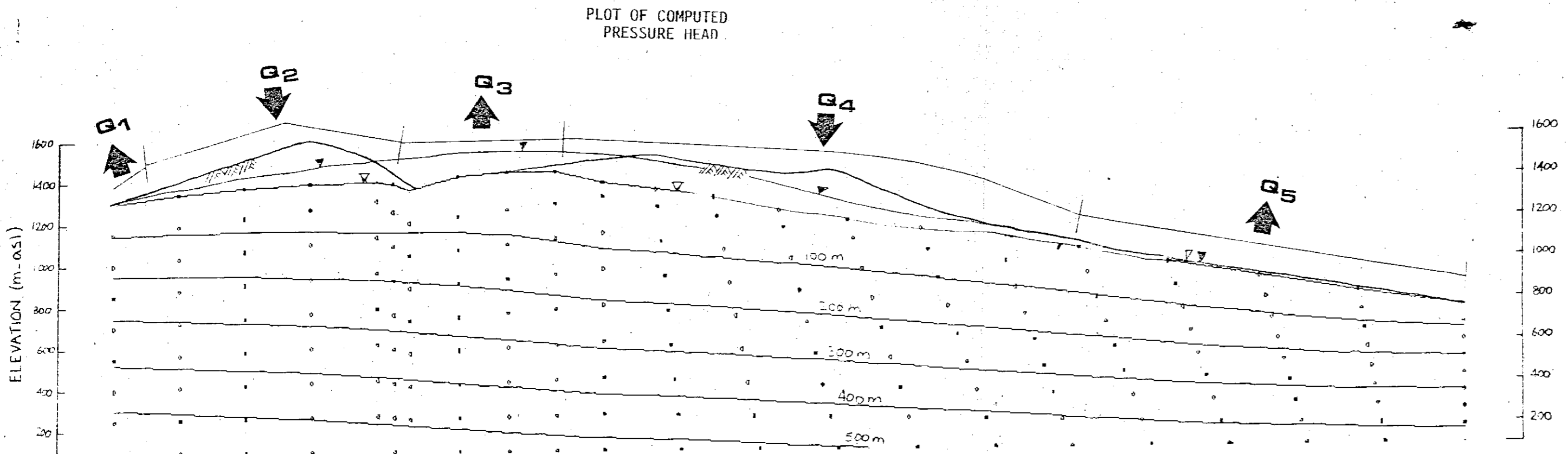
NOTES: 1. Computed fluxes are for a 1m thick section, hence are in units of L/s/m of thickness.

**FIG. 18**

|  |  |          |      |
|--|--|----------|------|
| QUINTETTE COAL LIMITED<br>GRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY | BY       | DATE |
|  |  | APPROVED | DATE |
| SUMMARY OF MODELLING OF<br>NATURAL GROUNDWATER FLOW<br>ALONG ANTICLINAL SECTION            |  |          |      |



Scale 1 cm = 200m



**SUMMARY OF MODELLING RESULTS**

| HYDRAULIC CONDUCTIVITY (m/s) |                  | COMPUTED FLUX (L/s/m) <sup>1</sup> |                |                |                |                | COMPUTED PIT INFLOW <sup>2</sup> |
|------------------------------|------------------|------------------------------------|----------------|----------------|----------------|----------------|----------------------------------|
| K <sub>h</sub>               | K <sub>v</sub>   | Q <sub>1</sub>                     | Q <sub>2</sub> | Q <sub>3</sub> | Q <sub>4</sub> | Q <sub>5</sub> | (l/s)                            |
| 10 <sup>-7</sup>             | 10 <sup>-8</sup> | .0014                              | .0043          | .0034          | .0089          | .0084          | 1.7                              |

- NOTES:
1. Computed fluxes are for a 1m thick section, hence are in units of L/s/m of thickness.
  2. Q<sub>3</sub> is computed specific discharge to pit. Total inflow estimated by multiplying by 500m pit width.

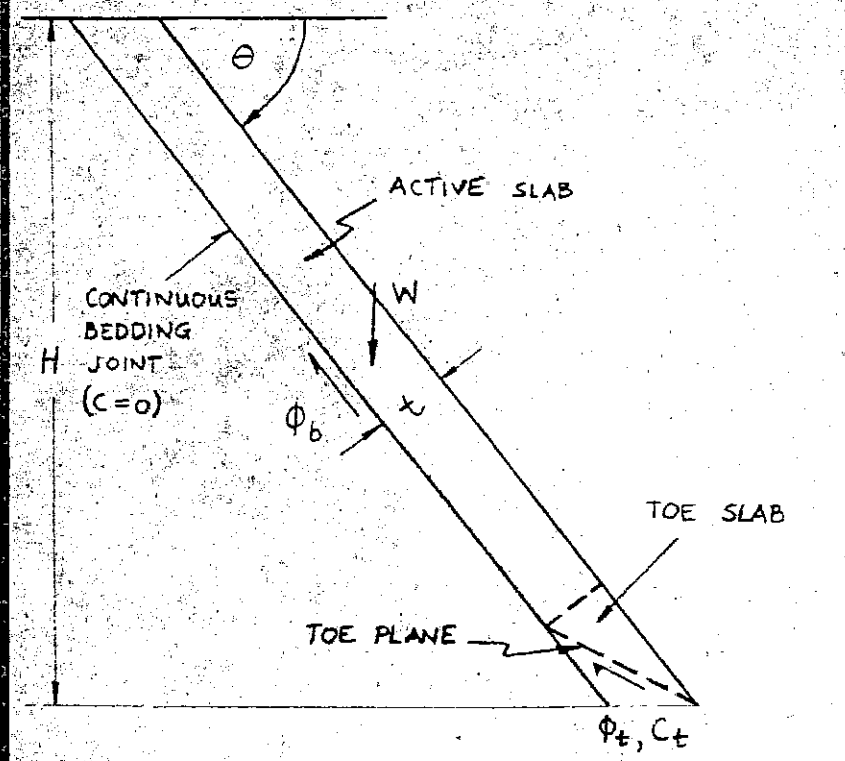
**FIG. 19**

QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEO TECHNICAL/HYDROGEOLOGICAL STUDIES

**PITEAU ASSOCIATES**  
GEO TECHNICAL CONSULTANTS  
VANCOUVER CALGARY

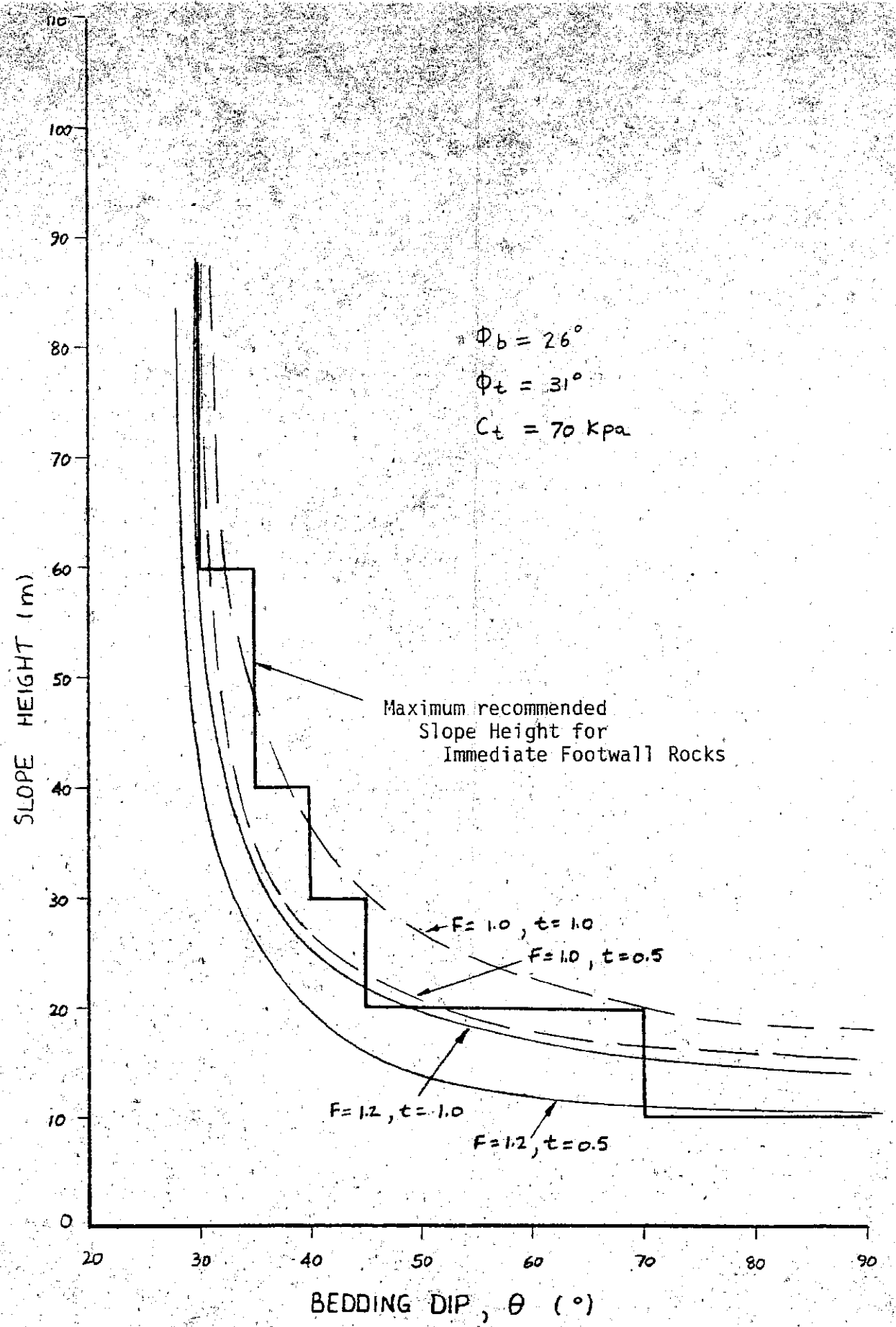
SUMMARY OF MODELLING OF  
POST MINING GROUNDWATER FLOW  
ALONG ANTICLINAL SECTION

|          |       |
|----------|-------|
| BY       | DATE  |
| DMG      | 25 87 |
| APPROVED | DATE  |
|          | 23 87 |

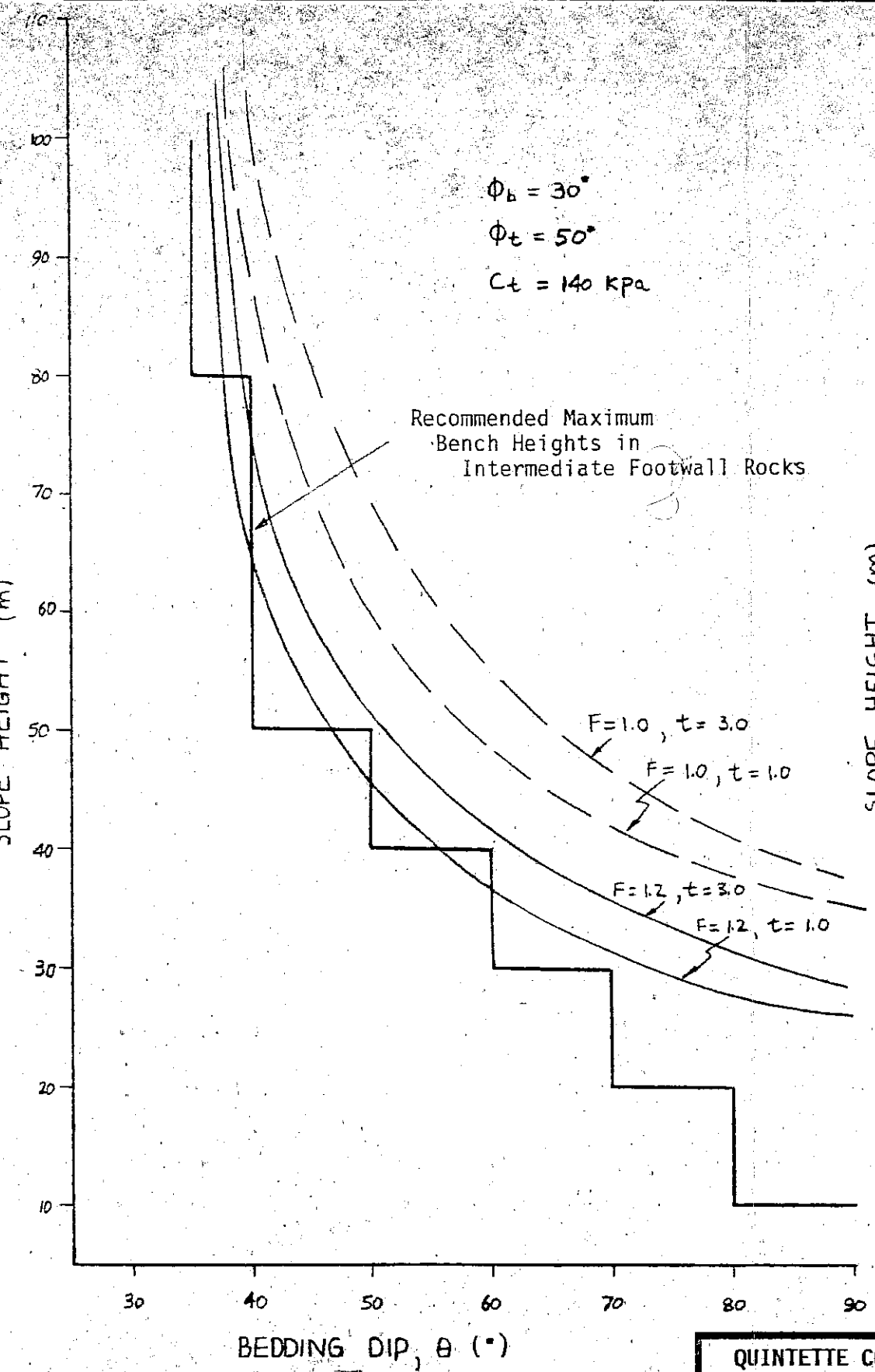


$W$  = Weight of Slab (unit thickness) =  $\gamma t$   
 $(\gamma = 24 \text{ KN/m})$   
 $\phi_b$  = Basal friction angle  
 $\phi_t, C_t$  = Friction angle, cohesion along toe plane  
 $H$  = Slope height  
 $\theta$  = Bedding dip  
 $t$  = Thickness of slab  
 $F$  = Factor of Safety

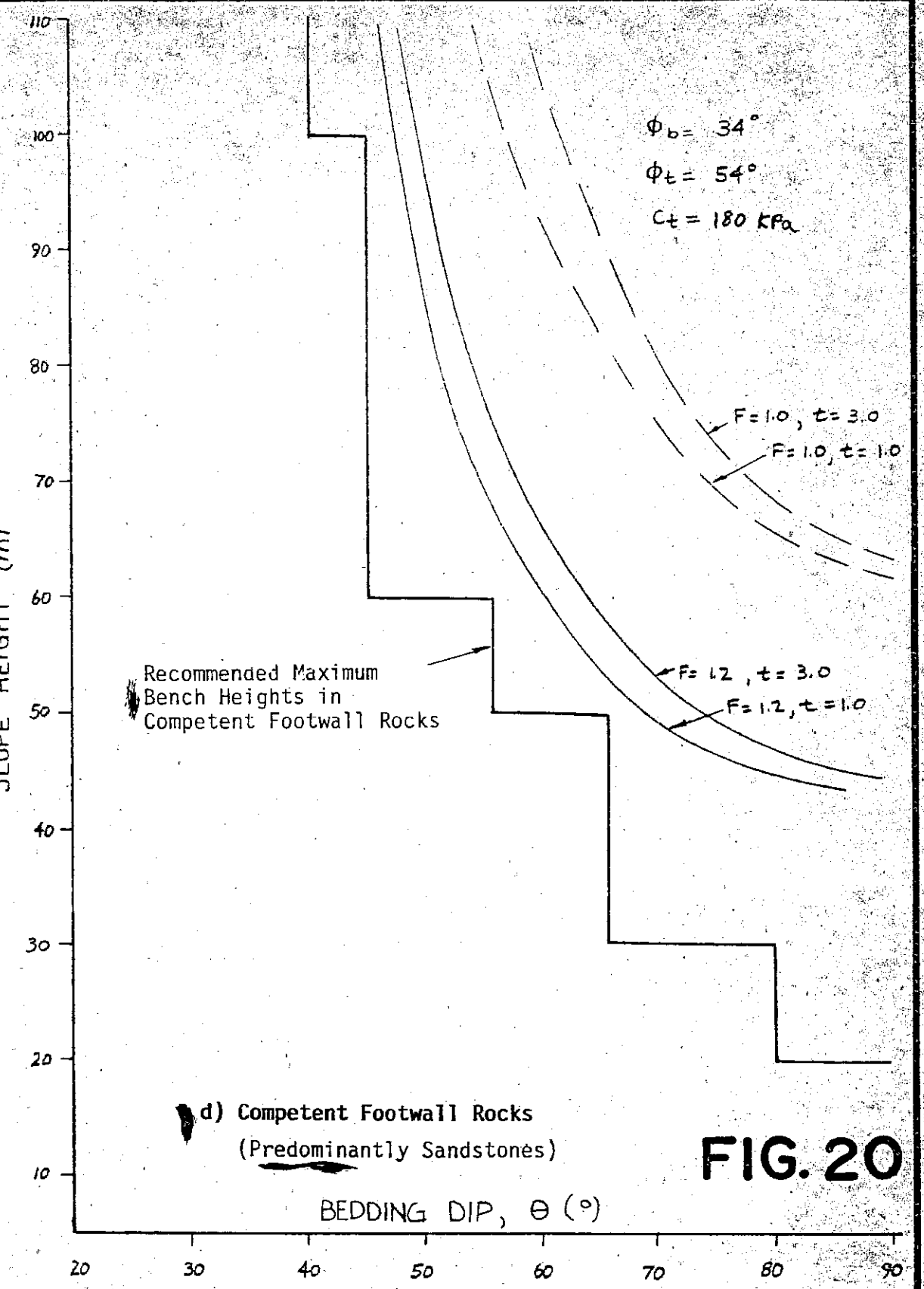
a) Schematic of Bilinear Failure Mechanism



b) Immediate Footwall Rocks  
(Predominantly Shales, Carbonaceous Shales + minor Coal splits, Sandstone)



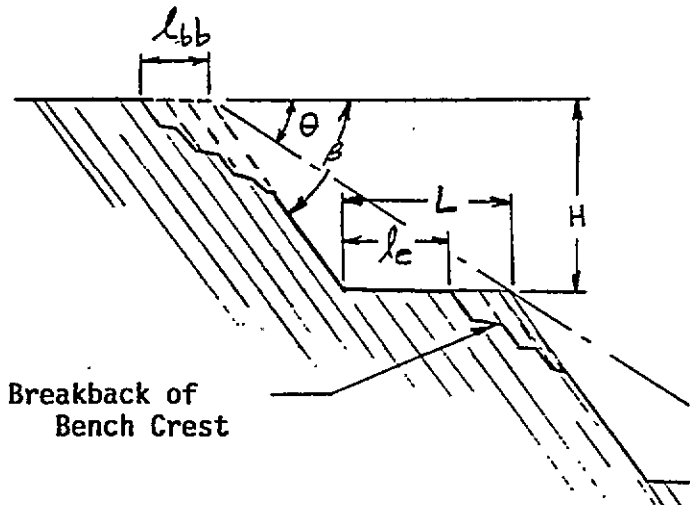
c) Intermediate Footwall Rocks  
(Interbedded Sandstones, Siltstones, Shales)



d) Competent Footwall Rocks  
(Predominantly Sandstones)

FIG. 20

|  |  |  |                 |
|--|--|--|-----------------|
| QUINTETTE COAL LIMITED<br>GRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES |  | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY |                 |
| RESULTS OF BILINEAR SLAB FAILURE ANALYSIS FOR FOOTWALL SLOPES                              |  | BY: PMG  | DATE: AUG '87   |
| APPROVED: [Signature]  |  | BY: BWC  | DATE: 339-GT-20 |

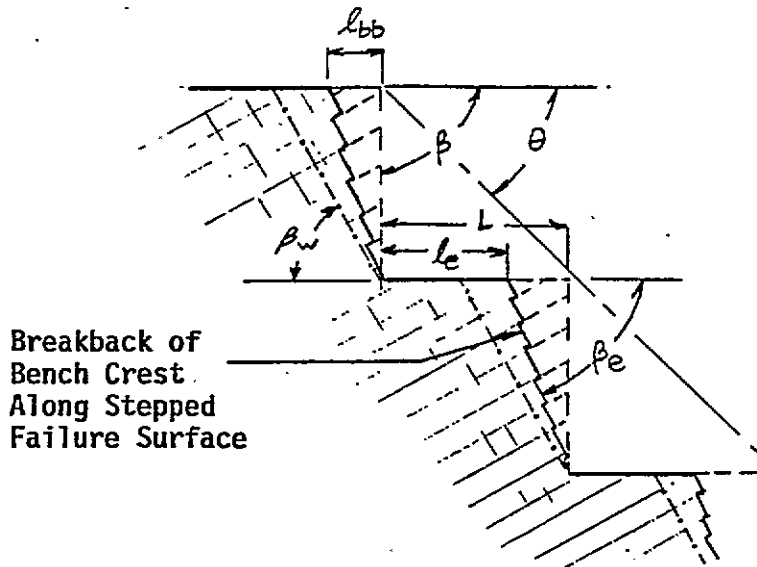


Breakback of Bench Crest

BENCH GEOMETRY PARAMETERS FOR FOOTWALL SLOPES

KEY

- H = Bench Height
- $l_{bb}$  = Breakback of Bench Crest
- $l_e$  = Effective Berm Width
- L = Design Berm Width ( $= l_e + l_{bb}$ )
- $\beta$  = Design Bench Face Angle
- $\beta_w$  = Apparent Plunge or Dip of Failure Considered to Control Bench Stability
- $\beta_e$  = Effective Bench Face Angle
- $\theta$  = Intermediate Slope Angle



Breakback of Bench Crest Along Stepped Failure Surface

BENCH GEOMETRY PARAMETERS FOR HANGING WALL SLOPES

**FIG. 21**

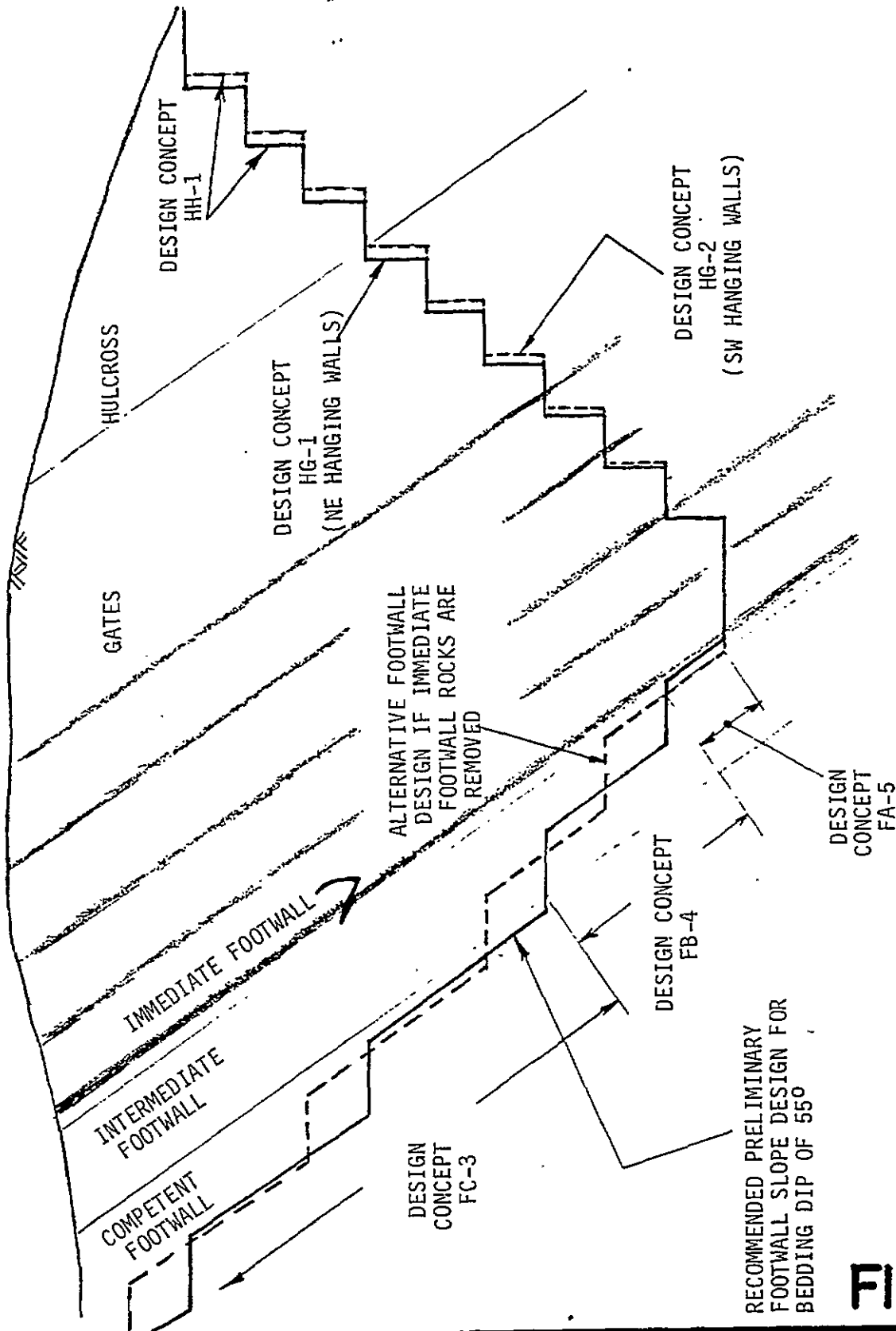
QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

BENCH GEOMETRY PARAMETERS

|            |           |
|------------|-----------|
| BY:        | DATE:     |
| PMH        | SEPT 87   |
| APPROVED:  | DWG:      |
| <i>PMH</i> | 339-GT-21 |



NOT TO SCALE

RECOMMENDED PRELIMINARY  
FOOTWALL SLOPE DESIGN FOR  
BEDDING DIP OF 55°

**FIG.22**

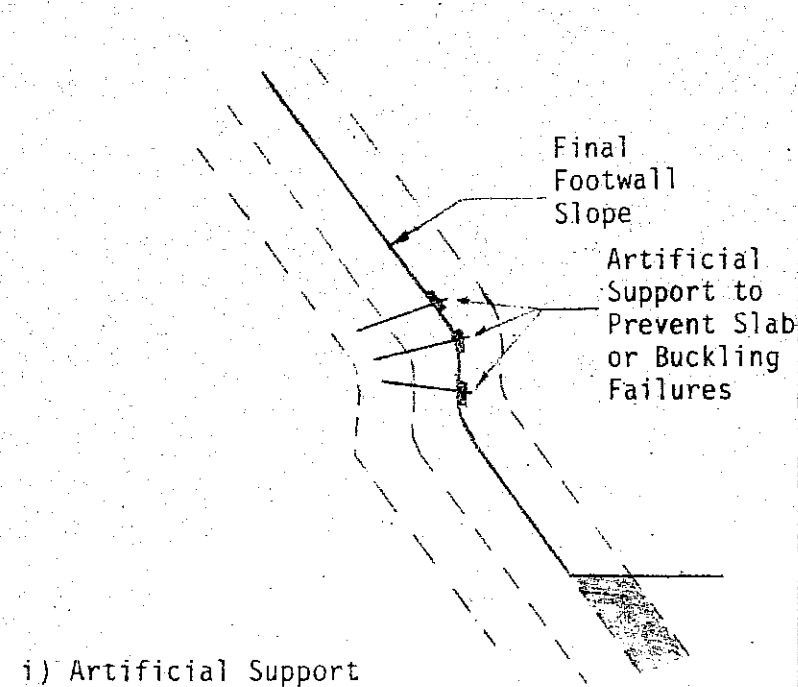
QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



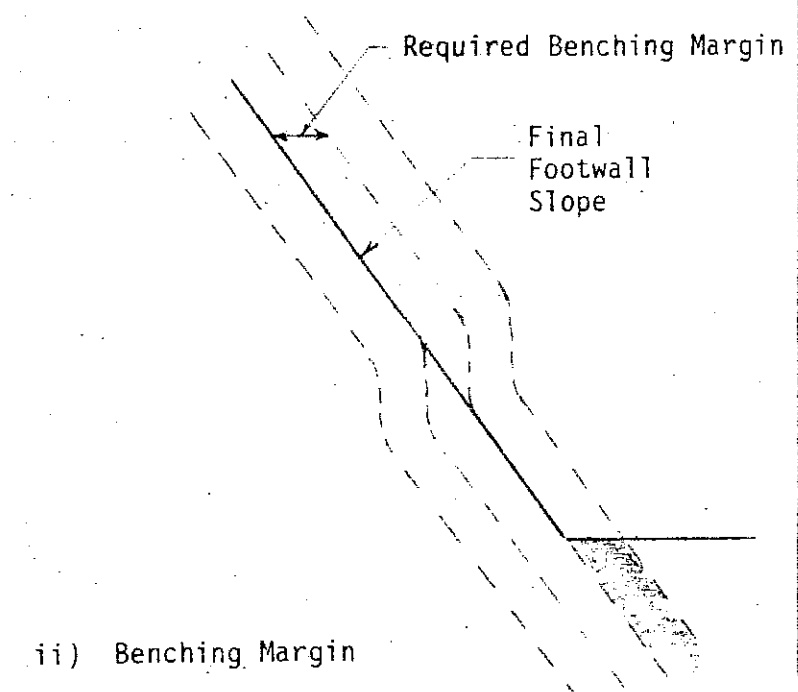
**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

SCHEMATIC SECTION ILLUSTRATING APPLICATION  
OF SLOPE DESIGN CONCEPTS

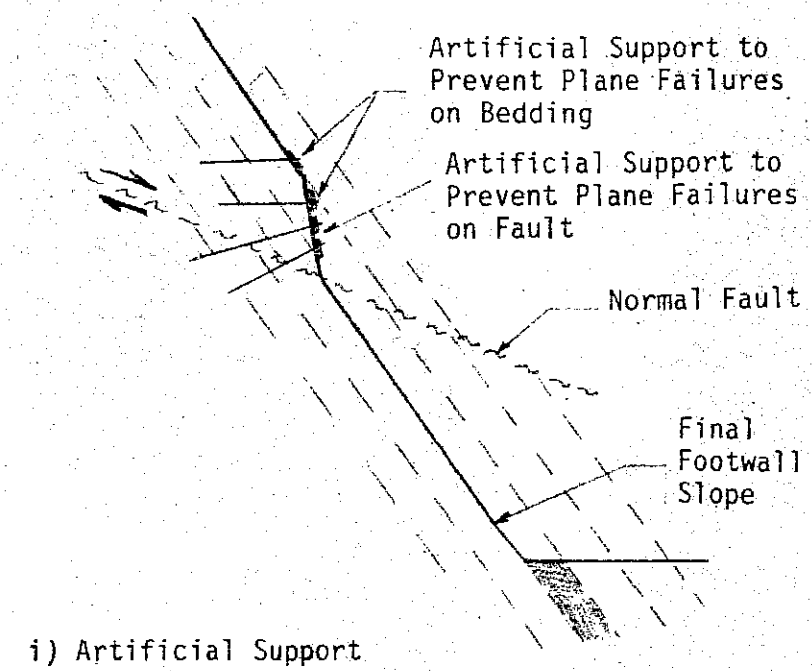
|           |           |
|-----------|-----------|
| BY:       | DATE:     |
| PMH       | SEPT. 87  |
| APPROVED: | DWG:      |
|           | 339-GT-22 |



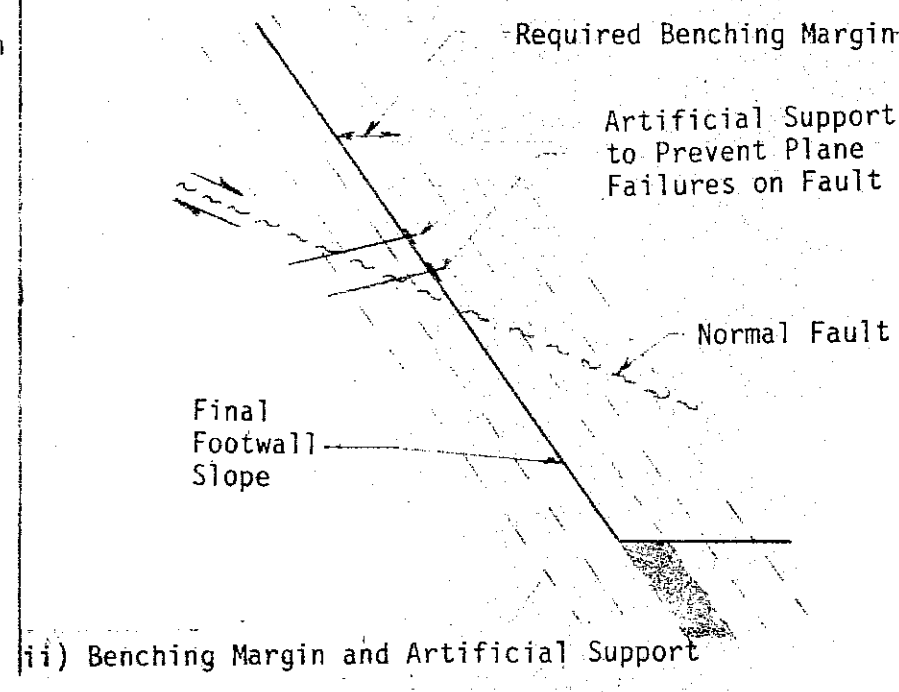
i) Artificial Support



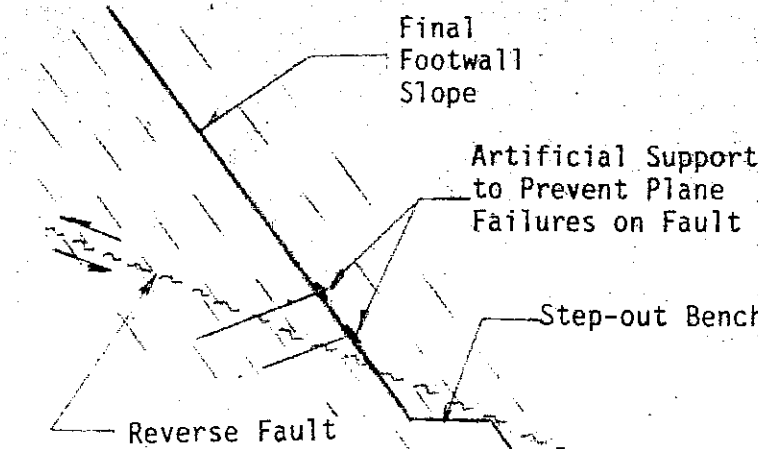
ii) Benching Margin



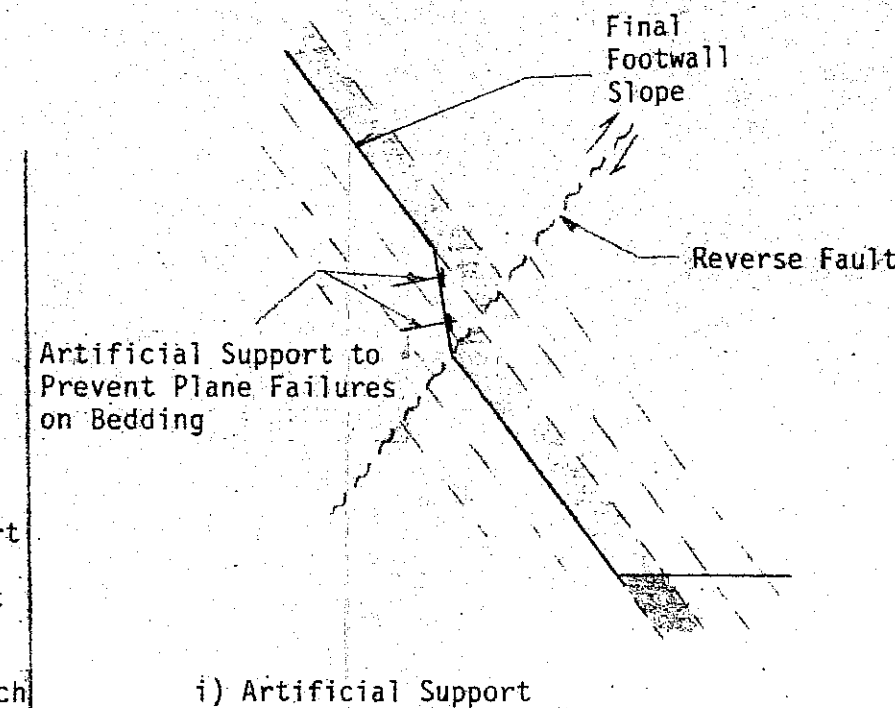
i) Artificial Support



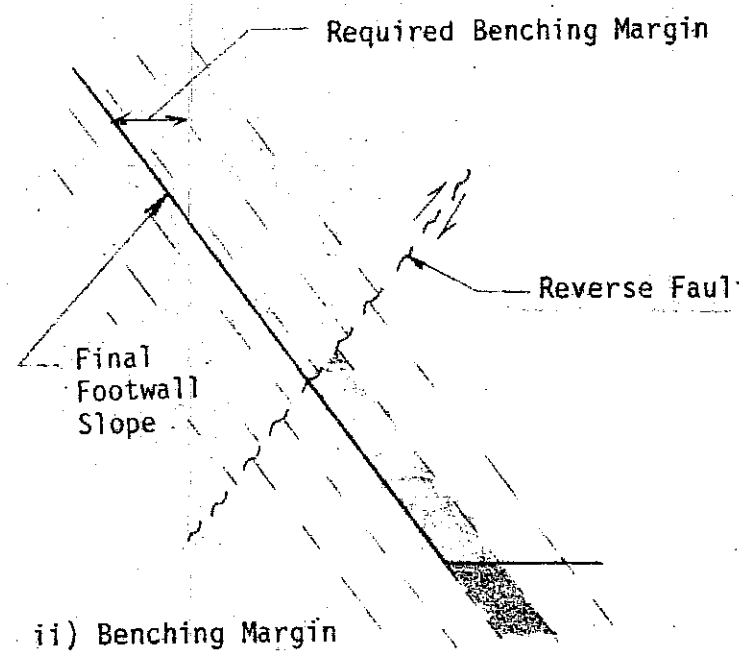
ii) Benching Margin and Artificial Support



c) REVERSE FAULT ( THRUST ) DIPPING OUT OF SLOPE

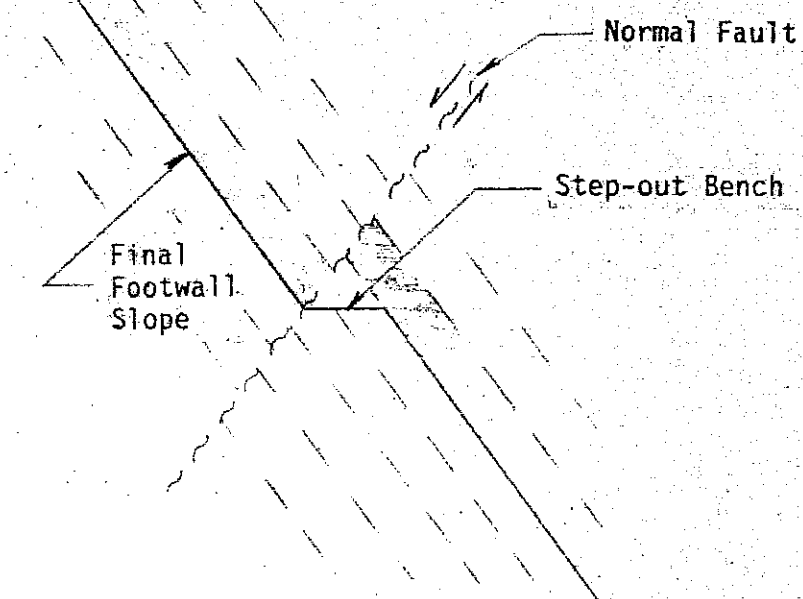


i) Artificial Support



ii) Benching Margin

d) REVERSE FAULT ( THRUST ) DIPPING INTO SLOPE



e) NORMAL FAULT DIPPING INTO SLOPE

BEDDING ROLLS OR FOLDS

b) NORMAL FAULT DIPPING OUT OF SLOPE

NOTE: Alternative remedial measures shown are intended to illustrate concepts only and should not be considered as final designs

FIG. 23

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL / HYDROGEOLOGICAL STUDIES



PITEAU & ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

CONCEPTUAL REMEDIAL MEASURES FOR FOOTWALL SLOPES

|           |                |
|-----------|----------------|
| BY: PMH   | DATE: SEPT 87  |
| APPROVED: | DWG: 339-4T-23 |



# 739-3

TABLE I

PERCENTAGE COMPOSITION BY ROCK TYPE

| ROCK MASS UNIT                       | AREA                             | COAL | CLAYSTONE TO CARBONACEOUS CLAYSTONE | SILTSTONE | SANDSTONE | CONGLOMERATE |
|--------------------------------------|----------------------------------|------|-------------------------------------|-----------|-----------|--------------|
| Hanging Wall <sup>1</sup>            | Grizzly - NE Limb                | 18   | 27                                  | 15        | 13        | 27           |
|                                      | Grizzly - SW Limb                | 15   | 30                                  | 24        | 29        | 2            |
|                                      | Transfer                         | 20   | 36                                  | 27        | 18        | -            |
| Immediate Footwall <sup>2,3</sup>    | All Areas                        | 3    | 82                                  | 8         | 7         | -            |
| Intermediate Footwall <sup>4,5</sup> | Grizzly and Transfer - East Limb | -    | 52                                  | 5         | 43        | -            |
| Competent Footwall <sup>4,5</sup>    | Transfer - West Limb             | -    | -                                   | -         | 100       | -            |

- NOTES:
1. Based on geotechnical core logging of diamond drill cores by PAEL.
  2. Initial (up to 3m) less competent material immediately beneath Seam K2.
  3. Based on 1:50 scale detailed seam correlations provided by QCL (QCL Dwg. 86-903-26-002).
  4. Initial 11m stratigraphically below the immediate footwall strata.
  5. Based on 1:200 scale seam correlations provided by QCL (QCL Dwg 86-903-26-003).

TABLE II

SUMMARY OF STATISTICAL ANALYSIS OF<sup>1,2</sup>  
 GEOTECHNICAL CORE LOGGING DATA

| ROCK TYPE                                   | LENGTH OF CORE LOGGED (m) | HARDNESS <sup>3</sup> H | DEGREE OF BREAKAGE <sup>3</sup> | TRUE SPACING OF NATURAL BEDDING JOINTS (m) | NATURAL CROSS JOINT FREQUENCY (No./m) | RQD (%) | RECOVERY (%) |
|---|---------------------------|-------------------------|---------------------------------|--|---------------------------------------|---------|--------------|
| Coal  | 95                        | 2.7                     | 7.7 (C-/C)                      | -  | -                                     | 41      | 87           |
| Claystone - Carbonaceous Claystone (Shales) | 149                       | 2.8                     | 9.6 (C+/D-)                     | 0.5  | 1.3                                   | 70      | 97           |
| Silty Claystone/ Siltstone                  | 102                       | 3.0                     | 10.6 (D-/D)                     | 0.6  | 1.3                                   | 75      | 98           |
| Sandstone                                   | 98                        | 3.4                     | 10.3 (D-/D)                     | 0.8  | 2.0                                   | 74      | 97           |
| Conglomerate                                | 69                        | 3.9                     | 11.3 (D/D+)                     | 0.8  | 1.6                                   | 74      | 99           |

- NOTES: 1. Based on geotechnical logging conducted on diamond drillholes 87001, 87002, 87003 and 87004.  
 2. Average values determined by weighting results of cumulative sums analyses based on length of core logged.  
 3. Refer to Appendix A for a description of rock Hardness and Degree of Breakage.

TABLE III

## SUMMARY OF ESTIMATED PIT INFLOWS

|  | TRANSFER PIT | GRIZZLY PIT |
|--|--------------|-------------|
| Surface Area of Pit (Km <sup>2</sup> )   | 2.57         | 1.00        |
| Surrounding Surface Area which Drains Towards Pit (km <sup>2</sup> )                     | 0.95         | 0.58        |
| Inflow Due to Direct Precipitation <sup>1</sup> and Surface Runoff (L/s)                 | 64           | 26          |
| Inflow from Seepage Through <sup>2</sup> Surficial Sediments (L/s)                       | 2.1          | 1.3         |
| Steady-state Inflow Due to <sup>3</sup> Groundwater Seepage from Rock (L/s)              | 18           | 7           |
| Transient Inflow Due to Dewatering <sup>4</sup> of Rock Mass in Response to Mining (L/s) | 15           | 14          |
| TOTAL ESTIMATED INFLOW TO PIT (L/s)  | 99           | 48          |

- NOTES:
1. Assumes average annual precipitation of 700mm/year, runoff coefficient of 0.35 from areas outside pit perimeter, and no evaporation of direct precipitation over pit areas.
  2. Assumes recharge equal to 10% of average annual precipitation over catchment areas which drain towards pits.
  3. Assumes steady-state inflow to pits controlled by precipitation on area extending 0.5km out from pit perimeters. Recharge was assumed to equal 10% of average annual precipitation and recharge areas were estimated to be 7Km<sup>2</sup> and 2.2Km<sup>2</sup> for the Transfer and Grizzly Pits, respectively. Inflow from west end walls of 1.7 L/s (based on computer modelling) is included in these values.
  4. Assumes that drawdown due to pit excavation extends approximately 0.5km out from pit perimeter, average drawdown is 40m, drainable porosity is 1% and pit life is 6 years for the Transfer Pit and 2 years for the Grizzly Pit.

TABLE IV

## SUMMARY OF PIEZOMETER INSTALLATIONS

| LOCATION                             | HOLE NUMBER | INCLINATION (°) | COLLAR ELEVATION (m-asl) | PIEZO. NUMBER | ELEVATION OF <sup>1</sup> CENTRE OF POCKET (m-asl) | STRATIGRAPHIC <sup>2</sup> LOCATION | WATER LEVEL              |                   | FLOW <sup>5</sup> |                    | HYDRAULIC <sup>6</sup> CONDUCTIVITY (m/s) |
|--------------------------------------|-------------|-----------------|--------------------------|---------------|--|-------------------------------------|--------------------------|-------------------|-------------------|--------------------|---|
|                                      |             |                 |                          |               |  |                                     | DEPTH <sup>3,4</sup> (m) | ELEVATION (m-asl) | USgpm             | l/s                |   |
| G<br>R<br>I<br>Z<br>Z<br>L<br>Y      | QHR87004    | 65              | 931.67                   | P1            | 831.23   | Top of J                            | 40.96                    | 894.55            |                   |                    | 1.5x10 <sup>-7</sup>                      |
|                                      |             |                 |                          | P2            | 867.33   | Between F & G                       | 7.46                     | 924.91            |                   |                    | 1.5x10 <sup>-7</sup>                      |
|                                      |             |                 |                          | S3            | 878.87   | Below F                             | 8.02                     | 924.40            |                   |                    | -   |
|                                      | QHR87007    | 90              | 1117.65                  | P1            | 947.90   | Below K2                            | 56.90                    | 1060.75           |                   |                    | 2x10 <sup>-8</sup>                        |
|                                      |             |                 |                          | P2            | 984.05   | Across G                            | 58.46                    | 1059.19           |                   |                    | -   |
|                                      |             |                 |                          | S3            | 1007.65  | Between F & G                       | 58.46                    | 1059.19           |                   |                    | -   |
|                                      | QHR87013    | 65              | 1041.15                  | P1            | 901.52   | Below K2                            | 4.04                     | 1037.49           |                   |                    | 8x10 <sup>-9</sup>                        |
|                                      |             |                 |                          | P2            | 923.13   | Between G & J                       | +2.53                    | 1044.24           | 4.0               | 0.25               | 6x10 <sup>-6</sup>                        |
|                                      |             |                 |                          | S3            | 940.45   | Above G                             | -                        | -                 | 3-5               | .19-.32            | -   |
|                                      | QHR87017    | 90              | 1014.93                  | P1            | 853.58   | Below K2                            | 17.88                    | 997.05            |                   |                    | 4x10 <sup>-9</sup>                        |
|                                      |             |                 |                          | P2            | 879.78   | Top of J                            | +0.48                    | 1016.27           | 0.33              | .02                | 5.5x10 <sup>-6</sup>                      |
|                                      |             |                 |                          | S3            | 887.73   | Below G                             | -                        | -                 | 4-7               | .25-.44            | -   |
| T<br>R<br>A<br>N<br>S<br>F<br>E<br>R | QHR87023    | 90              | 1601.62                  | P1            | 1432.12  | Below K2                            | 80.98                    | 1520.64           |                   |                    | 2.5x10 <sup>-9</sup>                      |
|                                      |             |                 |                          | P2            | 1471.12  | Across G                            | 80.73                    | 1520.89           |                   |                    | 2.5x10 <sup>-9</sup>                      |
|                                      |             |                 |                          | S3            | 1496.82  | F Seam                              | 21.68                    | 1579.94           |                   |                    | -   |
|                                      | QHR87024    | 90              | 1564.25                  | P1            | 1467.05  | Below G                             | 40.15                    | 1524.10           |                   |                    | 1x10 <sup>-9</sup>                        |
|                                      |             |                 |                          | P2            | 1494.80  | Between F & G                       | 31.69                    | 1532.56           |                   |                    | 8.5x10 <sup>-10</sup>                     |
|                                      |             |                 |                          | S3            | 1526.45  | Above F                             | 13.03                    | 1551.22           |                   |                    | -   |
|                                      | QHR87033    | 90              | 1437.70                  | P1            | 1341.80  | Below K2                            | 51.36                    | 1386.34           |                   |                    | 4.5x10 <sup>-8</sup>                      |
|                                      |             |                 |                          | S2            | 1366.10  | J Seam                              | 54.45                    | 1383.25           |                   |                    | -   |
|                                      | QHD86006    | 60              | 1325.06                  | P1            | 1241.14  | Below K2                            | +1.93                    | 1326.99           |                   |                    | -   |
| P2                                   |             |                 |                          | 1265.04       | J Seam   | +5.52                               | 1331.50                  | 0.05              | .0034             | 7x10 <sup>-8</sup> |   |
| S3                                   |             |                 |                          | 1291.54       | Above G  | -                                   | -                        | 2                 | 0.13              | -                  |   |

- NOTES: 1. For Standpipes (S2, S3, etc.) elevations are measured at the top of the underlying grout seal.
2. See Appendix D for complete lithology log and piezometer completion details.
3. Depth below ground surface, along the length of the hole.
4. "+" indicates m of head above piezometer top, except for QHD86006-P1 which is relative to collar elevation.
5. Flow is measured at top of piezometer tube.
6. Hydraulic conductivity values are based on falling head tests conducted in completed piezometers.

TABLE V  
SUMMARY OF KINEMATIC ASSESSMENTS AND BENCH GEOMETRY PARAMETERS<sup>1</sup>  
FOR HANGING WALL AND ENDWALL SLOPES

| WALL TYPE     | WALL AZIMUTH<br>(Dip Direction) | BEDDING<br>DIP<br>(°) | REF. DWG.<br>(APPENDIX<br>E) | PRINCIPAL KINEMATIC CONTROL     |                  |                        | APPARENT PLUNGE OR DIP <sup>4</sup><br>OF FAILURE CONSIDERED<br>TO CONTROL BENCH<br>STABILITY, $\beta_w$ (°) | BENCH GEOMETRY PARAMETERS <sup>5,6,7</sup>  |  |  |  |                                   | COMMENTS     |  |   |
|---------------|---------------------------------|-----------------------|------------------------------|---------------------------------|------------------|------------------------|--|---|--|--|--|-----------------------------------|--------------|--|---|
|               |                                 |                       |                              | TYPE OF <sup>2</sup><br>FAILURE | SETS<br>INVOLVED | INTENSITY <sup>3</sup> |  | APPARENT PLUNGE OR DIP <sup>4</sup><br>OF FAILURE USED TO<br>ASSESS BENCH GEOMETRY<br>$\beta_w$ (°) | BENCH CREST <sup>8</sup><br>BREAKBACK<br>$L_{bb}$<br>(m) | EFFECTIVE<br>BENCH FACE<br>ANGLE, $\beta_e$<br>(°) | EFFECTIVE <sup>9</sup><br>BERM WIDTH<br>$L_e$<br>(m) | TOTAL BERM<br>WIDTH<br>$L$<br>(m) |              | INTERMEDIATE<br>SLOPE ANGLE<br>$\theta$<br>(°)   |   |
| HANGING WALLS | 030°<br>(Northeast)             | 30 SW                 | E-1                          | Wedges<br>Planes                | 1,2,3,4<br>2,4   | Strong<br>Strong       | 53   | 52<br>(47-54)   | 7.8<br>(7.3-9.3)   | 68.7<br>(65-70)                                    | 10<br>(7.7-9.7)                                      | 17.8<br>(17)                      | 48.3<br>(50) | Structural analysis and kinematic assessments indicate controlling wedge failures are steeper, and hence, more favourable, on northeast hanging walls. Recommended preliminary bench geometry parameters for northeast and southwest hanging wall slopes reflects this difference.   |   |
|               |                                 | 45 SW                 | E-2                          | Planes<br>Wedges                | 2<br>1,2,3,4     | Strong<br>Moderate     | 52   |   |  |  |  |                                   |              |  |   |
|               |                                 | 60 SW                 | E-3                          | Wedges<br>Planes                | 1,2,3,4<br>2     | Strong<br>Weak         | 54   |   |  |  |  |                                   |              |  |   |
|               | 214°<br>(Southwest)             | 30 NE                 | E-4                          | Wedges<br>Planes                | 1,2,3,4<br>2     | Strong<br>Strong       | 55   | 45<br>(44-50)   | 10.0<br>(8.3-10.4)                                       | 63.4<br>(62.5-67.5)                                | 10<br>(7.6-9.7)                                      | 20.0<br>(18)                      | 45.0<br>(48) |  | Recommended preliminary bench geometry parameters assume minimum average effective bench face angles of 65° can be achieved, which seems reasonable based on observed conditions in the Shikano Pit. If field trials/slope documentation indicate flatter effective bench face angles, wider berms and flatter intermediate slope angles may be required. |
|               |                                 | 45 NE                 | E-5                          | Wedges<br>Planes                | 1,2,3,4<br>2     | Strong<br>Moderate     | 41   |   |  |  |  |                                   |              |  |   |
|               |                                 | 60 NE                 | E-6                          | Wedges                          | 1,2,3,4          | Weak                   | 45   |   |  |  |  |                                   |              |  |   |
| ENDWALLS      | 120°-124°<br>(Southeast)        | 30 SW                 | E-7                          | Planes                          | 1                | Strong                 | 82   | 72<br>(54-81)   | 3.2<br>(5.4-7.3)   | 80.5<br>(70-85)                                    | 10<br>(7.7-9.6)                                      | 13.2<br>(15.5)                    | 55.6<br>(52) | Based on observed conditions in the Shikano Pit, it appears unlikely that calculated effective bench face angles of 80.9° can be consistently achieved on 20m high benches. In this regard, effective bench face angles in the range 70° to 75° are considered more realistic and have been used for preliminary design. If results of field trials/slope documentation indicate steeper effective bench face angles can be achieved, narrower design berms and steeper intermediate slope angles may be feasible. |   |
|               |                                 | 45 SW                 | E-8                          | Planes<br>Wedges                | 1<br>1,2         | Strong<br>Moderate     | 70   |   |  |  |  |                                   |              |  |   |
|               |                                 | 60 SW                 | E-9                          | Planes                          | 1                | Strong                 | 72   |   |  |  |  |                                   |              |  |   |
|               |                                 | 30 NE                 | E-10                         | Wedges<br>Planes                | 1,3<br>3         | Moderate<br>Moderate   | 73   |   |  |  |  |                                   |              |  |   |
|               |                                 | 45 NE                 | E-11                         | Oblique Planes                  | 3                | Weak                   | *  |   |  |  |  |                                   |              |  |   |
|               |                                 | 60 NE                 | E-12                         | Planes                          | 1,3              | Weak                   | *  |   |  |  |  |                                   |              |  |   |
|               | 300°-304°<br>(Northwest)        | 30 SW                 | E-7                          | Oblique Wedges/Planes           | 2,3,4            | Weak                   | *  |   |  |  |  |                                   |              |  |   |
|               |                                 | 45 SW                 | E-8                          | Oblique Wedges/Planes           | 2,4              | Very weak              | *  |   |  |  |  |                                   |              |  |   |
|               |                                 | 60 SW                 | E-9                          | Oblique Planes                  | 2,4              | Very weak              | *  |   |  |  |  |                                   |              |  |   |
|               |                                 | 30 NE                 | E-10                         | Oblique Planes/Wedges           | 2,3,4            | Weak                   | *  |   |  |  |  |                                   |              |  |   |
|               |                                 | 45 NE                 | E-11                         | Planes                          | 1                | Moderate               | 77   |   |  |  |  |                                   |              |  |   |
|               |                                 | 60 NE                 | E-12                         | Planes                          | 1                | Moderate               | 74   |   |  |  |  |                                   |              |  |   |

- NOTES: 1. For slopes in Gates Formation only. Insufficient structural geologic information was available to meaningfully assess kinematically possible failure modes in Hulcross Formation rocks. In any event, due to the anticipated poor quality of the Hulcross Formation, ravelling and slaking, rather than kinematic failures, are expected to control stability, and hence design, in these rocks.
2. Due to the limited continuity of cross joints, all failure modes are assumed to be stepped failures.
3. Intensity refers to the relative degree of development of individual joint sets involved in a given failure mode.
4. \*\*\* Indicates no strong kinematic control is apparent.

5. See Fig. 21 for definitions of bench geometry parameters.
6. Based on double (i.e. 20m high) benches.
7. Recommended preliminary bench design criteria are given in parentheses.
8. Because of the stepped nature of all failure modes, bench crest breakback is assumed to be one-half of the breakback for throughgoing failure modes.
9. Effective berm widths of 10m for 20m high benches were used for assessment and comparison of alternative bench geometries. In terms of recommended design criteria, minimum effective berm widths of about 8m to 10m are considered appropriate.

TABLE VI  
SUMMARY OF SLOPE DESIGN CONCEPTS

| WALL TYPE <sup>1</sup><br>(Location) | ROCK MASS UNIT/<br>STRATIGRAPHIC<br>LOCATION   | GENERAL ROCK<br>TYPE/COMPETENCY  | RANGE OF<br>BEDDING<br>DIPS<br>(°)        | SLOPE <sup>2</sup><br>DESIGN<br>CONCEPT | FAILURE MODE <sup>3</sup><br>CONSIDERED TO<br>CONTROL BENCH<br>STABILITY         | RECOMMENDED SLOPE DESIGN <sup>4,5</sup>   |                                    |   |   |                                       |  | COMMENTS <sup>9,10,11</sup>  |   |   |
|--------------------------------------|--|--|---|---|--|---|------------------------------------|---|---|---------------------------------------|--|--|---|---|
|                                      |  |  |   |   |  | BENCH <sup>6</sup><br>HEIGHT,<br>H<br>(m) | DESIGN BENCH<br>FACE ANGLE,<br>(°) | DESIGN BERM <sup>7</sup><br>WIDTH, L<br>(m) | ANTICIPATED <sup>8</sup><br>BREAKBACK<br>/bb<br>(m) | EFFECTIVE<br>BERM WIDTH,<br>/e<br>(m) | EFFECTIVE<br>BENCH<br>FACE ANGLE,<br>/α<br>(°) |  | INTERMEDIATE<br>SLOPE ANGLE,<br>(°)   |   |
| FOOTWALLS                            | IMMEDIATE FOOTWALL<br>ROCKS<br><br>0 - 3.0m<br>Stratigraphically<br>below Seam K2            | Predominantly<br>Shale/Carb. Shale<br>with Minor Coal,<br>Siltstone, Sand-<br>stone/Relatively<br>Low Competency | 0 - 30                                    | FA-1                                    | Slab-Type Failures<br>(Planar Slab,<br>Bilinear Slab,<br>Ploughing,<br>Buckling) | Unbenched                                 | Parallel<br>Bedding                | -   | -   | -                                     | Parallel<br>Bedding                            | VARIABLE   | <ul style="list-style-type: none"> <li>- Available core information indicates this unit occurs throughout both the Grizzly and Transfer areas.</li> <li>- Assumes bedding is not undercut.</li> <li>- Assumes that due to limited thickness and location immediately beneath K2 Seam, this unit will be exposed only in the final bench at the toe of the slope, where the consequence of possible small failures is least severe.</li> <li>- Alternatively, complete stripping of this unit may result in fewer benches required on the overall slope and reduced overall waste stripping.</li> <li>- Where stripping of this unit is undertaken, ripping or controlled blasting should be used.</li> <li>- Additional stripping or artificial support may be required where rolls are encountered, where bedding dips steeper than anticipated or where unfavourably oriented faults transect the slope.</li> </ul> |   |
|                                      |  |  | 30 - 35                                   | FA-2                                    |  | 60  |                                    | 12  | 2   | 10                                    |  |  |   |   |
|                                      |  |  | 35 - 40                                   | FA-3                                    |  | 40  |                                    | 10  | 2   | 8                                     |  |  |   |   |
|                                      |  |  | 40 - 45                                   | FA-4                                    |  | 30  |                                    |   |   |                                       |  |  |   |   |
|                                      |  |  | 45 - 70                                   | FA-5                                    |  | 20  |                                    |   |   |                                       |  |  |   |   |
|                                      |  |  | 70 - 90                                   | FA-6                                    |  | 10  |                                    |   |   |                                       |  |  |   |   |
|                                      | INTERMEDIATE<br>FOOTWALL ROCKS<br><br>Stratigraphically<br>Below Immediate<br>Footwall Rocks | Interbedded<br>Sandstone<br>Siltstone and<br>Shale/Variable<br>Competency  | 0 - 35                                    | FB-1                                    |  | Unbenched                                 | -                                  | -   | -   | Parallel<br>Bedding                   | Variable                                       | <ul style="list-style-type: none"> <li>- Available core information indicates this unit occurs in the footwall strata throughout both limbs of the Grizzly Pit as well as the east limb of the Transfer Pit.</li> <li>- Assumes bedding is not undercut.</li> <li>- Artificial support may be required where rolls are encountered, where bedding dips steeper than anticipated or where unfavourably oriented faults transect the slope.</li> <li>- Limited slope depressurization may be required.</li> <li>- Ripping next to final walls should be carried out where feasible, otherwise controlled blasting should be utilized.</li> </ul> |   |   |
|                                      |  |  | 35 - 40                                   | FB-2                                    |  | 80  | 12                                 | 2   | 10  |                                       |  |  |   |   |
|                                      |  |  | 40 - 50                                   | FB-3                                    |  | 50  | 10                                 | 2   | 8   |                                       |  |  |   |   |
|                                      |  |  | 50 - 60                                   | FB-4                                    |  | 40  |                                    |   |   |                                       |  |  |   |   |
|                                      |  |  | 60 - 70                                   | FB-5                                    |  | 30  |                                    |   |   |                                       |  |  |   |   |
|                                      |  |  | 70 - 80                                   | FB-6                                    |  | 20  |                                    |   |   |                                       |  |  |   |   |
|                                      | COMPETENT FOOTWALL<br>ROCKS<br><br>Stratigraphically<br>Below Immediate<br>Footwall Rocks    | Sandstone/<br>Competent  | 0 - 40                                    | FC-1                                    |  | Unbenched                                 | -                                  | -   | -   | Parallel<br>Bedding                   | Variable                                       |  |   |   |
|                                      |  |  | 40 - 45                                   | FC-2                                    |  | 100                                       | 12                                 | 2   | 10  |                                       |  |  |   |   |
|                                      |  |  | 45 - 55                                   | FC-3                                    |  | 60  | 10                                 | 2   | 8   |                                       |  |  |   |   |
|                                      |  |  | 55 - 65                                   | FC-4                                    |  | 50  |                                    |   |   |                                       |  |  |   |   |
|                                      |  |  | 65 - 80                                   | FC-5                                    |  | 30  |                                    |   |   |                                       |  |  |   |   |
|                                      |  |  | 80 - 90                                   | FC-6                                    |  | 20  |                                    |   |   |                                       |  |  |   |   |
| HANGING WALLS<br>(NE Facing)         | GATES HANGING<br>WALL ROCKS<br><br>Stratigraphically<br>above the Base<br>of Seam K2         | Interbedded<br>Coal, Shale,<br>Siltstone, Sand-<br>stone and<br>Conglomerate,<br>Variable<br>Competency          | 20° SW<br>to<br>70° SW                    | HI-1                                    | Stepped Wedge<br>Failures<br>Stepped Plane<br>Failures                           | 20  | 90                                 | 17  | 7.3 - 9.3   | 7.7 - 9.7                             | 65 - 70  |  | 50  | <ul style="list-style-type: none"> <li>- Kinematically possible stepped wedge or stepped plane failures involving discontinuities are expected to control slope design.</li> <li>- Anticipated breakback, effective berm width and effective bench face angle based on statistical assessment of kinematically possible failures and results of slope documentation in the Shikano Pit.</li> <li>- Structural analysis indicates SW dipping fold limbs are kinematically more favourable than NE dipping limbs.</li> <li>- Some form of controlled blasting may be required to achieve anticipated breakbacks and effective bench face angles and minimize rockfalls and raveling.</li> <li>- In areas where significant thicknesses of competent sandstones or conglomerates will be exposed in the final wall, reduced breakback, steeper effective bench face angles, wider berms and/or steeper intermediate slopes may be feasible.</li> </ul> |
| HANGING WALLS<br>(SW Facing)         |  |  | 20° NE<br>to<br>70° NE                    | HI-2                                    |  | 20  | 90                                 | 18  | 8.3 - 10.4  | 7.6 - 9.7                             | 62.5 - 67.5                                    |  | 48  |   |
| ENDWALLS                             |  |  | 20° SW - 70° SW<br>and<br>20° NE - 70° NE | EH-1                                    |  | 20  | 90                                 | 15.5  | 5.4 - 7.3   | 7.7 - 9.6                             | 70 - 75  |  | 52  |   |
| HANGING WALLS/<br>ENDWALLS           | HULCROSS HANGING<br>WALL ROCKS<br><br>Stratigraphically<br>Above Gates                       | Interbedded<br>Marine Shale,<br>Siltstones/<br>Relatively<br>Low Competency                                      | -   | HI-1<br>EH-1                            | Raveling, Slaking  | 20  | 90                                 | 19  | 9.3 - 11.6  | 7.4 - 9.7                             | 60 - 65  |  | 46.5  | <ul style="list-style-type: none"> <li>- Due to limited exposures, few Hulcross rocks were mapped in the vicinity of the proposed pits or in the Shikano Pit.</li> <li>- These rocks may be exposed in the upper benches of the pits.</li> <li>- Long term stability is expected to be controlled by raveling and slaking.</li> <li>- Some form of controlled blasting may be required to achieve anticipated breakbacks or effective bench face angles.</li> </ul>   |

- NOTES:
1. Footwall and hanging wall slopes are assumed excavated parallel to the strike of bedding. Endwall slopes are assumed excavated perpendicular to the strike of bedding.
  2. Slope design concepts are identified using a simple coding system. The first symbol refers to the basic wall type (F = footwall, H = hanging wall, and E = endwall). The next symbol refers to the rock mass unit (A = Immediate Footwall, B = Intermediate Footwall, C = Competent Footwall, G = Gates Hanging Wall and H = Hulcross Hanging Wall). The last symbol refers to a range of bedding dips and varies depending on the basic wall type and general orientation of bedding.
  3. Descriptions of the various failure modes and analysis techniques are given in Section 5.
  4. See Fig. 2 for illustration of terms.
  5. Maximum anticipated slope heights of about 200m are assumed for preliminary design purposes. If slope heights in excess of 200m are proposed, reassessment of slope design criteria may be required.
  6. Bench heights have been chosen in increments of 10m.

7. Design berm width = effective (i.e. required) berm width plus anticipated breakback and does not include allowances for step-outs on intermediate berms where drill configuration does not permit the drill to be positioned at the toe of the intermediate bench. Final slope designs should include an additional margin to account for any required step-outs.
8. Anticipated breakback of bench crests on footwall slopes is assumed to be 2m for preliminary design purposes. Depending on the location of continuous bedding splits, rock fragmentation characteristics, and blasting/excavation technique utilized, actual breakback and effective berm width may vary.
9. Trial slopes and slope documentation should be used to evaluate and update slope design criteria on an ongoing basis.
10. Ripping and blasting trials should be conducted to determine the optimum excavation method for final walls.
11. Preliminary slope designs should be prepared based on detailed geological sections and reviewed prior to finalizing slope designs.

APPENDIX A

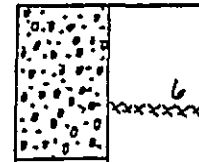
GEOTECHNICAL LOGS, BEDDING  
DIP INTERPRETATIONS AND  
DEGREE OF BREAKAGE AND  
HARDNESS CLASSIFICATIONS

JOB NUMBER

LITHOLOGY

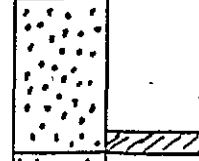
STRUCTURE

PEBBLE CONGLOMERATE



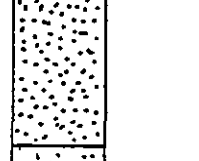
CRUSHED ZONE ( THICKNESS INDICATED IN cm.)

COARSE SANDSTONE



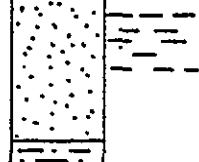
BROKEN ZONE ( LIMITS INDICATED)

MEDIUM SANDSTONE



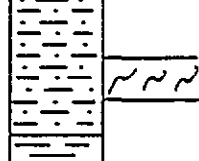
THIN CRUSHED OR BROKEN LAYERS

FINE SANDSTONE



INTENSE CALCITE VEINING

SILTSTONE



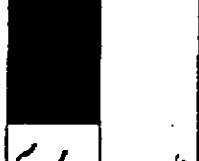
FAULT

CLAYSTONE AND CARBONACEOUS CLAYSTONE



CLAY OR SILT INFILLED JOINT ( THICKNESS OF INFILLING INDICATED IN cm. )

COAL



COALY OR CARBONACEOUS STRINGERS



QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU & ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

GRAPHIC LOG SYMBOLS

|            |        |
|------------|--------|
| BY:        | DATE:  |
| PMH        | AUG 87 |
| APPROVED:  | DWG:   |
| <i>PMH</i> | A-0    |



# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD86001

LOCATION GRIZZLY PIT  
 NORTHING: 6096557.33  
 EASTING: 623975.75  
 COLLAR ELEV: 953.30

AZIMUTH:                       
 INCLINATION: - 65°  
 DEPTH 485' / 147.9 m

DATE DRILLED: 1986

| SUMMARY OF CUSUMS ANALYSIS |                    |          |         |              |                 |       | DEPTH |        | GRAPHIC LOG |           | DESCRIPTIVE LOG                               | HYDROGEOLOGIC DATA   |          |
|----------------------------|--------------------|----------|---------|--------------|-----------------|-------|-------|--------|-------------|-----------|---|----------------------|----------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | JOINTS / | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE | FEET  | METRES | LITHOLOGY   | STRUCTURE |   | INSTALLATION DETAILS | COMMENTS |
| 2.7                        |                    |          |         |              |                 |       | 50    |        |             |           |   |                      |          |
|                            | 9.9                |          |         |              | 57              |       |       |        |             |           | CARBONACEOUS CLAYSTONE                        |                      |          |
|                            |                    |          |         | 100          |                 |       | 25    |        |             |           | ALTERNATING COARSE SANDSTONE AND CONGLOMERATE |                      |          |
| 3.6                        |                    |          |         |              |                 |       | 100   |        |             |           | COAL - D SEAM                                 |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | CARB. CLAYSTONE                               |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | FINE SANDSTONE                                |                      |          |
|                            | 12.4               |          |         |              |                 |       |       |        |             |           | CARBONACEOUS CLAYSTONE                        |                      |          |
|                            |                    |          |         |              | 70              |       | 150   |        |             |           | FINE SANDSTONE                                |                      |          |
|                            |                    |          |         |              |                 |       |       | 50     |             |           | SILTSTONE                                     |                      |          |
| 1.9                        | 8.3                |          |         |              | 80              |       |       |        |             |           | CARB. CLAYSTONE                               |                      |          |
|                            |                    |          |         |              | 57              |       | 200   |        |             |           | COAL - F SEAM                                 |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | CARBONACEOUS CLAYSTONE                        |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | CONGLOMERATE                                  |                      |          |
|                            |                    |          |         | 100          |                 |       | 250   | 75     |             |           |   |                      |          |
| 4.0                        | 11.5               |          |         |              | 62              |       |       |        |             |           |   |                      |          |
|                            |                    |          |         |              |                 |       | 300   |        |             |           |   |                      |          |
|                            |                    |          |         | 45           |                 |       |       |        |             |           | COAL - G SEAM                                 |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | CARBONACEOUS CLAYSTONE                        |                      |          |
|                            |                    |          |         |              |                 |       |       | 100    |             |           | SILTSTONE                                     |                      |          |
|                            |                    |          |         | 100          |                 |       | 350   |        |             |           |   |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | MEDIUM SANDSTONE                              |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | CARB. CLAYSTONE                               |                      |          |
|                            |                    |          |         | MC           |                 |       | 400   |        |             |           | COAL - J, K1 SEAM                             |                      |          |
| 2.4                        |                    |          |         |              | 56              |       |       | 125    |             |           | CARBONACEOUS CLAYSTONE                        |                      |          |
|                            | 8.3                |          |         |              | 75              |       |       |        |             |           | COAL - K2 SEAM                                |                      |          |
|                            |                    |          |         |              |                 |       |       |        |             |           | SILTSTONE                                     |                      |          |
|                            |                    |          |         |              |                 |       | 450   |        |             |           | CARBONACEOUS CLAYSTONE                        |                      |          |
|                            |                    |          |         | 100          |                 |       |       |        |             |           | SILTSTONE                                     |                      |          |
| 3.6                        |                    |          |         |              |                 |       |       |        |             |           | FINE SANDSTONE                                |                      |          |
|                            |                    |          |         |              |                 |       | 485   | 147.9  |             |           | SILTSTONE                                     | E.O.H.               |          |

QUINETTE COAL LIMITED  
 GRIZZLY - TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER      CALGARY

## GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD86001

|                    |                    |
|--------------------|--------------------|
| BY                 | DATE               |
| PMG                | AUG 87             |
| APPROVED           | DWG                |
| <i>[Signature]</i> | <i>[Signature]</i> |

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD86003

LOCATION

NORTHING: 6096400.24  
EASTING: 619865.63

AZIMUTH: \_\_\_\_\_

INCLINATION: -90°

COLLAR ELEV: 1532.40

DEPTH: 225.86m / 741'

DATE DRILLED: 1986

| SUMMARY OF CUSUMS ANALYSIS |                    |          |           |              |                 |       | DEPTH |        | GRAPHIC LOG |           | DESCRIPTIVE LOG                                     | HYDROGEOLOGIC DATA   |          |
|----------------------------|--------------------|----------|-----------|--------------|-----------------|-------|-------|--------|-------------|-----------|---|----------------------|----------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | JOINTS / | R Q D (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE | FEET  | METRES | LITHOLOGY   | STRUCTURE |   | INSTALLATION DETAILS | COMMENTS |
|                            |                    |          |           |              |                 |       | 50    |        |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       |       | 25     |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       | 100   |        |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       | 150   |        |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       |       | 50     |             |           |   |                      |          |
| 2.8                        | 10.5               |          |           |              |                 |       |       | 200    |             |           | COAL - D SEAM                                       |                      |          |
|                            |                    |          |           |              | 26              |       |       |        |             |           | CARBONACEOUS CLAYSTONE                              |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | FINE SANDSTONE                                      |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | MEDIUM SANDSTONE                                    |                      |          |
| 4.0                        | 12.3               |          |           |              |                 |       |       | 75     |             |           | - CROSS BEDDING EVIDENT                             |                      |          |
|                            |                    |          |           |              |                 |       |       | 250    |             |           | COARSE SANDSTONE                                    |                      |          |
|                            |                    |          |           |              | 34              |       |       |        |             |           | CARBONACEOUS CLAYSTONE                              |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | COAL - E1 SEAM                                      |                      |          |
|                            | 6.4                |          |           |              |                 |       |       | 300    |             |           | COAL - E2 SEAM                                      |                      |          |
|                            |                    |          |           |              | 100             |       |       |        |             |           | CLAYSTONE   |                      |          |
|                            |                    |          |           |              |                 |       |       | 100    |             |           |   |                      |          |
|                            | 10.7               |          |           |              | 53              |       |       | 350    |             |           | SILTSTONE - SWIRLED BEDDING                         |                      |          |
| 2.8                        |                    |          |           |              |                 |       |       |        |             |           | CLAYSTONE   |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | SILTSTONE   |                      |          |
|                            |                    |          |           |              |                 |       |       | 400    |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       |       | 125    |             |           | CARBONACEOUS CLAYSTONE                              |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | COAL - F SEAM                                       |                      |          |
|                            |                    |          |           |              | 90              |       |       | 150    |             |           | CARBONACEOUS CLAYSTONE                              |                      |          |
|                            |                    |          |           |              | 33              |       |       |        |             |           | SILTSTONE GRADING TO FINE SANDSTONE                 |                      |          |
| 4.0                        |                    |          |           |              |                 |       |       | 150    |             |           | SILTSTONE   |                      |          |
|                            | 8.7                |          |           |              | 100             |       |       | 500    |             |           | CARBONACEOUS CLAYSTONE - ABUNDANT CALCITE STRINGERS |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | COAL - G SEAM                                       |                      |          |
|                            |                    |          |           |              | MC              |       |       | 550    |             |           | CLAYSTONE   |                      |          |
| 2.6                        |                    |          |           |              |                 |       |       |        |             |           |   |                      |          |
|                            |                    |          |           |              | 100             |       |       | 175    |             |           | FINE SANDSTONE                                      |                      |          |
|                            |                    |          |           |              |                 |       |       | 600    |             |           | CARB. CLAYSTONE                                     |                      |          |
|                            |                    |          |           |              | 20              |       |       |        |             |           | COAL - J, K1 SEAM                                   |                      |          |
|                            |                    |          |           |              | MC              |       |       |        |             |           | CARBONACEOUS  |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | COAL - K2 SEAM                                      |                      |          |
|                            |                    |          |           |              |                 |       |       | 638    |             |           | CLAYSTONE   |                      |          |
|                            |                    |          |           |              |                 |       |       | 640    |             |           | - ABUND. CALCITE VEINS                              |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | MEDIUM SANDSTONE                                    |                      |          |
|                            |                    |          |           |              |                 |       |       | 660    |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       |       | 663    |             |           |   |                      |          |
| 3.7                        | 11.7               |          |           |              | 100             |       |       | 700    |             |           |   |                      |          |
|                            |                    |          |           |              |                 |       |       |        |             |           | SILTSTONE   |                      |          |
| 3.0                        | 8.0                |          |           |              |                 |       |       |        |             |           | CLAYSTONE   |                      |          |
|                            |                    |          |           |              |                 |       |       | 225    |             |           |   |                      |          |

E.O.H

QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

## GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD86003

|          |        |
|----------|--------|
| BY       | DATE   |
| PMG      | AUG 87 |
| APPROVED | DWG.   |
|          | A      |

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD86006

LOCATION TRANSFER PIT  
 NORTHING: 6095648.46  
 EASTING: 621718.59  
 COLLAR ELEV: 1325.06

AZIMUTH 220°  
 INCLINATION 60°  
 DEPTH 325' / 99.1 m

DATE DRILLED 1986

| SUMMARY OF CUSUMS ANALYSIS |                    |                  |          |         |              |                 | DEPTH |        | GRAPHIC LOG |           | DESCRIPTIVE LOG | HYDROGEOLOGIC DATA   |          |
|----------------------------|--------------------|------------------|----------|---------|--------------|-----------------|-------|--------|-------------|-----------|-----------------|--|----------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | BEDDING JOINTS / | JOINTS / | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE |        | LITHOLOGY   | STRUCTURE |                 | INSTALLATION DETAILS   | COMMENTS |
|                            |                    |                  |          |         |              |                 | FEET  | METRES |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 |  |          |
| 3.8                        | 10.6               |                  |          |         | 100          |                 |       |        |             |           |                 | Q <sub>1</sub> = ?<br>Q <sub>2</sub> = .05 usgpm<br>(0034 2/0) |          |
| 2.0                        |                    |                  |          |         | MC           |                 | 50    |        |             |           |                 | Q <sub>3</sub> = 2 usgpm<br>(0.13 2/0)                         |          |
|                            |                    |                  |          |         |              | 56              |       | 25     |             |           |                 |  |          |
|                            | 8.2                |                  |          |         |              |                 |       |        |             |           |                 |  |          |
| 3.1                        |                    |                  |          |         | 100          |                 | 100   |        |             |           |                 | 53   |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 | 38.7m  |          |
|                            | 10.0               |                  |          |         | MC           |                 | 150   |        |             |           |                 |  |          |
|                            |                    |                  |          |         |              | 65              |       | 50     |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 |  |          |
|                            | 12.0               |                  |          |         | 100          |                 | 200   |        |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 |  |          |
|                            | 7.3                |                  |          |         | MC           |                 |       |        |             |           |                 | P2 693   |          |
| 2.4                        |                    |                  |          |         |              | 58              | 250   | 75     |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 |  |          |
|                            |                    |                  |          |         | 100          |                 |       |        |             |           |                 |  |          |
|                            | 10.4               |                  |          |         |              |                 |       |        |             |           |                 |  |          |
| 3.5                        |                    |                  |          |         |              |                 | 300   |        |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 |  |          |
|                            |                    |                  |          |         |              |                 |       |        |             |           |                 | P1 96.9  |          |
|                            |                    |                  |          |         |              |                 | 325   | 99.1   |             |           |                 |  |          |

NOTE: See Appendix D for Details of Piezometer Installations.

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

## GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD86006

|           |                |
|-----------|----------------|
| BY<br>PMG | DATE<br>AUG 87 |
| APPROVED  | DWG            |

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD86007

|                             |                              |
|-----------------------------|------------------------------|
| LOCATION                    | AZIMUTH: <u>210°</u>         |
| NORTHING: <u>6095276.73</u> | INCLINATION: <u>-65°</u>     |
| EASTING: <u>622427.33</u>   | DEPTH: <u>455' / 138.8 m</u> |
| COLLAR ELEV: <u>1292.95</u> | DATE DRILLED: <u>1986</u>    |

| SUMMARY OF CUSUMS ANALYSIS |                    |          |         |              |                 |       | DEPTH  |           | GRAPHIC LOG |                        | DESCRIPTIVE LOG | HYDROGEOLOGIC DATA |  |
|----------------------------|--------------------|----------|---------|--------------|-----------------|-------|--------|-----------|-------------|------------------------|-----------------|--------------------|--|
| HARDNESS (R)               | DEGREE OF BREAKAGE | JOINTS / | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE |        | LITHOLOGY | STRUCTURE   | INSTALLATION DETAILS   |                 | COMMENTS           |  |
|                            |                    |          |         |              |                 | FEET  | METRES |           |             |                        |                 |                    |  |
| 4.0                        |                    |          |         | 95           |                 | 50    |        |           |             | FINE SANDSTONE         |                 |                    |  |
|                            |                    |          |         |              | 52              | 50    |        |           |             | MEDIUM SANDSTONE       |                 |                    |  |
|                            |                    |          |         |              |                 |       |        | 25        |             | CARBONACEOUS CLAYSTONE |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | CLAYSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 | 100   |        |           |             | SILTSTONE              |                 |                    |  |
| 2.6                        | 10.8               |          |         |              | 47              |       |        |           |             | CARB. CLAYSTONE        |                 |                    |  |
|                            |                    |          |         |              |                 | 150   |        |           |             | COAL - F SEAM          |                 |                    |  |
|                            |                    |          |         |              |                 | 50    |        |           |             | CARBONACEOUS CLAYSTONE |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | CLAYSTONE              |                 |                    |  |
|                            |                    |          |         |              | 100             | 200   |        |           |             | SILTSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | CLAYSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | SILTSTONE              |                 |                    |  |
| 3.3                        |                    |          |         |              | 40              | 250   |        | 75        |             | COAL - G SEAM          |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | SILTSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | CLAYSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 | 300   |        |           |             | SILTSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | FINE SANDSTONE         |                 |                    |  |
|                            | 8.1                |          |         |              |                 |       |        | 100       |             | CARB. CLAYSTONE        |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | COAL - J SEAM          |                 |                    |  |
|                            |                    |          |         |              |                 | 350   |        |           |             | CARB. CLAYSTONE        |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | COAL - K1 SEAM         |                 |                    |  |
| 2.3                        |                    |          |         |              |                 |       |        |           |             | CARBONACEOUS CLAYSTONE |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | COAL - K2 SEAM         |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | CARB. CLAYSTONE        |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | CLAYSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 | 400   |        |           |             | SILTSTONE              |                 |                    |  |
|                            |                    |          |         |              |                 |       |        | 125       |             | FINE SANDSTONE         |                 |                    |  |
| 3.6                        | 12.4               |          |         |              | 38              |       |        |           |             |                        |                 |                    |  |
|                            |                    |          |         |              |                 |       |        |           |             | SILTSTONE              |                 |                    |  |
|                            | 6.5                |          |         |              |                 | 450   |        |           |             |                        |                 |                    |  |
|                            |                    |          |         |              |                 | 455   | 138.8  |           |             |                        |                 | E.O.H              |  |

|  |  |
|--|--|
| QUINTETTE COAL LIMITED<br>GRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES | <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER      CALGARY |
| <b>GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD86007</b>                              | BY: PMG      DATE: AUG 87<br>APPROVED:      DWG:                               |

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD87001

LOCATION GRIZZLY PIT

NORTHING: 6096689.55

AZIMUTH: \_\_\_\_\_

EASTING: 623418.59

INCLINATION: 65°

COLLAR ELEV: 1021.15 m

DEPTH: 525 ft. / 160.13 m

DATE DRILLED: JULY, 1987

| SUMMARY OF CUSUMS ANALYSIS |                    |                                 |            |         |              |                 | DEPTH      |              | GRAPHIC LOG |           | DESCRIPTIVE LOG                                  | HYDROGEOLOGIC DATA   |                                 |
|----------------------------|--------------------|---------------------------------|------------|---------|--------------|-----------------|------------|--------------|-------------|-----------|--|----------------------|---------------------------------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | BEDDING JOINTS TRUE SPACING (m) | JOINTS / m | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE FEET | SCALE METRES | LITHOLOGY   | STRUCTURE |  | INSTALLATION DETAILS | COMMENTS                        |
| 3.8                        | 10.8               | 0.4                             | 0.2        | 67      | 96           | 70              | 50         |              |             |           | SILTSTONE<br>- OCC. CALCITE STRINGER             | CASING 30'           | HOLE IS FLOWING 2-4 gpm JUL '87 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | MEDIUM SANDSTONE<br>- SHALE AND COALEY STRINGERS |                      |                                 |
| 3.0                        | 8.0                | 0.4                             | 0.3        | 69      | 96           | 70              | 100        |              |             |           |  |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           |  |                      |                                 |
| 4.0                        | 10.3               | 0.3                             | 0.2        | 69      | 96           | 70              | 150        |              |             |           | SILTSTONE<br>- OCC. CALCITE STRINGER             |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | COAL   |                      |                                 |
| 4.0                        | 10.3               | 0.4                             | 0.3        | 69      | 96           | 70              | 50         |              |             |           | CARB. CLAYSTONE TO CLAYSTONE                     |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | SILTSTONE  |                      |                                 |
| 4.0                        | 10.3               | 0.7                             | 0.2        | 69      | 96           | 70              | 200        |              |             |           | CLAYSTONE CARBONACEOUS WITH DEPTH                |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | COAL - F SEAM                                    |                      |                                 |
| 4.0                        | 10.3               | 0.5                             | 0.2        | 69      | 96           | 70              | 250        |              |             |           | CARB. CLAYSTONE<br>CLAYSTONE                     |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | CARBONACEOUS CLAYSTONE                           |                      |                                 |
| 4.0                        | 10.3               | 0.6                             | 0.4        | 69      | 96           | 70              | 300        |              |             |           | CONGLOMERATE                                     |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | MEDIUM SANDSTONE                                 |                      |                                 |
| 4.0                        | 10.3               | 0.3                             | 0.4        | 69      | 96           | 70              | 350        |              |             |           | CONGLOMERATE                                     |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           |  |                      |                                 |
| 2.8                        | 13.0               | 6.2                             | 2.3        | 86      | 86           | 86              | 400        |              |             |           | COAL - G SEAM                                    |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | CARB. CLAYSTONE TO CLAYSTONE                     |                      |                                 |
| 2.8                        | 13.0               | 0.6                             | 0.1        | 91      | 99           | 99              | 450        |              |             |           | SILTSTONE  |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | CLAYSTONE CARBONACEOUS WITH DEPTH                |                      |                                 |
| 7.0                        | 13.0               | 1.2                             | 0.1        | 91      | 99           | 99              | 500        |              |             |           | COAL - J, K1 SEAM                                |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | CARBONACEOUS CLAYSTONE                           |                      |                                 |
| 7.0                        | 13.0               | 1.5                             | 0.2        | 91      | 99           | 99              | 525        | 160.13       |             |           | COAL - K2 SEAM                                   |                      |                                 |
|                            |                    |                                 |            |         |              |                 |            |              |             |           | SILTSTONE TO FINE SANDSTONE                      |                      |                                 |

QUINTETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

 **PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER      CALGARY

**GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD87001**

BY: PMG      DATE: JUL '87  
APPROVED: \_\_\_\_\_

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD87002

LOCATION GRIZZLY PIT

NORTHING 6096678.45

EASTING 623250.51

AZIMUTH \_\_\_\_\_

INCLINATION - 90°


COLLAR ELEV 1081.36

DEPTH 324' / 98.8 m

DATE DRILLED JULY, 1987

| SUMMARY OF CUSUMS ANALYSIS |                    |                                 |            |         |              |                 | DEPTH |        | GRAPHIC LOG |           | DESCRIPTIVE LOG | HYDROGEOLOGIC DATA   |          |
|----------------------------|--------------------|---------------------------------|------------|---------|--------------|-----------------|-------|--------|-------------|-----------|-----------------|----------------------|----------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | BEDDING JOINTS TRUE STACING (M) | JOINTS / M | RQD (%) | RECOVERY (%) | BEDDING DIP (%) | FEET  | METRES | LITHOLOGY   | STRUCTURE |                 | INSTALLATION DETAILS | COMMENTS |
|                            |                    |                                 |            |         |              |                 |       |        |             |           |                 | CASING 15'           |          |
| 2.4                        | 6.0                |                                 |            | 15      |              |                 | 50    |        |             |           |                 |                      |          |
|                            |                    | 0.4                             | 0.2        |         |              |                 |       | 25     |             |           |                 |                      |          |
|                            |                    |                                 |            |         |              |                 | 100   |        |             |           |                 |                      |          |
|                            |                    |                                 |            |         |              | 22              |       |        |             |           |                 |                      |          |
| 3.9                        | 12.7               | 1.1                             | 0.1        | 87      | 100          |                 | 150   |        |             |           |                 |                      |          |
|                            |                    |                                 |            |         |              |                 |       | 50     |             |           |                 |                      |          |
|                            |                    | 1.2                             |            |         |              | 12?             | 200   |        |             |           |                 |                      |          |
|                            | 5.0                |                                 |            | 17      | 72           |                 |       |        |             |           |                 |                      |          |
| 2.7                        | 10.6               | 0.2                             | 0.2        | 81      | 100          |                 | 250   | 75     |             |           |                 |                      |          |
|                            |                    | 0.5                             |            |         |              |                 |       |        |             |           |                 |                      |          |
|                            |                    |                                 |            |         |              | 24              |       |        |             |           |                 |                      |          |
| 2.3                        | 6.6                |                                 |            | 36      | 89           |                 | 300   |        |             |           |                 |                      |          |
|                            |                    | 0.2                             | 0.1        |         |              |                 |       |        |             |           |                 |                      |          |
|                            |                    |                                 |            |         |              |                 |       |        |             |           |                 |                      |          |
|                            |                    | 0.5                             | 0.1        | 70      |              |                 | 324   | 98.8   |             |           |                 |                      |          |

STATIC WATER LEVEL 76.7' (23.4m) Jul 87

|  |  |  |
|--|--|--|
| QUINTETTE COAL LIMITED<br>GRIZZLY - TRANSFER PROJECT<br>GEOTECHNICAL / HYDROGEOLOGICAL STUDIES |  | PITEAU ASSOCIATES<br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER CALGARY |
| <b>GEOTECHNICAL / HYDROGEOLOGICAL LOG OF DRILLHOLE QHD 87002</b>                               |  | BY PMG<br>DATE July 87   |
|  |  | APPROVED DWG   |

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD87003

LOCATION GRIZZLY PIT

NORTHING: 6095802.93

EASTING: 623915.72

COLLAR ELEV: 996.29

AZIMUTH: \_\_\_\_\_

INCLINATION: - 65°

DEPTH 181.0 m / 593.8'

DATE DRILLED: JULY, 1987

| SUMMARY OF CUSUMS ANALYSIS |                    |                                 |           |         |              |                 | DEPTH      |              | GRAPHIC LOG |           | DESCRIPTIVE LOG   | HYDROGEOLOGIC DATA   |  |
|----------------------------|--------------------|---------------------------------|-----------|---------|--------------|-----------------|------------|--------------|-------------|-----------|---|----------------------|--|
| HARDNESS (R)               | DEGREE OF BREAKAGE | BEDDING JOINTS TRUE SPACING (M) | JOINTS /m | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE FEET | SCALE METRES | LITHOLOGY   | STRUCTURE |   | INSTALLATION DETAILS | COMMENTS   |
|                            |                    |                                 |           |         |              |                 |            |              |             |           |   |                      |  |
|                            |                    |                                 |           |         |              |                 | 50         |              |             |           | SILTSTONE<br>- MANY RUSTY JOINT SURFACES<br>- MANY COALEY STRINGERS                       |                      | CASING 13'<br><br>HOLE IS FLOWING LESS THAN 1/4 gpm (TRICKLE)<br><br>JUL '87 |
|                            | 8.1                | 0.2                             | 0.3       | 41      | 90           |                 |            |              |             |           | FINE SANDSTONE<br>- MANY COALEY LENSES INCREASING DOWNWARD                                |                      |  |
| 3.2                        |                    | 0.2                             |           |         |              |                 | 25         |              |             |           | COAL - D SEAM (?)   |                      |  |
|                            |                    |                                 |           |         |              |                 | 100        |              |             |           | CARB. CLAYSTONE<br>- CORE TYPICALLY BREAKS THROUGH COALEY LENSES                          |                      |  |
|                            |                    |                                 |           |         |              | 51              |            |              |             |           | SILTSTONE   |                      |  |
|                            |                    |                                 |           |         |              |                 | 150        |              |             |           | CARBONACEOUS CLAYSTONE  |                      |  |
|                            | 10.7               |                                 |           |         | 90           |                 | 50         |              |             |           | 174<br>176<br>COAL - E SEAM (?)   |                      |  |
|                            |                    | 0.2                             | 0.1       | 76      |              |                 |            |              |             |           | CARB. CLAYSTONE   |                      |  |
|                            |                    |                                 |           |         |              |                 | 200        |              |             |           | 192<br>195<br>SILTSTONE<br>- CALCITE STRINGERS<br>- SWIRLED BEDDING<br>CARB. CLAYSTONE    |                      |  |
| 2.7                        |                    | 0.6                             |           |         |              |                 |            |              |             |           | SILTSTONE<br>- CALCITE STRINGERS<br>- SOME RUST ON JOINT SURFACES<br>- SOME COALEY LENSES |                      |  |
|                            |                    | 0.3                             |           | 100     | 59           |                 | 75         |              |             |           | CARB. CLAYSTONE   |                      |  |
|                            |                    | 0.9                             |           |         |              |                 | 250        |              |             |           | COAL - F SEAM   |                      |  |
|                            |                    |                                 |           | 91      |              |                 |            |              |             |           | CARB. CLAYSTONE<br>- VERY LOOSE BEDDING JOINTS  |                      |  |
|                            |                    | 0.2                             | 0.1       |         |              | 54              | 300        |              |             |           |   |                      |  |
|                            |                    |                                 |           |         |              |                 | 100        |              |             |           | CONGLOMERATE  |                      |  |
|                            | 8.6                | 0.5                             |           | 100     |              |                 | 350        |              |             |           | COAL - G SEAM   |                      |  |
| 3.3                        |                    |                                 |           |         |              |                 |            |              |             |           | CARB. CLAYSTONE<br>- SOME CALCITE STRINGERS   |                      |  |
|                            |                    | 0.5                             | 0.1       |         | 48           |                 | 400        |              |             |           | FINE SANDSTONE  |                      |  |
|                            |                    |                                 |           |         |              |                 | 125        |              |             |           | CARB. CLAYSTONE   |                      |  |
|                            |                    |                                 |           |         |              |                 |            |              |             |           | COAL - J, K1 SEAM   |                      |  |
| 2.3                        |                    |                                 |           | 31      | 97           |                 | 450        |              |             |           | CARBONACEOUS CLAYSTONE  |                      |  |
|                            |                    |                                 |           |         |              |                 |            |              |             |           | COAL - K2 SEAM  |                      |  |
|                            |                    |                                 |           |         |              |                 |            |              |             |           | SILTSTONE TO FINE SANDSTONE   |                      |  |
|                            |                    |                                 |           |         |              |                 |            |              |             |           | 478<br>480<br>CARBONACEOUS CLAYSTONE  |                      |  |
| 3.6                        | 11.6               | 0.7                             | 0.1       | 85      |              | 45              | 150        |              |             |           | FINE SANDSTONE<br>- SOME CALCITE STRINGERS  |                      |  |
|                            |                    |                                 |           |         | 100          |                 | 500        |              |             |           | SILTSTONE   |                      |  |
|                            |                    |                                 |           |         |              |                 | 550        |              |             |           |   |                      |  |
|                            |                    |                                 |           |         |              |                 | 175        |              |             |           |   |                      |  |
|                            |                    |                                 |           |         |              |                 | 593.8      | 181.0        |             |           |   |                      | E.O.H.   |

QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

|   |  |           |                 |
|---|--|-----------|-----------------|
| <b>GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD87003</b> |  | BY<br>PMG | DATE<br>Aug '87 |
|   |  | APPROVED  | DWG.            |

# GEOTECHNICAL / HYDROGEOLOGICAL LOG

QHD87004

LOCATION TRANSFER PIT  
 NORTHING: 6095885.15  
 EASTING: 620622.54  
 COLLAR ELEV.: 1589.74

AZIMUTH:                       
 INCLINATION: -90°  
 DEPTH: 151.0 m / 495'

DATE DRILLED: JULY, 1987

| SUMMARY OF CUSUMS ANALYSIS |                    |                                 |            |         |              |                 | DEPTH |        | GRAPHIC LOG |                | DESCRIPTIVE LOG   | HYDROGEOLOGIC DATA   |          |
|----------------------------|--------------------|---------------------------------|------------|---------|--------------|-----------------|-------|--------|-------------|----------------|---|----------------------|----------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | BEDDING JOINTS TRUE SPACING (M) | JOINTS / M | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE |        | LITHOLOGY   | STRUCTURE      |   | INSTALLATION DETAILS | COMMENTS |
|                            |                    |                                 |            |         |              |                 | FEET  | METRES |             |                |   |                      |          |
|                            |                    |                                 |            |         |              |                 | 50    |        |             |                |   |                      |          |
|                            |                    | 0.5                             | 0.2        | 80      |              |                 |       | 25     |             |                | CARB. CLAYSTONE<br>- RUSTY/WEATHERED JOINT SURFACES   |                      |          |
|                            |                    |                                 |            |         |              |                 |       |        |             |                | COAL - D SEAM (?)   |                      |          |
|                            |                    | 0.4                             | 0.2        |         |              | 53              | 100   |        |             |                | CARB. CLAYSTONE   |                      |          |
|                            |                    |                                 |            |         | 96           |                 |       |        |             |                | COAL - E SEAM (?)   |                      |          |
|                            |                    |                                 |            |         |              |                 |       |        |             |                | CARB. CLAYSTONE<br>- CALCITE STRINGERS  |                      |          |
| 2.6                        | 8.7                | 0.7                             | 0.2        | 47      |              |                 | 150   |        |             | 45<br>146      | SILTSTONE<br>- X-JOINTS ≈ 11 CORE AXIS  |                      |          |
|                            |                    |                                 |            |         |              |                 |       | 50     |             |                | CARB. CLAYSTONE   |                      |          |
|                            |                    |                                 |            |         |              | 53              |       |        |             |                | COAL - F SEAM   |                      |          |
|                            |                    |                                 |            |         |              |                 | 200   |        |             |                | SILTSTONE   |                      |          |
|                            |                    |                                 |            |         |              |                 |       |        |             |                | FINE SANDSTONE<br>- OCC. CALCITE STRINGER   |                      |          |
| 3.9                        |                    | 0.5                             | 0.1        | 89      |              | 53              | 250   | 75     |             |                | MEDIUM SANDSTONE<br>- OCC. CALCITE STRINGER<br>- SOME COALEY STRINGERS  |                      |          |
|                            |                    |                                 |            |         |              |                 |       |        |             |                | FINE SANDSTONE  |                      |          |
|                            | 11.1               |                                 |            |         |              |                 |       |        |             |                | COAL - G SEAM   |                      |          |
|                            |                    |                                 |            |         |              |                 | 300   |        |             |                | CARB. CLAYSTONE & SILTSTONE<br>- SWIRLED BEDDING<br>- LOOSE JOINTING ON CONTACT ZONE                                      |                      |          |
| 2.5                        |                    | 0.4                             | 0.1        | 56      | 99           | 37              |       | 100    |             |                | CARB. CLAYSTONE   |                      |          |
|                            |                    |                                 |            |         |              |                 |       |        |             |                | COAL - J, K1, K2 SEAM   |                      |          |
|                            | 6.9                |                                 |            |         |              |                 | 350   |        |             |                | CARB. CLAYSTONE   |                      |          |
|                            |                    | 1.8                             |            |         |              |                 |       |        |             |                | FINE SANDSTONE<br>- MASSIVE<br>- CALCITE ON CROSS JOINT SURFACES<br>- SLIGHTLY WEATHERED<br>- CORE TENDS TO BREAK AXIALLY |                      |          |
|                            |                    | 2.0                             |            |         |              | 37              | 400   | 125    |             | 416.0<br>421.5 |   |                      |          |
| 3.3                        | 11.6               | 1.9                             | 0.2        | 90      |              |                 |       |        |             |                | SILTSTONE   |                      |          |
|                            |                    | 0.6                             |            |         |              | 47              | 450   |        |             |                |   |                      |          |
|                            |                    |                                 |            |         |              |                 | 495   | 151.0  |             |                |   |                      |          |
|                            |                    |                                 |            |         |              |                 | 500   |        |             |                | CONGLOMERATE  |                      |          |

QUINETTE COAL LIMITED  
 GRIZZLY-TURNER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU & ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER      CALGARY

## GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD87004

|          |         |
|----------|---------|
| BY       | DATE    |
| PMG      | Aug '87 |
| APPROVED | DWG.    |
|          | A-9     |

E.O.H



**GEOTECHNICAL / HYDROGEOLOGICAL LOG**

QHD85002

LOCATION

NORTHING: 6096247.89

EASTING: 620665.99

COLLAR ELEV: 1549.97

AZIMUTH: 226°

INCLINATION: -75°

DEPTH: 145.08 m / 476'

DATE DRILLED: 1985

| SUMMARY OF CUSUMS ANALYSIS |                    |          |         |              |                 | DEPTH |        | GRAPHIC LOG |           | DESCRIPTIVE LOG                 | HYDROGEOLOGIC DATA   |          |
|----------------------------|--------------------|----------|---------|--------------|-----------------|-------|--------|-------------|-----------|---------------------------------|----------------------|----------|
| HARDNESS (R)               | DEGREE OF BREAKAGE | JOINTS / | RQD (%) | RECOVERY (%) | BEDDING DIP (°) | SCALE | SCALE  | LITHOLOGY   | STRUCTURE |                                 | INSTALLATION DETAILS | COMMENTS |
|                            |                    |          |         |              |                 | FEET  | METRES |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 | 50    |        |             |           | SILTSTONE                       |                      |          |
| 6.6                        |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | CONGLOMERATE                    |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | CARBONACEOUS CLAYSTONE          |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | COAL - A SEAM (?)               |                      |          |
| 2.8                        |                    |          |         | 100          |                 |       |        |             |           | FINE SANDSTONE                  |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | CLAYSTONE TO CARB. CLAYSTONE    |                      |          |
|                            |                    |          |         |              |                 | 100   |        |             |           | SILTY SANDSTONE                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | COAL - B SEAM (?)               |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | FINE SANDSTONE                  |                      |          |
|                            |                    |          |         |              |                 | 150   |        |             |           | CLAYSTONE TO SILTSTONE W/ DEPTH |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | SILTY SANDSTONE                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | COAL - C SEAM (?)               |                      |          |
| 10.9                       |                    |          |         | 87           |                 |       |        |             |           | FINE SANDSTONE                  |                      |          |
|                            |                    |          |         |              |                 | 200   |        |             |           | MEDIUM SANDSTONE                |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | FINE SANDSTONE                  |                      |          |
| 3.8                        |                    |          |         |              |                 |       |        |             |           | SILTY SANDSTONE                 |                      |          |
|                            |                    |          |         |              |                 | 250   |        |             |           | SILTSTONE                       |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | SILTY SANDSTONE                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 | 300   |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
| 2.8                        |                    |          |         |              |                 |       |        |             |           | COAL - D SEAM (?)               |                      |          |
|                            |                    |          |         |              |                 | 350   |        |             |           | SILTSTONE                       |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           | COAL - E SEAM (?)               |                      |          |
|                            |                    |          |         |              |                 | 400   |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 | 450   |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 |       |        |             |           |                                 |                      |          |
|                            |                    |          |         |              |                 | 476.0 | 145.08 |             |           |                                 |                      |          |

E.O.H.

QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

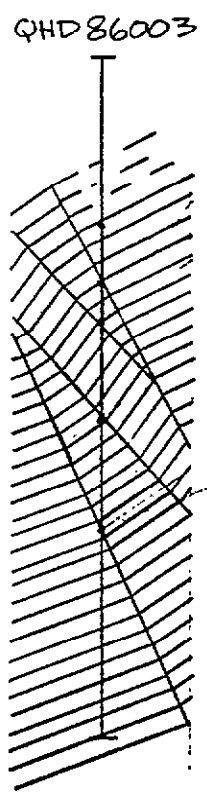
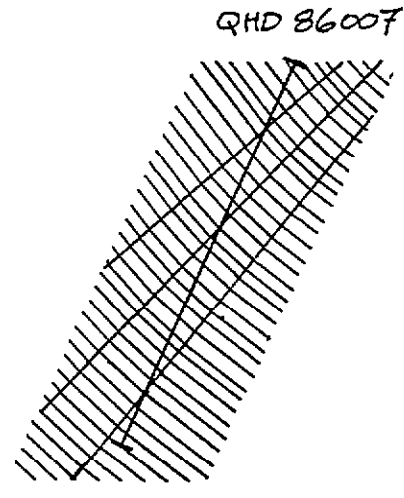
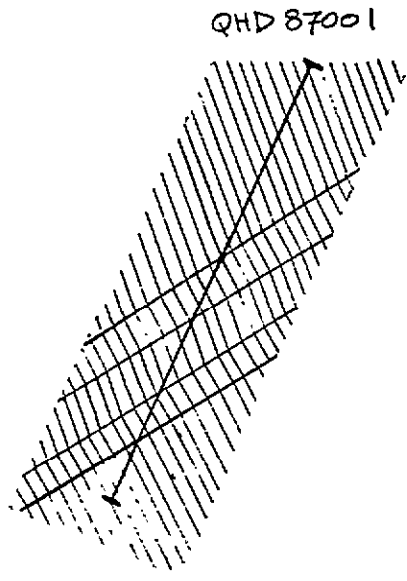


PITEAU & ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

**GEOTECHNICAL/HYDROGEOLOGICAL LOG OF DRILLHOLE QHD85002**

APPROVED: [Signature] DATE: JULY 87  
DWG: [Signature]

JOB NUMBER 81-339-GT



SCALE 1:2500

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL - HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

BEDDING DIP CONSTRUCTIONS FOR DRILLHOLES QHD 86003,  
 QHD 86007 AND QHD 87001

|               |                  |
|---------------|------------------|
| BY:<br>PMH    | DATE:<br>SEPT 87 |
| APPROVED:<br> | DWG:<br>A-10     |

**TABLE A-1**  
**QUALITATIVE & QUANTITATIVE EXPRESSIONS**  
**FOR CONSISTENCY OF COHESIVE SOIL AND ROCK\***

| HARDNESS | CONSISTENCY         | FIELD IDENTIFICATION   | APPROXIMATE RANGE OF UNCONFINED COMPRESSIVE STRENGTH |                 |
|----------|---------------------|--|--|-----------------|
|          |                     |  | MPa  | p.s.i.          |
| S1       | very soft soil      | Easily penetrated several inches by fist; shows distinct heel marks.   | <0.025   | <3.5            |
| S2       | soft soil           | Easily penetrated several inches by thumb; faint heel marks.   | 0.025 - 0.05   | 3.5 - 7         |
| S3       | firm soil           | Can be penetrated by thumb with moderate effort; difficult to cut with hand spade.   | 0.05 - 0.10  | 7 - 14          |
| S4       | stiff soil          | Readily indented by thumb but penetrated only with great effort; cannot be cut with hand spade.                                    | 0.1 - 0.2  | 14 - 28         |
| S5       | very stiff soil     | Readily indented by thumbnail; requires pneumatic spade for excavation.  | 0.20 - 0.4   | 28 - 56         |
| S6       | hard soil           | Indented with difficulty by thumbnail.   | >0.4   | >56             |
| R0       | extremely soft rock | Indented by thumbnail.   | 0.2 - 0.7  | 28 - 100        |
| R1       | very soft rock      | Crumbles under firm blows with point of geological pick; can be peeled by a pocket knife.  | 0.7 - 7.0  | 100 - 1,000     |
| R2       | soft rock           | Can be peeled by a pocket knife with difficulty; shallow indentations made by firm blow of geological pick.                        | 7.0 - 28   | 1,000 - 4,000   |
| R3       | average rock        | Cannot be scraped or peeled with a pocket knife; specimen can be fractured with single firm blow of hammer end of geological pick. | 28 - 56  | 4,000 - 8,000   |
| R4       | hard rock           | Specimen requires more than one blow with hammer end of geological pick to fracture it.  | 56 - 112   | 8,000 - 16,000  |
| R5       | very hard rock      | Specimen requires many blows of hammer end of geological pick to fracture it.  | 112 - 224  | 16,000 - 32,000 |
| R6       | extremely hard rock | Specimen can only be chipped with geological pick.   | >224   | >32,000         |

\* Modified Rock Hardness Classification

S1 to S6 Modified after Terzaghi, K. and Peck, R.B., 1967. "Soil Mechanics in Engineering Practice, 2nd Edition, John Wiley and Sons Inc., New York. p.30.

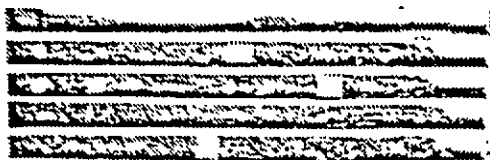
R1 to R5 Modified after Piteau, D.R., 1970. "Geological Factors Significant to the Stability of Slopes Cut in Rock" in Planning Open Pit Mines, Van Rensburg Ed. Aug. 29-Sept. 4, 1970. Balkema. p.51 and 68.

**TABLE A-2**  
**DEGREE OF BREAKAGE CLASSIFICATION**

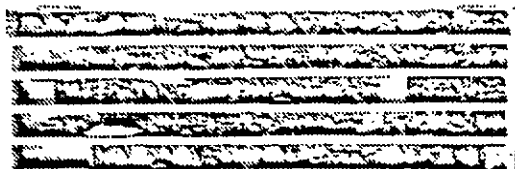
Degree of Breakage is a visual and thus somewhat subjective estimation of the quality of the rock in terms of the number of fractures or breaks. General categories, numerical equivalents and qualifying descriptions are given below. Photographic illustrations of the Degree of Breakage Classifications are given in Fig. 2.

| CATEGORY      | NUMERICAL EQUIVALENT | MEAN SPACING OF BREAKS OR DIAMETER OF FRAGMENTS (in.) | QUALITY DESCRIPTIONS  |
|---------------|----------------------|---|---|
| A-<br>A<br>A+ | 1<br>2<br>3          | $\ll \frac{1}{2}$                                     | Mostly fault gouge with/without minor rock fragments<br>Gouge and crushed rock<br>Crushed rock with/without minor gouge |
| B-<br>B<br>B+ | 4<br>5<br>6          | $\frac{1}{2}$ to 2                                    | Crushed rock - no gouge<br>Crushed rock - diameter of pieces $\ll 2$ in.<br>Broken rock - fracture spacing $\ll 2$ in.  |
| C-<br>C<br>C+ | 7<br>8<br>9          | 2 - 4   | Mean spacing 2 to 3 in.<br>Mean spacing 3 in.<br>Mean spacing 3 to 4 in.  |
| D-<br>D<br>D+ | 10<br>11<br>12       | 4 - 8   | Mean spacing 4 to 6 in.<br>Mean spacing 6 in.<br>Mean spacing 6 to 8 in.  |
| E-<br>E<br>E+ | 13<br>14<br>15       | $> 8$   | Mean spacing 8 to 12 in.<br>Mean spacing 12 to 14 in.<br>Mean spacing $> 24$ in.  |

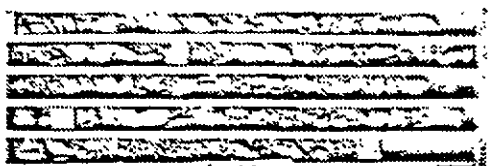
NOTE: Care should be taken to identify all fault/shear zones (Category A). However, for other Degrees of Breakage, the category should be averaged over the length of the core run.



A (2)



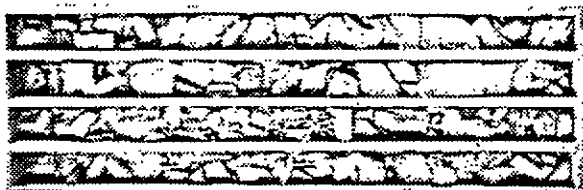
A+ (3)



B- (4)



B (5)



B+ (6)



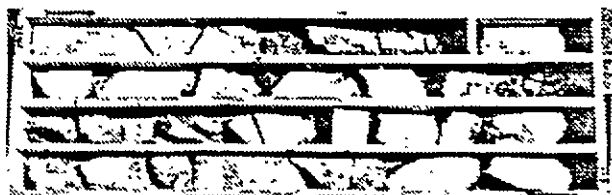
C- (7)



C (8)



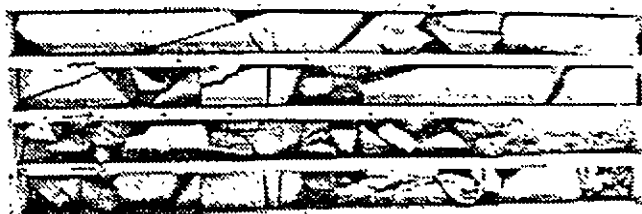
C+ (9)



D- (10)



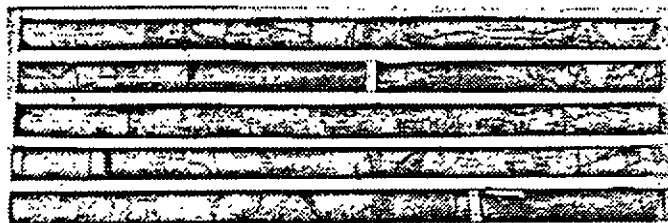
D (11)



D+ (12)



E- (13)



E (14)

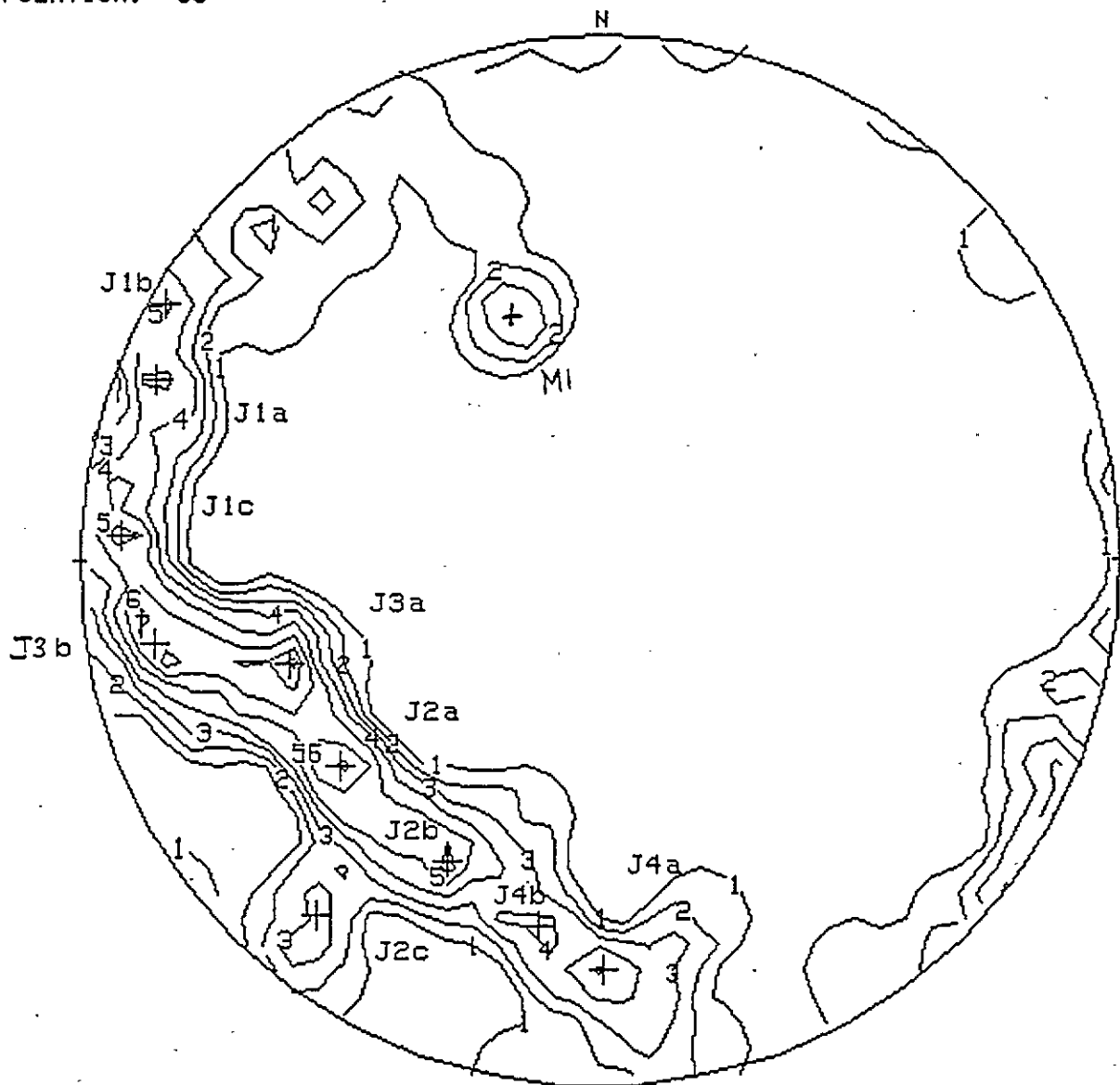
DEGREE OF BREAKAGE CLASSIFICATION

APPENDIX B

LOWER HEMISPHERE EQUAL AREA  
PROJECTIONS OF JOINTS RELATIVE TO  
VARIOUS BEDDING ORIENTATIONS

OBSERVATIONS: 55  
 POPULATION: 55

CONTOUR PLOT



| <u>LABEL</u> | <u>DIP DIRECTION</u> | <u>DIP</u> | <u>CONCENTRATION (%)</u> |
|--------------|----------------------|------------|--------------------------|
| J1a          | 112                  | 81         | 5                        |
| J1b          | 120                  | 86         | 5                        |
| J1c          | 093                  | 81         | 6                        |
| J2a          | 052                  | 53         | 7                        |
| J2b          | 027                  | 54         | 6                        |
| J2c          | 039                  | 75         | 3                        |
| J3a          | 072                  | 53         | 8                        |
| J3b          | 079                  | 76         | 7                        |
| J4a          | 359                  | 67         | 5                        |
| J4b          | 010                  | 60         | 4                        |
| MI           | 159                  | 41         |                          |

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

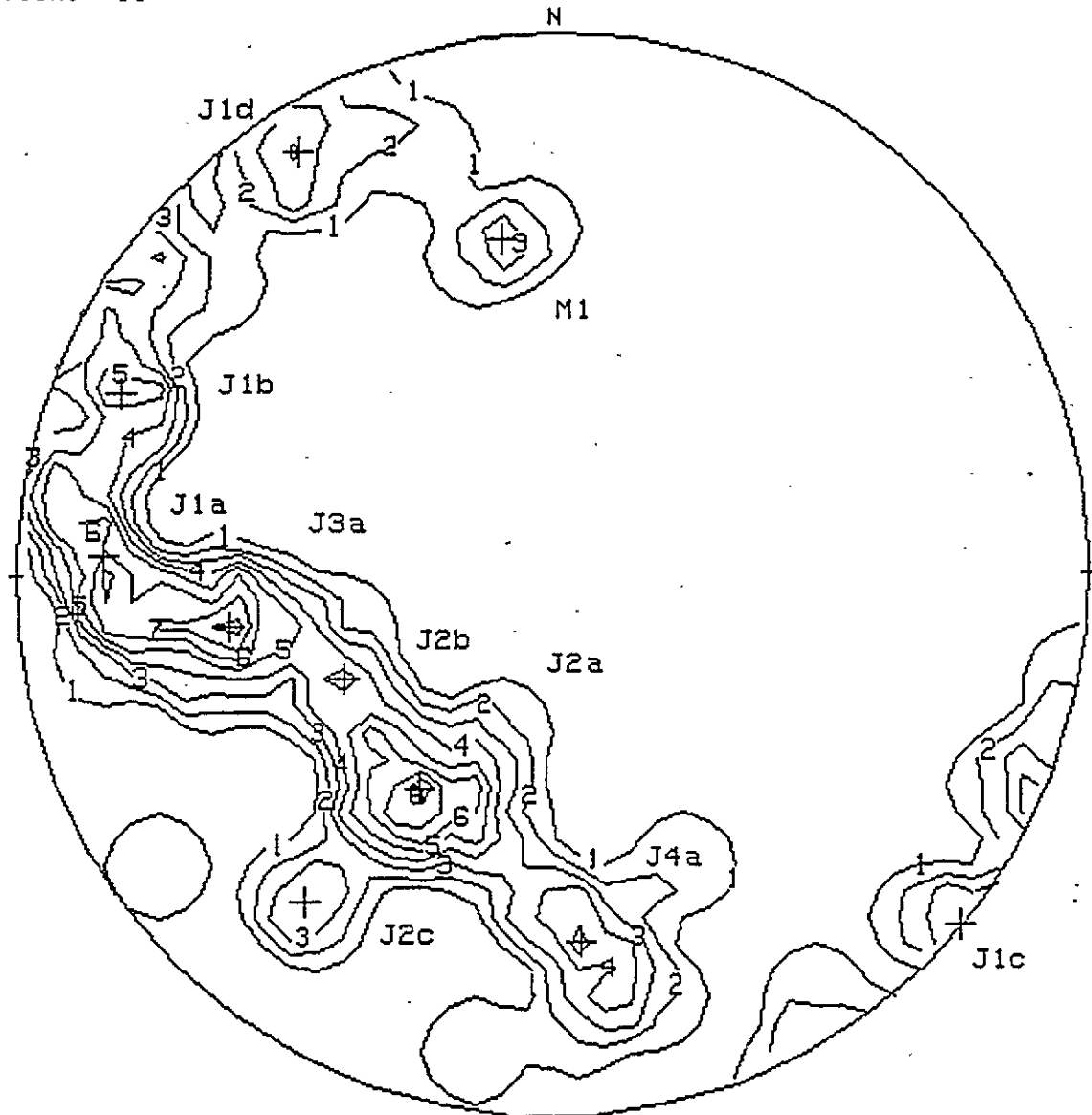
PITEAU ASSOCIATES ENGINEERING LTD.

GEODAT: LOWER HEMISPHERE EQUAL AREA PROJECTION  
 JOINTS ON SW LIMBS RELATIVE TO BEDDING DIP 30 DEG

|              |                 |
|--------------|-----------------|
| By:<br>PMH   | Date:<br>AUG 87 |
| Page:<br>B-1 | Job#:<br>33A-GT |

OBSERVATIONS: 55  
 POPULATION: 55

CONTOUR PLOT



| <u>LABEL</u> | <u>DIP DIRECTION</u> | <u>DIP</u> | <u>CONCENTRATION (%)</u> |
|--------------|----------------------|------------|--------------------------|
| J1a          | 092                  | 72         | 6                        |
| J1b          | 113                  | 76         | 5                        |
| J1c          | 310                  | 90         | 4                        |
| J1d          | 148                  | 81         | 4                        |
| J2a          | 032                  | 39         | 9                        |
| J2b          | 064                  | 36         | 6                        |
| J2c          | 037                  | 65         | 4                        |
| J3a          | 081                  | 51         | 8                        |
| J4a          | 355                  | 57         | 5                        |
| M1           | 171                  | 52         | 4                        |

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

PITEAU ASSOCIATES ENGINEERING LTD.

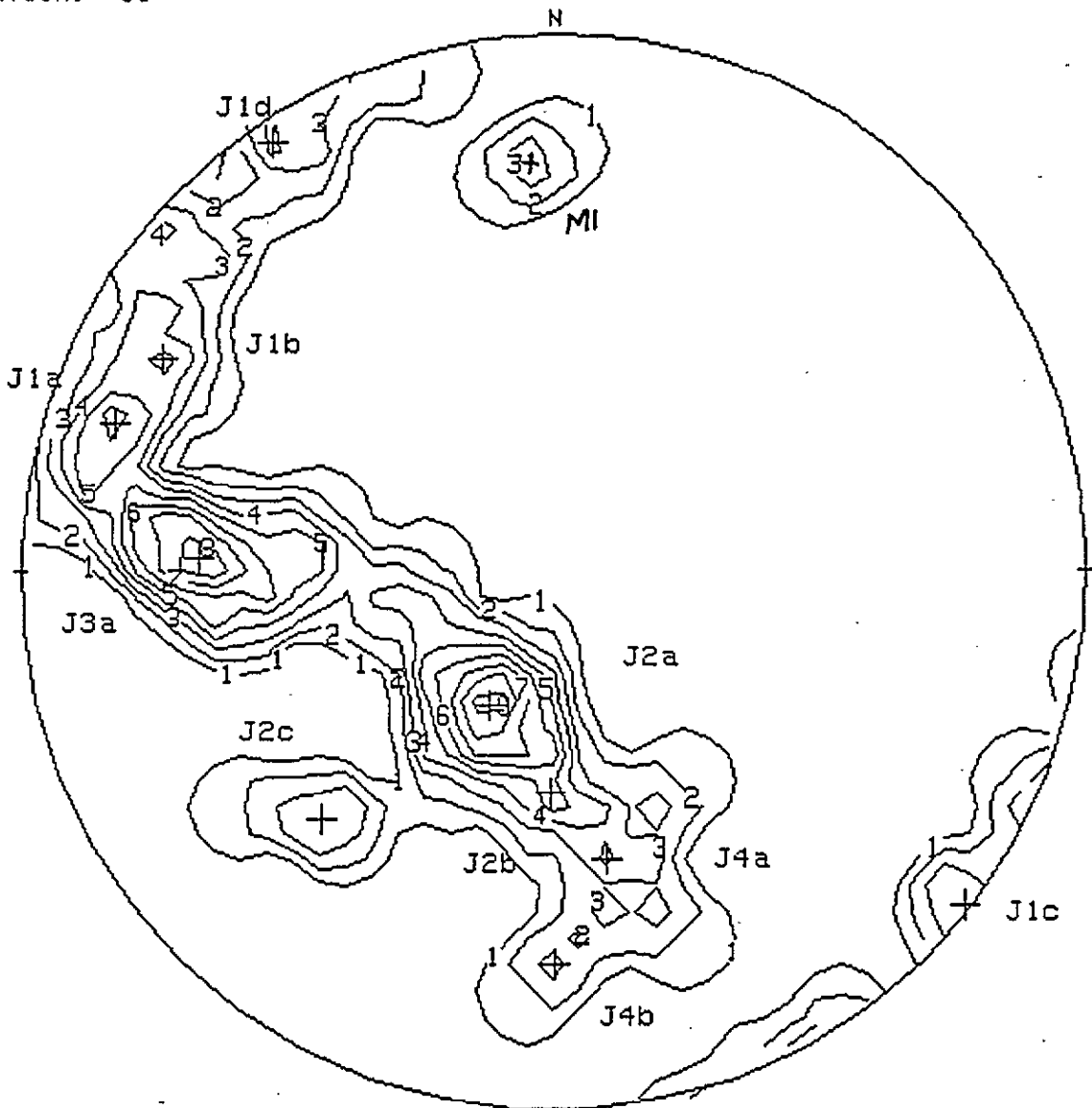
GEO DAT: LOWER HEMISPHERE EQUAL AREA PROJECTION  
 JOINTS ON SW LIMBS RELATIVE TO BEDDING DIP 45 DEG

|              |                 |
|--------------|-----------------|
| By:<br>PMH   | Date:<br>AUG 87 |
| Page:<br>B-2 | Job#:<br>339-GT |



OBSERVATIONS: 55  
 POPULATION: 55

CONTOUR PLOT



| <u>LABEL</u> | <u>DIP DIRECTION</u> | <u>DIP</u> | <u>CONCENTRATION (%)</u> |
|--------------|----------------------|------------|--------------------------|
| J1a          | 108                  | 76         | 6                        |
| J1b          | 118                  | 72         | 5                        |
| J1c          | 309                  | 89         | 4                        |
| J1d          | 146                  | 85         | 4                        |
| J2a          | 026                  | 23         | 9                        |
| J2b          | 001                  | 34         | 5                        |
| J2c          | 043                  | 53         | 4                        |
| J3a          | 092                  | 56         | 8                        |
| J4a          | 349                  | 45         | 4                        |
| J4b          | 360                  | 62         | 4                        |
| MI           | 176                  | 65         | 4                        |

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

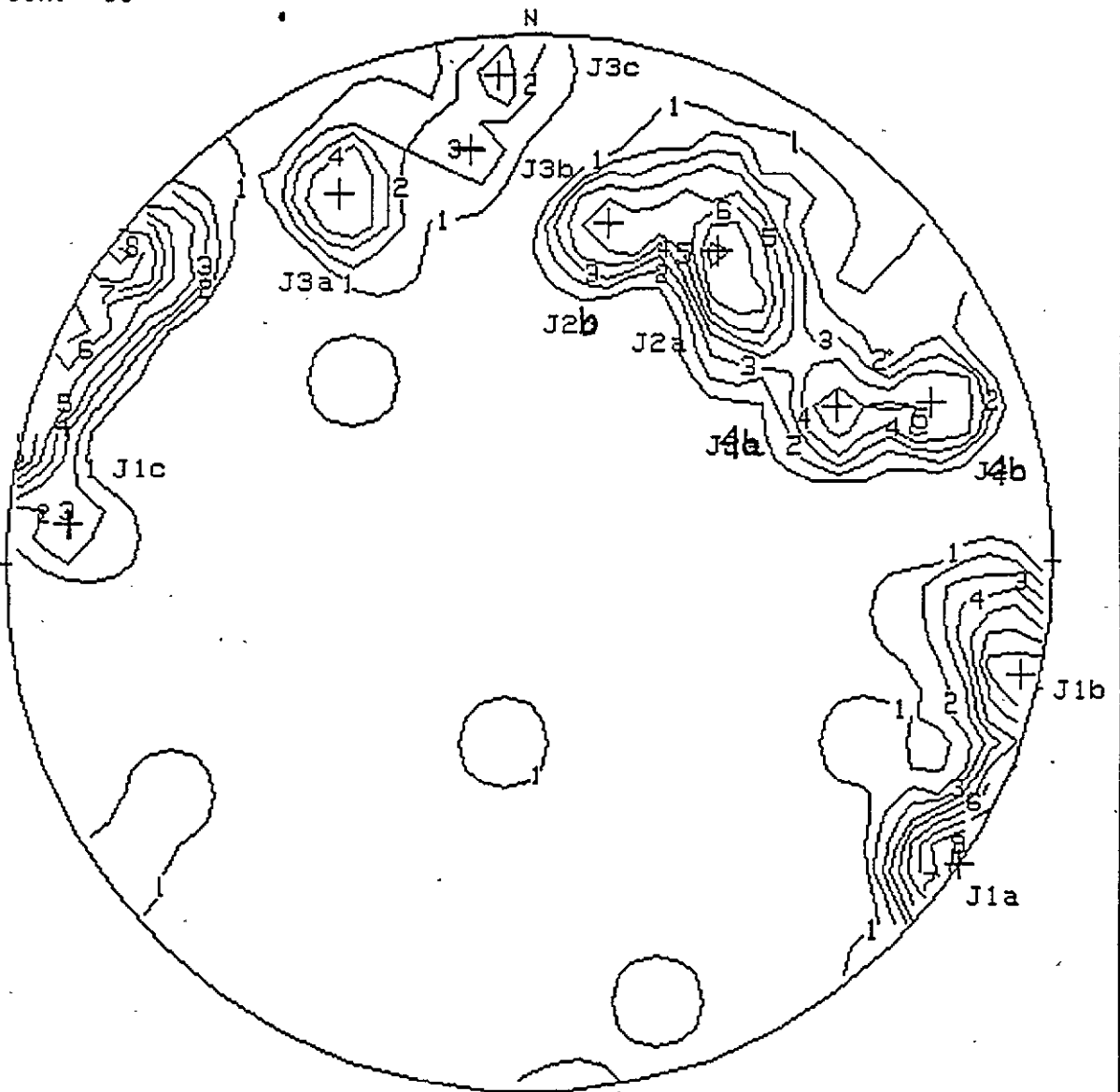
PITEAU ASSOCIATES ENGINEERING LTD.

GEO DAT: LOWER HEMISPHERE EQUAL AREA PROJECTION  
 JOINTS ON SW LIMBS RELATIVE TO BEDDING DIP 60 DEG

|              |                 |
|--------------|-----------------|
| By:<br>PMH   | Date:<br>AUG 87 |
| Page:<br>B-3 | Job#:<br>339-GT |

OBSERVATIONS: 66  
 POPULATION: 66

CONTOUR PLOT



| <u>LABEL</u> | <u>DIP DIRECTION</u> | <u>DIP</u> | <u>CONCENTRATION (%)</u> |
|--------------|----------------------|------------|--------------------------|
| J1a          | 305                  | 90         | 10 7                     |
| J1b          | 283                  | 86         | 7 5                      |
| J2a          | 211                  | 58         | 8 5                      |
| J4a          | 243                  | 55         | 6 4                      |
| J4b          | 249                  | 71         | 5 3                      |
| J2b          | 193                  | 55         | 6 4                      |
| J3a          | 152                  | 68         | 5 3                      |
| J1c          | 095                  | 77         | 3 2                      |
| J3b          | 171                  | 68         | 3 2                      |
| J3c          | 176                  | 81         | 3 2                      |

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

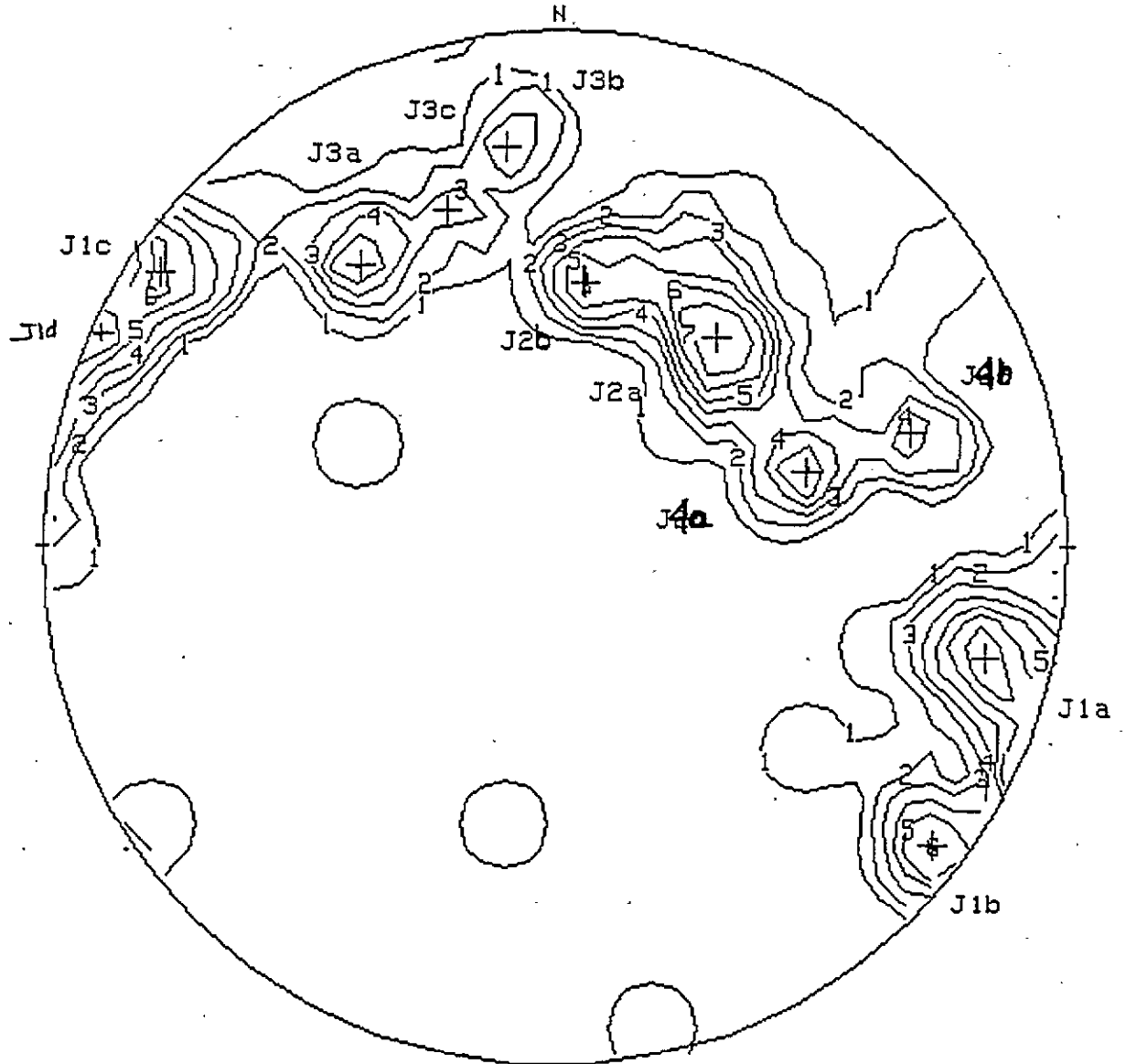
PITEAU ASSOCIATES ENGINEERING LTD.

GEODAT: LOWER HEMISPHERE EQUAL AREA PROJECTION  
 JOINTS ON NE LIMBS RELATIVE TO BEDDING DIP 30 DEG

|              |                 |
|--------------|-----------------|
| By:<br>PMH   | Date:<br>AUG 87 |
| Page:<br>B-4 | Job#:<br>339-6T |

OBSERVATIONS: 66  
 POPULATION: 66

CONTOUR PLOT



| <u>LABEL</u> | <u>DIP DIRECTION</u> | <u>DIP</u> | <u>CONCENTRATION (%)</u> |
|--------------|----------------------|------------|--------------------------|
| J1a          | 284                  | 75         | 8 5                      |
| J1b          | 308                  | 83         | 6 4                      |
| J1c          | 124                  | 83         | 6 4                      |
| J2a          | 218                  | 42         | 8 5                      |
| J4a          | 254                  | 42         | 6 4                      |
| J2b          | 186                  | 42         | 6 4                      |
| J4b          | 252                  | 61         | 5 3                      |
| J3a          | 144                  | 56         | 6 4                      |
| J3b          | 172                  | 67         | 3 2                      |
| J3c          | 161                  | 58         | 3 2                      |
| J1d          | 114                  | 82         | 7 5                      |

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

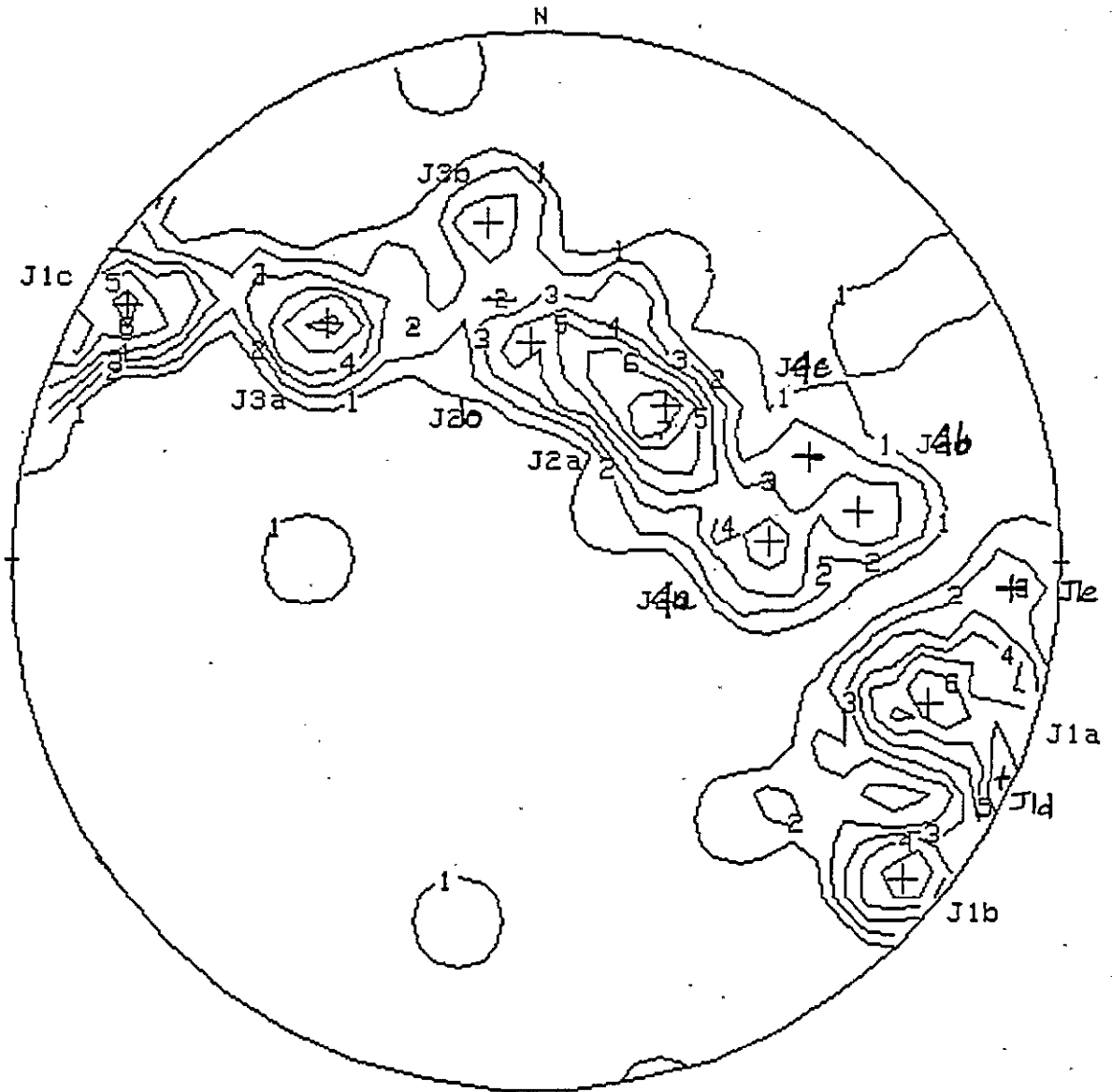
PITEAU ASSOCIATES ENGINEERING LTD.

GEODAT: LOWER HEMISPHERE EQUAL-AREA PROJECTION  
 JOINTS ON NE LIMBS RELATIVE TO BEDDING DIP 45 DEG

|              |                 |
|--------------|-----------------|
| By:<br>PMH   | Date:<br>AUG 87 |
| Page:<br>B-5 | Job#:<br>339-6T |

OBSERVATIONS: 66  
 POPULATION: 66

CONTOUR PLOT



| <u>LABEL</u> | <u>DIP DIRECTION</u> | <u>DIP</u> | <u>CONCENTRATION (%)</u> |
|--------------|----------------------|------------|--------------------------|
| J1a          | 290                  | 68         | 75                       |
| J1b          | 311                  | 81         | 53                       |
| J1c          | 122                  | 81         | 75                       |
| J2a          | 220                  | 31         | 85                       |
| J2b          | 178                  | 34         | 43                       |
| J3a          | 138                  | 50         | 64                       |
| J3b          | 171                  | 54         | 32                       |
| J4a          | 265                  | 36         | 53                       |
| J4b          | 261                  | 52         | 32                       |
| J4c          | 249                  | 46         | 32                       |
| J4d          | 244                  | 87         | 75                       |
| J4e          | 273                  | 82         | 32                       |

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

PITEAU ASSOCIATES ENGINEERING LTD.

GEODAT: LOWER HEMISPHERE EQUAL AREA PROJECTION  
 JOINTS ON NE LIMBS RELATIVE TO BEDDING DIP 60 DEG

|              |                 |
|--------------|-----------------|
| By:<br>PMH   | Date:<br>AUG 07 |
| Page:<br>B-6 | Job#:<br>339-GT |

APPENDIX C

TEST PIT LOGS  
SOILS TESTING RESULTS

737-3

## EXPLANATION OF TERMS USED IN THE SOIL CLASSIFICATION

### 1. Coarse Material

- SAND (#200 sieve to #4 sieve)
- GRAVEL (#4 sieve to 76 mm)
- COBBLES (76 mm to 200 mm)
- BOULDERS (rock greater than 200 mm)

### 2. Percentage of Minor Components

- and (35 to 50%)
- some (20 to 35%)
- little (10 to 20%)
- trace (1 to 10%)

### 3. Plasticity

- High (Liquid limit above 50)
- Medium (Liquid limit between 30 and 50)
- Low (Liquid limit below 30)
- Slight (Plasticity Index between 4 and 7)

### 4. Structure and Sensitivity

- Stratified (Alternating layers of varying type)
- Laminated (Alternating layers less than 1/4", 6 mm)
- Varved (Where the laminations consists of very fine material)
- Fissured (Material breaks along plane of fracture)
- Slickensided (If fracture plane appeared glossy)
- Blocky (If material can be broken in small and hard angular lumps)
- Nuggetted (If soil breaks into small nuggets or cubes)
- Homogeneous (Consistent material mixture such as nonstratified clay, till)
- Lensed (Small pockets of different texture)

#### Sensitivity

- High (8 - 16)
- Medium (4 - 8)
- Low (2 - 4)

### 5. Consistency and Density (As determined by pocket penetrometer readings and SPT tests)

- Very Soft Less than 12 kPa (Undrained shear strength)
- Soft 12 to 24 kPa
- Firm 24 to 48 kPa
- Stiff 48 to 95 kPa
- Very stiff 95 to 190 kPa
- Hard Greater than 190 kPa
  
- Very loose 0-4 blows/0.3 m
- Loose 4-10 blows/0.3 m
- Medium dense 10-30 blows/0.3 m (Compact)
- Dense 30-50 blows/0.3 m
- Very dense over 50 blows/0.3 m

### 6. Group Symbols (refer to following page)

GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, OL, MH, CH, OH, PT

| MAJOR DIVISIONS   |   |  | GROUP SYMBOLS                                 | TYPICAL NAMES   | CLASSIFICATION CRITERIA  |   |   |
|---|---|--|---|---|--|---|---|
| COARSE-GRAINED SOILS<br>More than 50% retained on No. 200 sieve * | GRAVELS<br>50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS  | GW  | Well-graded gravels and gravel-sand mixtures, little or no fines              | Classification on basis of percentage of fines<br>Less than 5% Pass No.200 sieve GW, GP, SW, SP<br>More than 12% Pass No.200 sieve GM, GC, SM, SC<br>5% to 12% Pass No.200 sieve.<br>Borderline Classification requiring use of dual symbols | $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4<br>$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |   |
|   |   |  | GP  | Poorly graded gravels and gravel-sand mixtures, little or no fines            |  |   |   |
|   |   | GRAVELS WITH FINES   | GH  | Silty gravels, gravel-sand-silt mixtures                                      |  | Atterberg limits plot below "A" line or plasticity index less than 4  | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols          |
|   |   |  | GC  | Clayey gravels, gravel-sand-clay mixtures                                     |  | Atterberg limits plot above "A" line and plasticity index greater than 7  |   |
|   |   | SANDS<br>More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS                                   | SW  |  | Well-graded sands and gravelly sands, little or no fines  | $C_u = \frac{D_{60}}{D_{10}}$ Greater than 6<br>$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
|   |   |  |   | SP  |  | Poorly graded sands and gravelly sands, little or no fines  |   |
|   | SANDS WITH FINES  |  | SH  | Silty sands, sand-silt mixtures   |  | Atterberg limits plot below "A" line or plasticity index less than 4  | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols          |
|   |   |  | SC  | Clayey sands, sand-clay mixtures  |  | Atterberg limits plot above "A" line and plasticity index greater than 7  |   |
|   | FINE-GRAINED SOILS<br>50% or more passes No. 200 sieve *          |  | SILTS AND CLAYS<br>Liquid limit 50% or less   | ML  |  | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands  |   |
|   |   |  |   | CL  |  | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, loam clays               |   |
|   |   | OL   |   | Organic silts and organic silty clays of low plasticity                       |  |   |   |
|   |   | SILTS AND CLAYS<br>Liquid limit greater than 50%             | MH  | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts |  |   |   |
| CH  |   |  | Inorganic clays of high plasticity, fat clays |   |  |   |   |
| OH  |   |  | Organic clays of medium to high plasticity    |   |  |   |   |
| PT  |   |  | Peat, muck and other highly organic soils     | Visual-Manual Identification, See ASTM Designation D 2488                     |  |   |   |
| Highly Organic Soils  |   |  |   |   |  |   |   |

\* Based on the material passing the 3-in. (75-mm) sieve

### UNIFIED SOIL CLASSIFICATION SYSTEM

(USCS)

TEST PIT NO. 1

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 2

GROUND SURFACE ELEVATION ~863m  
 GROUNDWATER ELEVATION \_\_\_\_\_  
 (at time of digging) \_\_\_\_\_

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol | Description   | Samples    | Comments                                     |
|---------|----------|--------|---|------------|--|
| 1       | 5        |        | DARK BROWN PEAT TO SILTY PEAT<br>- soft.  | GS1        | W.C. = 413%                                  |
| 2       |          |        | TAN CLAYEY SILT WITH TRACE<br>ORGANIC FIBRES - soft - high<br>compressibility   | GS2        | W.C. = 79.1%<br>P.L. = 51.4%<br>L.L. = 83.0% |
| 3       | 10       |        | DARK GREY SILT /CLAYEY SILT<br>WITH TRACE FINE SAND - soft<br>to firm - low plasticity.   | GS3        | W.C. = 21.6%<br>P.L. = 20.2%<br>L.L. = 26.6% |
| 4       | 15       |        | BROWN GREY SILTY SAND TO SANDY<br>SILT WITH GRAVEL AND COBBLES<br>- medium dense, till like<br><br>- grades coarser, drier and<br>denser with depth | GS4<br>GS5 | W.C. = 9.2%<br>W.C. = 10.7%                  |
| 6       | 20       |        | TD = 5.3m<br>- considerable sloughing and<br>intermittent seepage from<br>2.0 to 3.5m   |            |  |
| 7       |          |        |   |            |  |
| 8       | 25       |        |   |            |  |

QUINETTE COAL LIMITED  
 GRIZZLY TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOG OF TEST PIT  
 NO. 1

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |



TEST PIT NO. 2

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 2

GROUND SURFACE ELEVATION ~848m

GROUNDWATER ELEVATION -

(at time of digging) -

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol | Description   | Samples | Comments |
|---------|----------|--------|---|---------|----------|
|         |          |        | MOTTLED DARK BROWN SILTY SAND WITH GRAVEL AND TRACE COBBLES AND ROOTS               |         |          |
| 1       |          |        | LIGHT BROWN SILTY SAND/SANDY SILT WITH LITTLE GRAVEL AND TRACE ROOTS - medium dense | GS1     |          |
|         | -5       |        | BEDROCK   |         |          |
| 2       |          |        | TD = 1.6m<br>- no seepage or sloughing  |         |          |
| 3       | 10       |        |   |         |          |
| 4       |          |        |   |         |          |
|         | 15       |        |   |         |          |
| 5       |          |        |   |         |          |
|         | 20       |        |   |         |          |
| 6       |          |        |   |         |          |
|         | 25       |        |   |         |          |
| 7       |          |        |   |         |          |
|         |          |        |   |         |          |
| 8       |          |        |   |         |          |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO. 2

By: AFS

Job: 81-339-GT

Date: July '87

Dwg:

TEST PIT NO. 3

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 2

GROUND SURFACE ELEVATION ~848m

GROUNDWATER ELEVATION -  
(at time of digging)

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol | Description  | Samples | Comments   |
|---------|----------|--------|--|---------|------------|
| 1       |          |        | BROWN/GREY SILTY SAND WITH GRAVEL, COBBLES AND BOULDERS UP TO .3m IN DIAMETER, TRACE ROOTS |         |            |
| 2       | 5        |        | BROWN/GREY SILTY SAND/SANDY SILT WITH SOME GRAVEL AND COBBLES - medium dense to stiff      | GS1     | W.C. = 18% |
| 3       | 10       |        | BEDROCK AT 2.4m<br>TD = 2.4m<br>- slight seepage and sloughing at 1.0m                     |         |            |
| 4       |          |        |  |         |            |
| 5       | 15       |        |  |         |            |
| 6       | 20       |        |  |         |            |
| 7       |          |        |  |         |            |
| 8       | 25       |        |  |         |            |

QUINTETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO. 3

By: AFS

Date:  
July '87

Job:  
81-339-GT

Dwg:

TEST PIT NO. 4



METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION SED. POND 3

GROUND SURFACE ELEVATION ~ 775m  
 GROUNDWATER ELEVATION -  
 (at time of digging)

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol   | Description  | Samples | Comments   |
|---------|----------|--|--|---------|--|
| 1       |          |   | BROWN/GREY SILTY CLAY WITH TRACE ORGANICS AND NUMEROUS LENSES OF SAND, AND SAND AND GRAVEL<br>- low to medium plasticity<br>- stiff          | GS1     | W.C. = 26.3%<br>P.L. = 12.6%<br>L.L. = 29.6%           |
| 2       | 5        |  | BROWN/GREY SAND AND GRAVEL, WITH COBBLES AND BOULDERS TO 0.3m IN DIAMETER AND TRACE SILT<br>- medium dense<br>- granular material is rounded | GS2     | LIKELY GLACIOFLUVIAL DEPOSIT (see grain size analysis) |
| 3       | 10       |  | - grades cleaner and denser with depth   | GS3     |  |
| 4       |          |  |  |         |  |
| 5       | 15       |  |  |         |  |
| 6       | 20       |  | TD = 5.1m<br>- no seepage<br>- caved in when T.P. at 5.1m depth  |         |  |
| 7       |          |  |  |         |  |
| 8       | 25       |  |  |         |  |

QUINETTE COAL LIMITED  
 GRIZZLY TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOG OF TEST PIT  
 NO. 4

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

TEST PIT NO. 5

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 3

GROUND SURFACE ELEVATION ~ 790

GROUNDWATER ELEVATION -

(at time of digging) -

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol | Description  | Samples | Comments                  |
|---------|----------|--------|--|---------|---------------------------|
| 1       | 5        |        | DARK BROWN SANDY SILT WITH LITTLE GRAVEL. ORGANICS IN UPPER 0.4m<br>- medium dense/stiff                     | GS1     | W.C. = 28.6%              |
| 2       |          |        | DARK BROWN SAND AND GRAVEL WITH LITTLE SILT AND COBBLES.<br>- medium dense = granular material is subangular | GS2     |                           |
| 3       | 10       |        | LIGHT BROWN SILT WITH LITTLE FINE SAND AND LENSES OF SAND AND GRAVEL - medium dense                          | GS3     | W.C. = 16.7%              |
| 4       |          |        | LIGHT BROWN SILTY SAND AND GRAVEL<br>- medium dense-saturated  |         |                           |
| 5       | 15       |        | BROWN/GREY FINE TO MEDIUM SAND WITH TRACE SILT, COARSE SAND AND GRAVEL<br>- medium dense                     | GS4     | (SEE GRAIN SIZE ANALYSIS) |
| 6       | 20       |        | TD = 5.3m<br>- no seepage<br>- slight sloughing throughout   |         |                           |
| 7       |          |        |  |         |                           |
| 8       | 25       |        |  |         |                           |

QUINTETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO. 5

By: AFS

Date:  
July '87

Job:  
81-339-GT

Dwg:

TEST PIT NO. 6

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 3

**GS** - GRAB SAMPLE

GROUND SURFACE ELEVATION ~786m

**U** - UNDISTURBED SAMPLE

GROUNDWATER ELEVATION -

(at time of digging) -

| Depth-m | Depth-ft | Symbol | Description  | Samples | Comments  |
|---------|----------|--------|--|---------|---|
| 1       | 5        |        | LIGHT BROWN SAND AND GRAVEL WITH<br>COBBLES AND TRACE SILT AND<br>BOULDERS TO .25m DIAMETER<br>- medium dense<br>- granular material is rounded<br><br>- grades grey | GS1     | LIKELY GLACIOFLUVIAL DEPOSIT<br><br>(SEE GRAIN SIZE ANALYSIS) |
| 3       | 10       |        |  | GS2     |   |
| 5       |          |        | TD = 4.8m<br>- no seepage<br>- little sloughing after T.P.<br>reached 2.5 to 3.0m  |         |   |
| 6       | 20       |        |  |         |   |
| 7       |          |        |  |         |   |
| 8       | 25       |        |  |         |   |

QUINETTE COAL LIMITED  
 GRIZZLY TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS

VANCOUVER CALGARY

LOG OF TEST PIT  
 NO. 6

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

TEST PIT NO. 7

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 3

**GS** - GRAB SAMPLE

GROUND SURFACE ELEVATION ~820m

**U** - UNDISTURBED SAMPLE

GROUNDWATER ELEVATION -  
(at time of digging)

| Depth-m | Depth-ft | Symbol | Description  | Samples    | Comments   |
|---------|----------|--------|--|------------|--|
| 1       |          |        | BROWN/GREY MEDIUM SAND<br>- medium dense   | GS1        | (SEE GRAIN SIZE ANALYSIS)  |
|         | 5        |        | BROWN/GREY SAND AND GRAVEL WITH<br>TRACE COBBLES - medium dense  | GS2        |  |
| 2       |          |        | BROWN/GREY SILTY FINE SAND WITH<br>LENSES OF SANDY SILTY CLAY AND<br>TRACE GRAVEL AND COBBLES<br>- dense | GS3<br>GS4 | (SEE GRAIN SIZE ANALYSIS)<br>W.C. = 24.4% } SANDY SILTY CLAY<br>P.L. = 22.6% } MEDIUM PLASTICITY<br>L.L. = 37.9% |
| 3       | 10       |        | - grades siltier and denser<br>with depth  |            |  |
| 4       |          |        |  |            |  |
|         | 15       |        |  | GS5        | W.C. = 20.3%   |
| 5       |          |        | GREY SILTY CLAY/CLAYEY SILT,<br>TRACE FINE SAND<br>- medium plasticity<br>- very stiff                   |            | W.C. = 25.3%<br>P.L. = 20.9%<br>L.L. = 33.0%   |
| 6       | 20       |        |  | GS6        |  |
| 7       |          |        | TD = 6.2m<br>- no seepage or sloughing   |            |  |
| 8       | 25       |        |  |            |  |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO. 7

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

TEST PIT NO. 8

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION GRIZZLY DUMP 3

GS - GRAB SAMPLE

GROUND SURFACE ELEVATION ~ 786m

U - UNDISTURBED SAMPLE

GROUNDWATER ELEVATION -  
(at time of digging)

| Depth-m | Depth-ft | Symbol | Description   | Samples | Comments                  |
|---------|----------|--------|---|---------|---------------------------|
|         |          |        | BROWN FINE TO MEDIUM SAND WITH ORGANICS<br>- loose to medium dense  | GS1     |                           |
| 1       | 5        |        | BROWN/GREY GRAVEL WITH SAND AND TRACE COBBLES<br><br>- medium dense<br>- granular material is subrounded to rounded |         |                           |
| 2       |          |        |   |         |                           |
| 3       | 10       |        |   |         |                           |
| 4       |          |        |   |         |                           |
| 5       | 15       |        |   | GS2     | (SEE GRAIN SIZE ANALYSIS) |
| 6       | 20       |        | RS = 5.2m<br>- no seepage<br>- caved in when T.P. reached 5.2m depth  |         |                           |
| 7       |          |        |   |         |                           |
| 8       | 25       |        |   |         |                           |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO. 8

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

TEST PIT NO. 9

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION SED. POND 2

GROUND SURFACE ELEVATION ~780m  
 GROUNDWATER ELEVATION \_\_\_\_\_  
 (at time of digging) \_\_\_\_\_

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol | Description  | Samples        | Comments  |
|---------|----------|--------|--|----------------|---|
| 1       | 5        |        | DARK BROWN SILTY CLAY/CLAYEY SILT WITH TRACE SAND, GRAVEL AND ORGANICS (ROOTS IN UPPER 0.4m)<br>- medium plasticity<br>- stiff                 | GS1<br><br>GS2 | W.C = 26.3%<br><br>W.C. = 26.7%<br>P.L. = 17.0%<br>L.L. = 35.1% |
| 2       | 10       |        | BROWN/GREY GRAVEL WITH SAND, COBBLES, TRACE SILT AND TRACE BOULDERS UP TP .25m IN DIAMETER<br>- medium dense<br>- granular material is rounded | GS3            | (SEE GRAIN SIZE ANALYSIS)                                       |
| 5       | 15       |        | TD = 4.3m<br>- no seepage<br>- some sloughing after T.P. reached 2.5m depth  |                |   |
| 6       | 20       |        |  |                |   |
| 7       | 25       |        |  |                |   |
| 8       |          |        |  |                |   |

QUINETTE COAL LIMITED  
 GRIZZLY TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOG OF TEST PIT  
 NO.9

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |



TEST PIT NO. 10

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

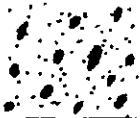

LOCATION SED. POND 2

GROUND SURFACE ELEVATION ~780m

GROUNDWATER ELEVATION -  
(at time of digging)

GS - GRAB SAMPLE

U - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol  | Description  | Samples | Comments                  |
|---------|----------|---|--|---------|---------------------------|
|         |          |  | BROWN SAND AND GRAVEL AND TRACE SILT, COBBLES AND ORGANICS<br>- medium dense   | GS1     | (SEE GRAIN SIZE ANALYSIS) |
| 1       | 5        |  | BROWN/GREY SAND AND GRAVEL WITH LITTLE COBBLES AND TRACE BOULDERS TO 0.25m IN DIAMETER<br>- medium dense<br>- granular material is rounded | GS2     |                           |
| 4       | 15       |   | TD = 3.8m<br>- no seepage<br>- some sloughing after T.P. reached 3.0m depth  |         |                           |
| 6       | 20       |   |  |         |                           |
| 7       | 25       |   |  |         |                           |
| 8       |          |   |  |         |                           |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO.10

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

TEST PIT NO. 11

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION SED. POND 1

GROUND SURFACE ELEVATION ~786m

GROUNDWATER ELEVATION (at time of digging) ~785m

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol | Description   | Samples | Comments                                     |
|---------|----------|--------|---|---------|--|
|         |          |        | BROWN SILTY SAND AND GRAVEL WITH ORGANICS - loose   |         |  |
| 1       |          |        | GREY SAND AND GRAVEL WITH COBBLES AND TRACE BOULDERS UP TO 0.20m IN DIAMETER<br>- saturated<br>- medium dense |         |  |
| 2       | 5        |        | GREY CLAYEY SILT/SILTY CLAY<br>- very soft to soft  | GS1     | W.C. = 34.9%<br>P.L. = 27.9%<br>L.L. = 40.0% |
| 3       | 10       |        |   |         |  |
| 4       | 15       |        |   |         |  |
| 5       | 20       |        |   |         |  |
| 6       | 20       |        | TD = 6.0m   | GS2     | W.C. = 38.4%<br>P.L. = 19.7%<br>L.L. = 39.0% |
| 7       |          |        |   |         |  |
| 8       | 25       |        |   |         |  |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO.11

By: AFS

Date:  
July '87

Job:  
81-339-GT

Dwg:

TEST PIT NO. 12

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

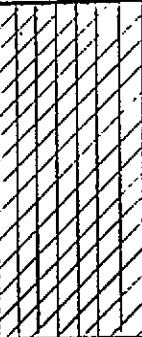

LOCATION SED. POND 1

GROUND SURFACE ELEVATION ~786m

GROUNDWATER ELEVATION  
(at time of digging) ~784m

**GS** - GRAB SAMPLE

**U** - UNDISTURBED SAMPLE

| Depth-m | Depth-ft | Symbol   | Description  | Samples | Comments                                     |
|---------|----------|--|--|---------|--|
| 1       | 5        |   | MOTTLED GREY/BROWN CLAYEY SILT/<br>SILTY CLAY WITH TRACE SAND<br>- stiff                                 | GS1     | W.C. = 29.8%<br>P.L. = 26.2%<br>L.L. = 40.0% |
| 3       | 10       |  | BROWN SAND AND GRAVEL WITH<br>COBBLES<br>- saturated<br>- medium dense<br>- granular material is rounded |         |  |
| 5       | 15       |  | TD = 4.5m<br>- continuous sloughing below<br>2.1m depth  |         |  |
| 6       | 20       |  |  |         |  |
| 7       |          |  |  |         |  |
| 8       | 25       |  |  |         |  |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO. 12

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

TEST PIT NO. 13

METHOD OF DIGGING TEST PIT CAT 235 BACKHOE

LOCATION SED. POND 1

GS - GRAB SAMPLE

GROUND SURFACE ELEVATION ~790m

U - UNDISTURBED SAMPLE

GROUNDWATER ELEVATION  
(at time of digging) \_\_\_\_\_

| Depth-m | Depth-ft | Symbol | Description   | Samples | Comments |
|---------|----------|--------|---|---------|----------|
|         |          |        | RUSTY BROWN SAND AND GRAVEL WITH COBBLES, LITTLE SILT AND TRACE ORGANICS - medium dense     |         |          |
| 1       | 5        |        | GREY SAND AND GRAVEL WITH COBBLES AND TRACE BOULDERS UP TO 0.20m IN DIAMETER - medium dense |         |          |
| 2       |          |        |   |         |          |
| 3       | 10       |        |   |         |          |
| 4       | 15       |        | TD = 3.5m<br>- some sloughing after test pit reached 2.5m depth<br>- no seepage             |         |          |
| 5       |          |        |   |         |          |
| 6       | 20       |        |   |         |          |
| 7       |          |        |   |         |          |
| 8       | 25       |        |   |         |          |

QUINETTE COAL LIMITED  
GRIZZLY TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES

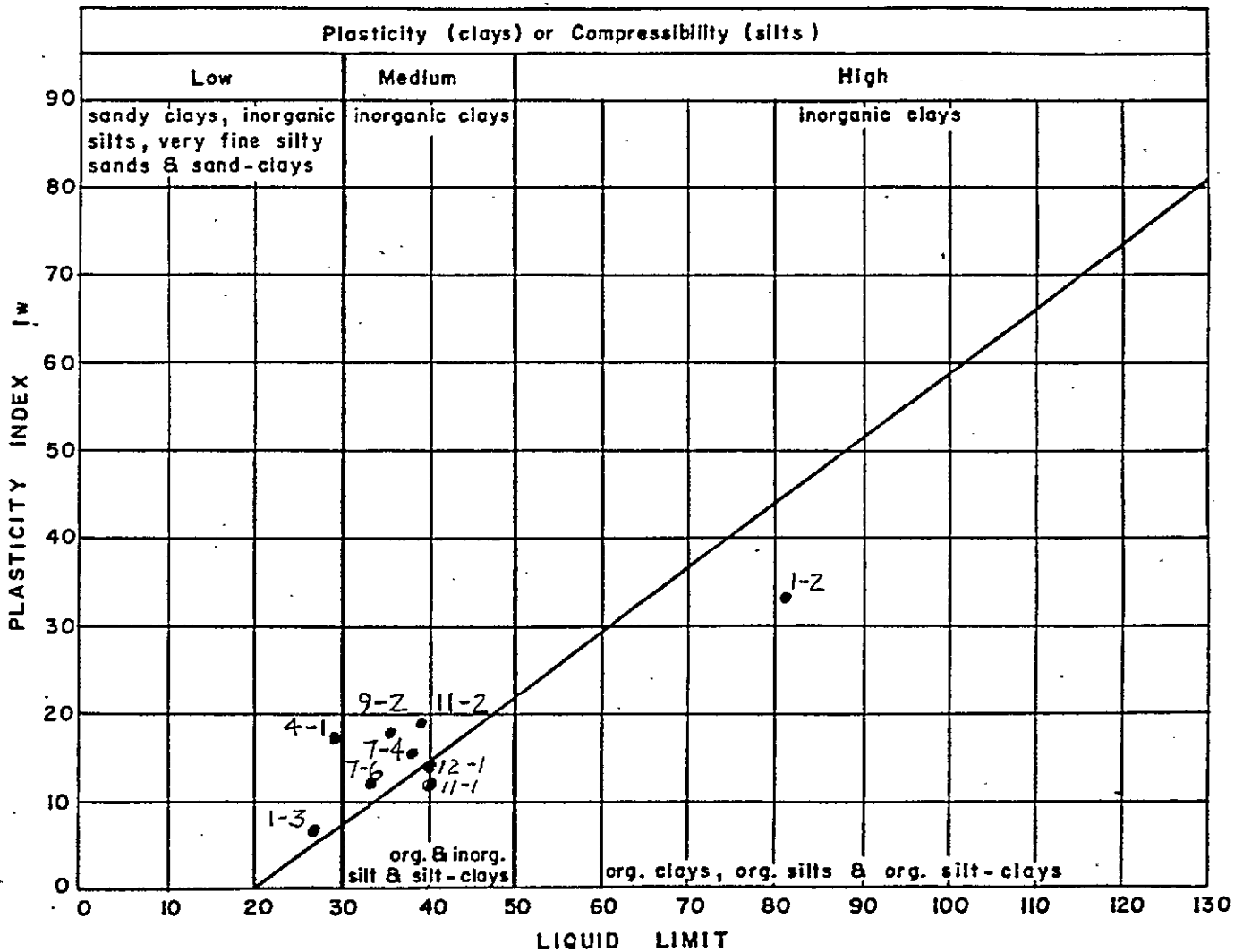


PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOG OF TEST PIT  
NO.13

|                |                |
|----------------|----------------|
| By: AFS        | Date: July '87 |
| Job: 81-339-GT | Dwg:           |

| Hole No. | Sample No. | Depth (m) | W.C. % | Lw % | Pw % | Iw % | Description & Remarks |
|----------|------------|-----------|--------|------|------|------|-----------------------|
| 1        | 2          | 2.3       | 79.1   | 83.0 | 51.4 | 31.1 |                       |
| 1        | 3          |           | 21.6   | 26.6 | 20.2 | 6.4  |                       |
| 4        | 1          |           | 26.3   | 29.6 | 12.6 | 17.0 |                       |
| 7        | 4          |           | 24.4   | 37.9 | 22.6 | 15.4 |                       |
| 7        | 6          |           | 25.3   | 33.0 | 20.9 | 12.1 |                       |
| 9        | 2          |           | 26.7   | 35.1 | 17.0 | 18.1 |                       |
| 11       | 1          |           | 34.9   | 40.0 | 27.9 | 12.1 |                       |
| 11       | 2          |           | 38.4   | 39.0 | 19.7 | 19.3 |                       |
| 12       | 1          |           | 29.8   | 40.0 | 26.2 | 13.8 |                       |



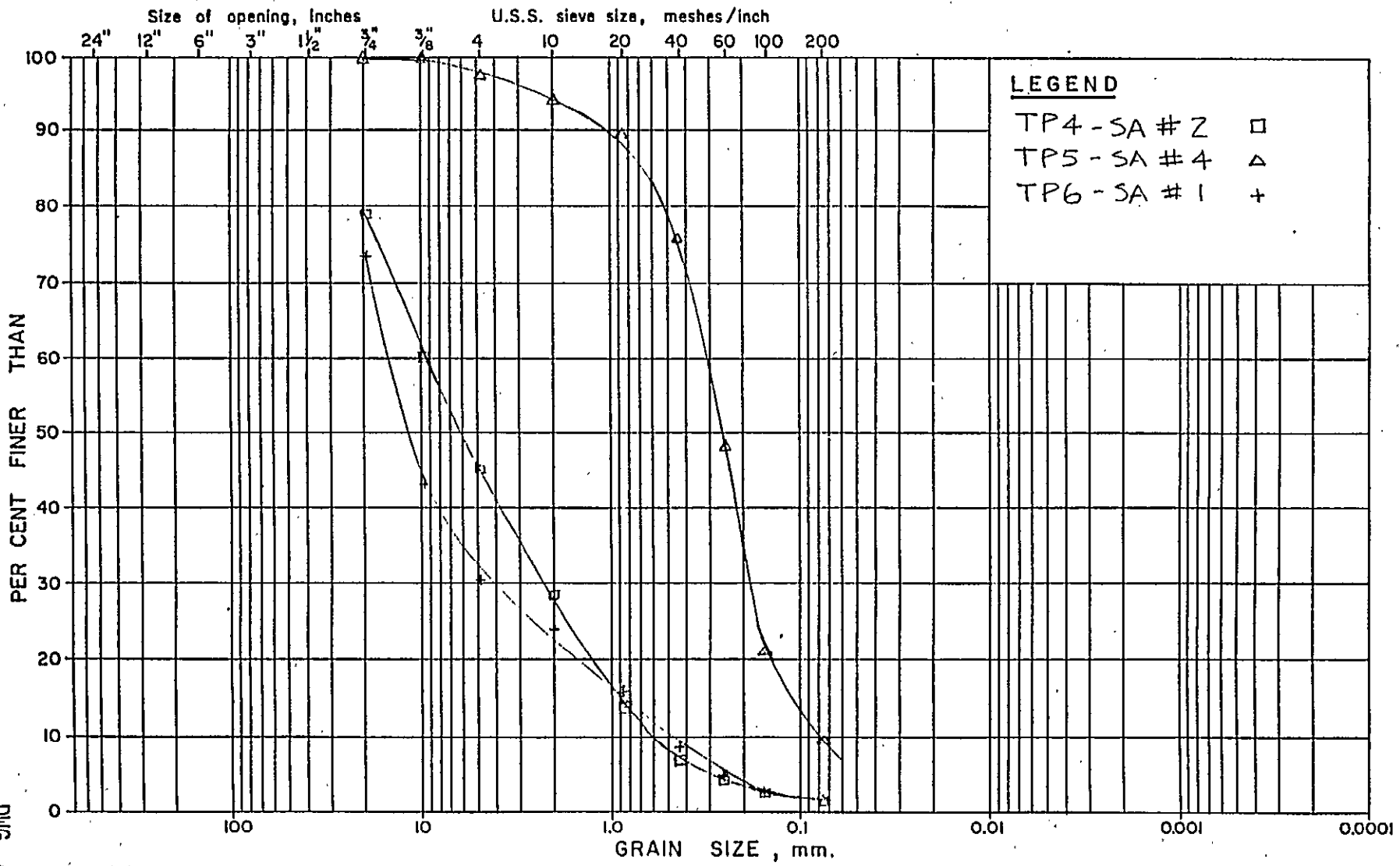
PLASTICITY CHART FOR SOIL CLASSIFICATION

PITEAU ASSOCIATES  
 GEOTECHNICAL AND  
 HYDROGEOLOGICAL CONSULTANTS

PLASTICITY CHART

|            |              |
|------------|--------------|
| by HWN     | date AUG '87 |
| job 81-339 | dwg          |

M.I.T. GRAIN SIZE SCALE



**LEGEND**  
 TP4 - SA # 2    □  
 TP5 - SA # 4    △  
 TP6 - SA # 1    +

PITEAU & ASSOCIATES

DWG. 404-ST16

|                 |                |             |        |      |           |        |      |              |           |
|-----------------|----------------|-------------|--------|------|-----------|--------|------|--------------|-----------|
| BOULDER<br>SIZE | COBBLE<br>SIZE | coarse      | medium | fine | coarse    | medium | fine | fine grained |           |
|                 |                | GRAVEL SIZE |        |      | SAND SIZE |        |      | SILT SIZE    | CLAY SIZE |

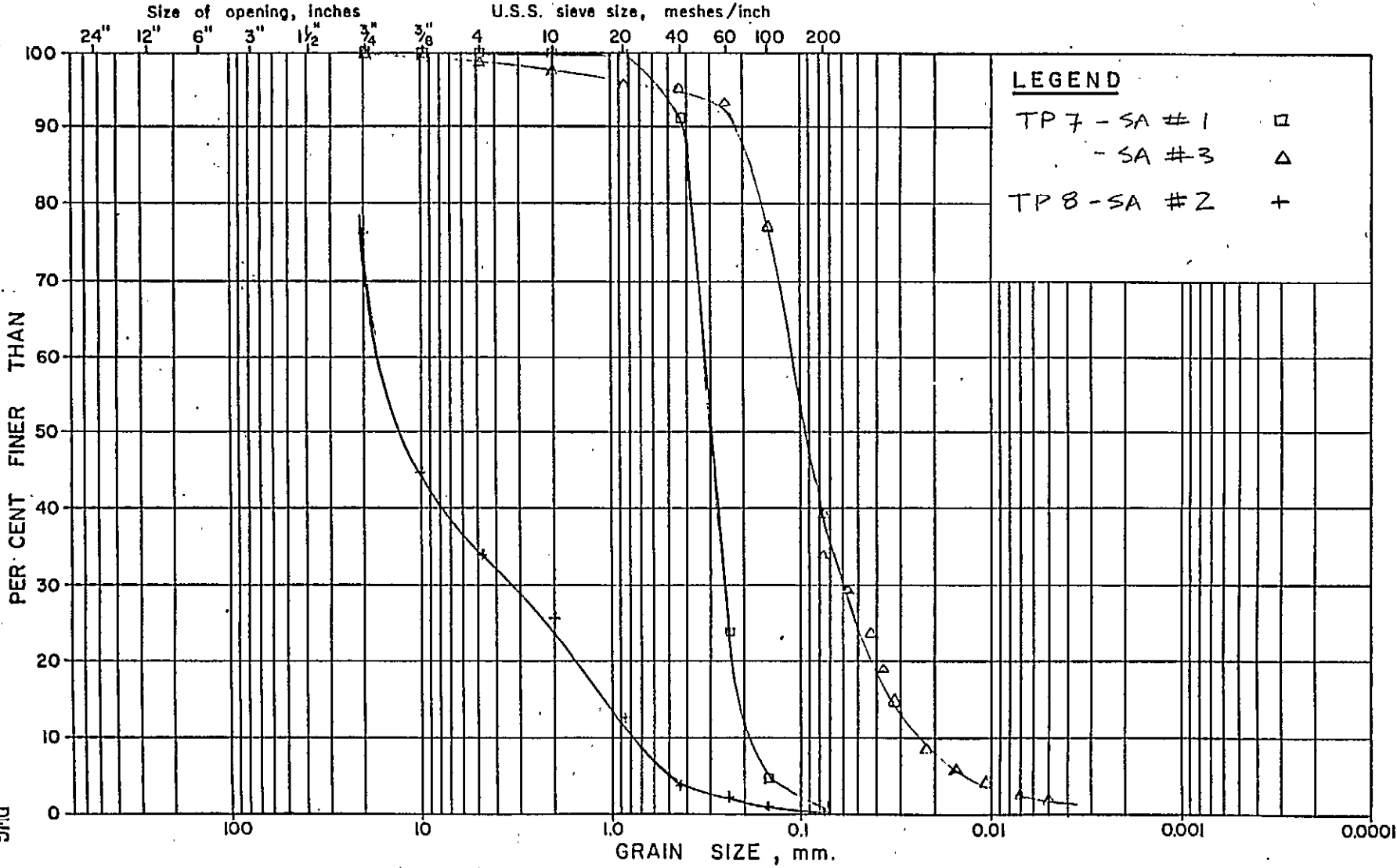
GRAIN SIZE DISTRIBUTION

Figure

M.I.T. GRAIN SIZE SCALE

PITEAU & ASSOCIATES

DMG. 404-ST16



**LEGEND**  
 TP 7 - SA # 1     □  
                   - SA # 3     △  
 TP 8 - SA # 2     +

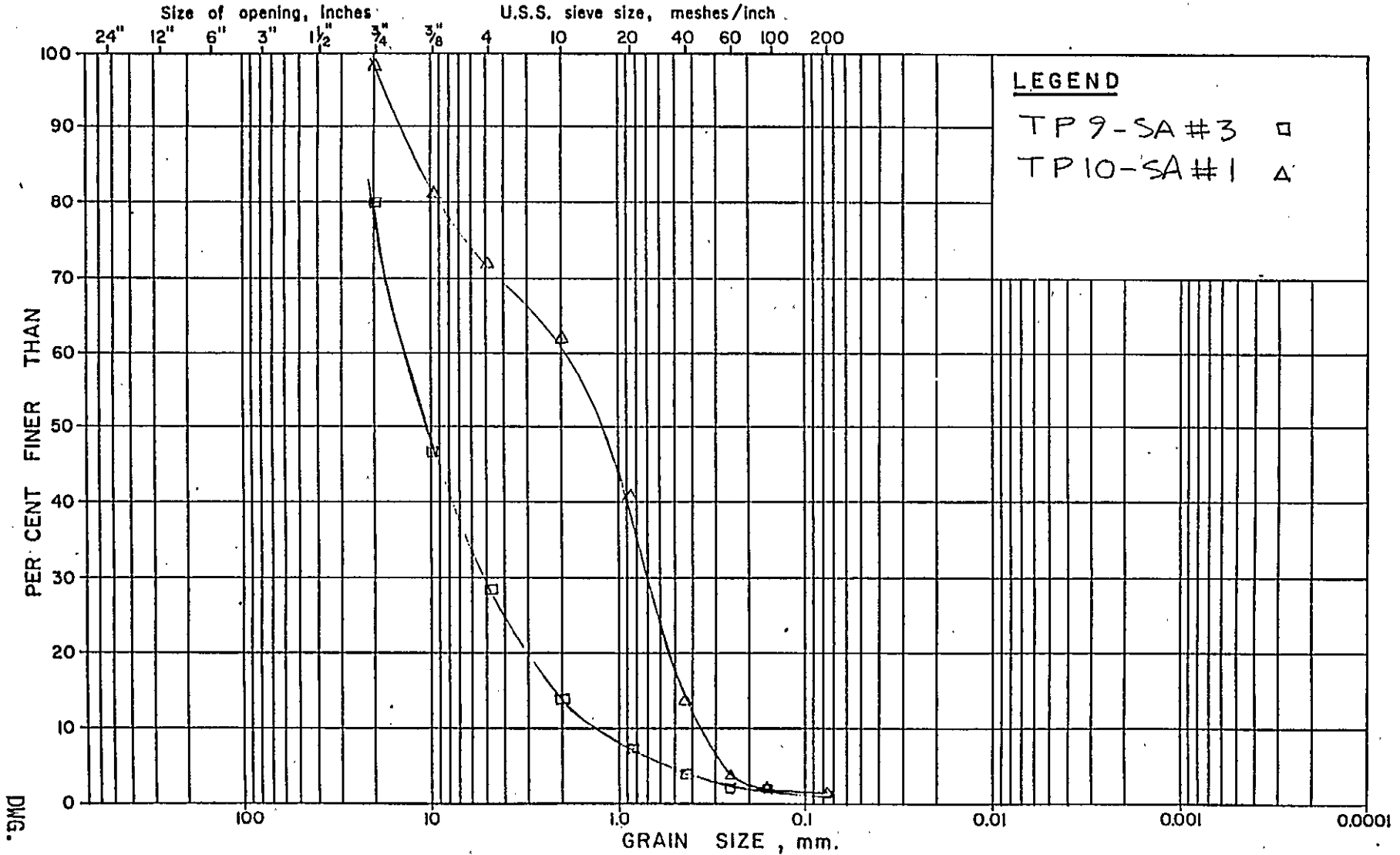
GRAIN SIZE DISTRIBUTION

Figure

| BOULDER<br>SIZE | COBBLE<br>SIZE | GRAVEL SIZE |        |      | SAND SIZE |        |      | SILT SIZE    |  | CLAY SIZE |  |
|-----------------|----------------|-------------|--------|------|-----------|--------|------|--------------|--|-----------|--|
|                 |                | coarse      | medium | fine | coarse    | medium | fine | fine grained |  |           |  |

M.I.T. GRAIN SIZE SCALE

PITEAU & ASSOCIATES



DWG. 404-ST16

|              |             |             |        |      |           |        |      |              |           |
|--------------|-------------|-------------|--------|------|-----------|--------|------|--------------|-----------|
| BOULDER SIZE | COBBLE SIZE | coarse      | medium | fine | coarse    | medium | fine | fine grained |           |
|              |             | GRAVEL SIZE |        |      | SAND SIZE |        |      | SILT SIZE    | CLAY SIZE |

GRAIN SIZE DISTRIBUTION

Figure



APPENDIX D

HYDROGEOLOGICAL LOGS

Job No. 81339-CT

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHR87004  
Sheet 1 of 2

## PROJECT QUINTETTE - GRIZZLY PIT

Purpose of hole SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Reference elevation 931.67 m - asl

Coordinates:

Type of drilling AIR ROTARY

Elevation type:  Surveyed  
 Allimeter  
 From map

E 624117.60 Angle from horizontal 65°  
N 6096486.65 Bearing          °Azimuth

Rig           
Drilling fluid AIR

Casing stick up 0.0 m - above ground

| (1) (2)*<br>Lithology                                | (2) (3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling           |                            |                                  | Comments      |  |
|--|-----------------------------------|-----------------|------------------------|----------------------|-----------|--------------------------|----------------------------|----------------------------------|---------------|--|
|  |                                   | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m)   | (8) Hydraulic Conductivity |                                  |               |  |
|  |                                   |                 |                        |                      |           |                          | Test Type                  | Value (m/s)                      | (2) Depth (m) |  |
| Ground level   | P1 P2 S3<br>137 mm                |                 |                        |                      |           |                          |                            |                                  |               | STICK UP:<br>P1 = 1.05 m<br>P2 = 0.84 m<br>S3 = 0.76 m |
| 12.8<br>COAL - D SEAM (918.9)<br>(?) 16.0<br>(915.7) |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |
| 20   |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |
| 36.8<br>COAL - F SEAM (894.9)<br>40                  |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |
| 42.8<br>(888.9)                                      |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |
| 50   | S3<br>52.8<br>(878.87)            |                 |                        |                      |           | 8.78<br>924.40<br>9/7/87 |                            |                                  |               | 305 m SLOTS  |
| 60   | P2<br>64.34<br>867.53             |                 |                        |                      |           | 8.30<br>924.91<br>9/7/87 | f                          | 1.5 x 10 <sup>-7</sup><br>9/7/87 |               | 3.36 m SLOTS<br>7.3 m POCKET                           |
| 70   |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |
| 72.8<br>(853.7)                                      |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |
| 80 COAL - G SEAM                                     |                                   |                 |                        |                      |           |                          |                            |                                  |               |  |

Contractor          Logged by PMG  
Date started          Checked by           
Date finished          Date JULY 31, 1987

SCALE: Vertical 1:          approximate  
Horizontal - N.T.S.

\* Bracketed numbers refer to notes following the logs



**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

# HYDROGEOLOGIC LOG (Continued)

DRILLHOLE No QHR87004  
Sheet 2 of 2

PROJECT QUINTETTE - GRIZZLY PIT

Reference elevation 931.67 m-asl

Job No. 81329-6T

| (1) (2)*<br>Lithology                       | (2) (3)<br>Completed Construction                          | During Drilling |                         |                      |           | After Drilling            |                            |                                  | Comments |                              |
|---|--|-----------------|-------------------------|----------------------|-----------|---------------------------|----------------------------|----------------------------------|----------|------------------------------|
|   |  | (2) Depth (m)   | (2) (4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2) (7) Water Level (m)   | (8) Hydraulic Conductivity |                                  |          |                              |
|   |  |                 |                         |                      |           | Test Type                 | Value (m/s)                | (2) Depth (m)                    |          |                              |
| COAL - G SEAM<br>CONTD.<br>83.0<br>(848.67) | <p style="text-align: center;">PI<br/>100.4<br/>831.23</p> |                 |                         |                      |           |                           |                            |                                  |          |                              |
| 90  |  |                 |                         |                      |           |                           |                            |                                  |          |                              |
| 102.0<br>COAL - J, K1 SEAM<br>(829.67)      |  |                 |                         |                      |           | 42.01<br>894.55<br>9/7/87 | f                          | 1.5 x 10 <sup>-7</sup><br>9/7/87 |          | 3.36 m SLOTS<br>8.3 m POCKET |
| 109.6<br>(822.07)                           |  |                 |                         |                      |           |                           |                            |                                  |          |                              |
| 110<br>112.8<br>(818.91)                    |  |                 |                         |                      |           |                           |                            |                                  |          |                              |
| COAL - K2 SEAM<br>115.0<br>(816.47)         |  |                 |                         |                      |           |                           |                            |                                  |          |                              |
| 120<br>BOTTOM OF HOLE 123.0<br>(808.67)     |  |                 |                         |                      |           |                           |                            |                                  |          |                              |
| 130   |  |                 |                         |                      |           |                           |                            |                                  |          |                              |
| 140   |  |                 |                         |                      |           |                           |                            |                                  |          |                              |

Logged by PMG Checked by

SCALE: Vertical 1: approximate  
Horizontal - N.t.

**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

\*Bracketed numbers refer to notes following the logs

Job No. 81339-GT

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHR87007

Sheet 1 of 2

PROJECT QUINETTE - GRIZZLY PIT

Purpose of hole SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Reference elevation 1117.65 m - asl

Elevation type:  Surveyed  
 Allimeter  
 From map

Coordinates:

E 623136.87 Angle from horizontal 90°  
 N 6096526.69 Bearing ° Azimuth

Type of drilling AIR ROTARY

Rig

Drilling fluid AIR

Casing stick up 0.25 m - above ground

| (1)(2)*<br>Lithology | (2)(3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling         |                            |             | Comments   |
|----------------------|----------------------------------|-----------------|------------------------|----------------------|-----------|------------------------|----------------------------|-------------|--|
|                      |                                  | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m) | (8) Hydraulic Conductivity |             |  |
|                      |                                  |                 |                        |                      |           |                        | Test Type                  | Value (m/s) |  |
| Ground level         |                                  |                 |                        |                      |           |                        |                            |             | STICK UP:<br>P1 = 0.64 m<br>P2 = 0.59 m<br>S3 = 0.12 m |
| 10                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 20                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 30                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 40                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 50                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 60                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 70                   |                                  |                 |                        |                      |           |                        |                            |             |  |
| 80                   |                                  |                 |                        |                      |           |                        |                            |             |  |

Contractor.....  
 Date started.....  
 Date finished.....

Logged by FMG  
 Checked by.....  
 Date AUG 4, 1987

SCALE: Vertical 1:..... approximate  
 Horizontal - N1s

\*Bracketed numbers refer to notes following the logs



**PITEAU & ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

# HYDROGEOLOGIC LOG (Continued)

DRILLHOLE No Q.HR87007

Sheet 2 of 2

PROJECT QUINTETTE - GRIZZLY PIT

Reference elevation 1117.65 m-asl

Job No. 81339-GT

| (1)(2)*<br>Lithology               | (2)(3)<br>Completed Construction | During Drilling     |                              |                            |              | After Drilling               |                            |                                  | Comments                      |
|------------------------------------|----------------------------------|---------------------|------------------------------|----------------------------|--------------|------------------------------|----------------------------|----------------------------------|-------------------------------|
|                                    |                                  | (2)<br>Depth<br>(m) | (2)(4)<br>Water Level<br>(m) | (5)<br>Water Flow<br>(Lps) | (6)<br>Other | (2)(7)<br>Water Level<br>(m) | (8) Hydraulic Conductivity |                                  |                               |
|                                    |                                  |                     |                              |                            |              |                              | Test Type                  | Value (m/s)                      |                               |
| 81.0<br>COAL - F SEAM (1036.7)     |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 86.4<br>(1031.3)                   |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 90                                 |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 100                                |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 110                                | S3<br>110.0<br>(1007.65)         |                     |                              |                            |              | 59.30<br>1059.19<br>9/7/87   |                            |                                  | 305 m SLOTS                   |
| 120                                |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 130                                | P2<br>132.6<br>984.05            |                     |                              |                            |              | 59.30<br>1059.19<br>9/7/87   |                            |                                  | 334 m SLOTS<br>11.0 m POCKET  |
| 134.1<br>COAL - G SEAM (983.6)     |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 137.6<br>(980.1)                   |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 140                                |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 150                                |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 153.9<br>COAL - J, K1 SEAM (963.8) |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 160                                |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 162.7<br>(955.0)                   |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 164.0 (953.7)<br>COAL - K2 SEAM    |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 165.2 (952.5)                      |                                  |                     |                              |                            |              |                              |                            |                                  |                               |
| 170 HOLE BOTTOM 171.2<br>(948.5)   | P1<br>169.75<br>947.90           |                     |                              |                            |              | 57.79<br>1060.75<br>9/7/87   | f                          | 2.0 x 10 <sup>-8</sup><br>7/7/87 | 1.83 m SLOTS<br>3.91 m POCKET |

Logged by PMG Checked by

SCALE: Vertical 1: approximate  
Horizontal - N.A.

\* Bracketed numbers refer to notes following the logs



PITEAU & ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHR87013

Sheet 1 of 2

## PROJECT QUINETTE - GRIZZLY PIT

Purpose of hole: SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Coordinates:

E 623477.31 Angle from horizontal 65°  
 N 6096728.48 m Bearing \_\_\_\_\_ °Azimuth

Type of drilling: AIR ROTARY

Rig \_\_\_\_\_

Drilling fluid: AIR

Reference elevation: 1041.15 m - asl

Elevation type: Surveyed   
 Allimeter   
 From map

Casing stick up: 0.11 m - above ground

Job No. 81339-GT

| (1)(2)*<br>Lithology                  | (2) (3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling         |                            |             | Comments   |
|---------------------------------------|-----------------------------------|-----------------|------------------------|----------------------|-----------|------------------------|----------------------------|-------------|--|
|                                       |                                   | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m) | (8) Hydraulic Conductivity |             |  |
|                                       |                                   |                 |                        |                      |           |                        | Test Type                  | Value (m/s) |  |
| Ground level                          | P1 P2 S3<br>137 mm                |                 |                        |                      |           |                        |                            |             | STICK UP:<br>P1 = 0.72 m<br>P2 = 0.54 m<br>S3 = 0.47 m |
| COAL - D SEAM (7)<br>33.4<br>(1007.8) |                                   |                 |                        |                      |           |                        |                            |             |  |
| COAL - F SEAM<br>55.8<br>(985.4)      |                                   |                 |                        |                      |           |                        |                            |             |  |
| 61.2<br>(980.0)                       |                                   |                 |                        |                      |           |                        |                            |             |  |

Contractor \_\_\_\_\_ Logged by PMG  
 Date started \_\_\_\_\_ Checked by \_\_\_\_\_  
 Date finished \_\_\_\_\_ Date JULY 31, 1987

SCALE: Vertical 1: \_\_\_\_\_ approximate  
 Horizontal N.T.

\*Bracketed numbers refer to notes following the logs



# HYDROGEOLOGIC LOG (Continued)

DRILLHOLE No QHR87013  
Sheet 2 of 2

PROJECT QUINTETTE - GRIZZLY PIT

Reference elevation 1041.15 m-asl

Job No. 81339-5T

| (1)(2)*<br>Lithology               | (2) (3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling              |  |                                 | Comments                                       |
|------------------------------------|-----------------------------------|-----------------|------------------------|----------------------|-----------|-----------------------------|--|---------------------------------|--|
|                                    |                                   | (2) Depth (m)   | (2)(4) Water Level (m) | (6) Water Flow (Lps) | (8) Other | (2)(7) Water Level (m)      | (8) Hydraulic Conductivity<br>Test Type    Value (m/s) |                                 |  |
|                                    |                                   |                 |                        |                      |           |                             |  |                                 |  |
|                                    | S3<br>100.7<br>(940.45)           |                 |                        |                      |           |                             |  |                                 | 3-5 USGPM FLOW<br>3.05 m SLOTS                 |
| 103.0<br>COAL - G SEAM (938.2)     |                                   |                 |                        |                      |           |                             |  |                                 |  |
| 107.4<br>(933.0)                   |                                   |                 |                        |                      |           |                             |  |                                 |  |
|                                    | P2<br>118.02<br>(923.13)          |                 |                        |                      |           | +2.53<br>1044.24<br>21/7/87 | P  | 6 x 10 <sup>-6</sup><br>21/7/87 | 4.0 USGPM FLOW<br>2.75 m SLOTS<br>7.9 m POCKET |
| 123.4<br>COAL - J, K1 SEAM (917.8) |                                   |                 |                        |                      |           |                             |  |                                 |  |
| 131.2<br>(910.0)                   |                                   |                 |                        |                      |           |                             |  |                                 |  |
| 133.8<br>COAL - K2 SEAM (907.4)    |                                   |                 |                        |                      |           |                             |  |                                 |  |
| 135.7<br>(905.5)                   |                                   |                 |                        |                      |           |                             |  |                                 |  |
|                                    | P1<br>139.63<br>(901.52)          |                 |                        |                      |           | 4.88<br>1037.49<br>7/7/87   | F  | 8 x 10 <sup>-9</sup><br>9/7/87  | 3.26 m SLOTS<br>7.8 m POCKET                   |
| 144.0<br>BOTTOM OF HOLE (897.2)    |                                   |                 |                        |                      |           |                             |  |                                 |  |

Logged by PMG      Checked by \_\_\_\_\_  
\*Bracketed numbers refer to notes following the logs

SCALE: Vertical 1: \_\_\_\_\_ approximate  
Horizontal - N.E.



**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER      CALGARY

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHR87017

Sheet 1 of 2

## PROJECT QUINTETTE - GRIZZLY PIT

Purpose of hole SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Reference elevation 1014.93 m - asl

Coordinates:

Elevation type:  Surveyed  
 Altimeter  
 From map

E 673891.66 Angle from horizontal 90°  
 N 6075936.65 Bearing                      °Azimuth

Type of drilling AIR ROTARY  
 Rig                       
 Drilling fluid AIR

Casing stick up 0.0 m-above ground

Job No. 81339GT

| (1)(2)*<br>Lithology | (2)(3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling         |                            |             | Comments      |  |
|----------------------|----------------------------------|-----------------|------------------------|----------------------|-----------|------------------------|----------------------------|-------------|---------------|--|
|                      |                                  | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m) | (8) Hydraulic Conductivity |             |               |  |
|                      |                                  |                 |                        |                      |           |                        | Test Type                  | Value (m/s) | (2) Depth (m) |  |
| Ground level         | PI P2 S3<br>137 mm               |                 |                        |                      |           |                        |                            |             |               | STICK UP:<br>P1 = 1.13 m<br>P2 = 0.86 m<br>S3 = 0.69 m |
| 43.2<br>(971.7)      |                                  |                 |                        |                      |           |                        |                            |             |               |  |
| COAL - D SEAM (?)    |                                  |                 |                        |                      |           |                        |                            |             |               |  |
| 50.4<br>(964.5)      |                                  |                 |                        |                      |           |                        |                            |             |               |  |
| 72.8<br>(942.1)      |                                  |                 |                        |                      |           |                        |                            |             |               |  |
| COAL - F SEAM        |                                  |                 |                        |                      |           |                        |                            |             |               |  |
| 79.2<br>(935.7)      |                                  |                 |                        |                      |           |                        |                            |             |               |  |

Contractor                      Logged by PMG  
 Date started                      Checked by                       
 Date finished                      Date AUG 4, 1987

SCALE: Vertical 1:                      approximate  
 Horizontal - N.L.  
 \*Bracketed numbers refer to notes following the logs

 **PITEAU & ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY



# HYDROGEOLOGIC LOG (Continued)

DRILLHOLE No QHR87017

Sheet 2 of 2

PROJECT QUINTETTE - GRIZZLY PIT

Reference elevation 1014.93 m-asl

Job No. 91339-GT

| (1)(2)*<br>Lithology               | (2) (3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling               |  |               | Comments  |
|------------------------------------|-----------------------------------|-----------------|------------------------|----------------------|-----------|------------------------------|--|---------------|---|
|                                    |                                   | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m)       | (8) Hydraulic Conductivity             |               |   |
|                                    |                                   |                 |                        |                      |           | Test Type                    | Value (m/s)                            | (2) Depth (m) |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
| 115.6<br>COAL - G SEAM (899.3)     |                                   |                 |                        |                      |           |                              |  |               |   |
| 120<br>120.4 (894.5)               |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    | S3<br>127.2 (887.73)              |                 |                        |                      |           |                              |  |               | 4-7 USGPM FLOW<br>(0.25 - 0.44 l/s)<br>3.05 m SLOTS           |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
| 136.8<br>COAL - J, K1 SEAM (878.1) | P2<br>135.15 (879.78)             |                 |                        |                      |           | 4.48<br>(1016.23)<br>21/7/87 | P<br>5.5 x 10 <sup>-6</sup><br>21/7/87 |               | ~53 USGPM FLOW<br>(1.02 l/s)<br>2.05 m SLOTS<br>4.70 m POCKET |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
| 149.4<br>COAL - K2 SEAM (863.5)    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
| 165.2<br>BOTTOM OF HOLE (849.7)    | P1<br>161.35 (853.58)             |                 |                        |                      |           | 19.01<br>(937.05)<br>9/7/87  | F<br>5.54 x 10 <sup>-5</sup><br>9/7/87 |               | 3.2 m SLOTS<br>7.70 m POCKET                                  |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |
|                                    |                                   |                 |                        |                      |           |                              |  |               |   |

Logged by PMG Checked by \_\_\_\_\_

SCALE: Vertical 1: \_\_\_\_\_ approximate  
Horizontal - N.ta.

**P** PITEAU & ASSOCIATES  
GEO-TECHNICAL CONSULTANTS  
VANCOUVER CALGARY

\* Bracketed numbers refer to notes following the logs

Job No. 81339 - GT

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHR87023

Sheet 1 of 2

## PROJECT QUINTETTE - TRANSFER PIT

Purpose of hole: SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Reference elevation: 1601.62 m - asl

Coordinates:

Type of drilling: AIR ROTARY

Elevation type:  Surveyed  
 Allimeter  
 From map

E. 62.0432.17 Angle from horizontal: -90°

Rig: \_\_\_\_\_

N. 60.25783.11 Bearing: \_\_\_\_\_ °Azimuth

Drilling fluid: AIR

Casing stick up: 0.10 m - above ground

| (1)(2)*<br>Lithology                            | (2)(3)<br>Completed Construction | During Drilling     |                              |                            |              | After Drilling               |                            |             | Comments   |
|---|----------------------------------|---------------------|------------------------------|----------------------------|--------------|------------------------------|----------------------------|-------------|--|
|   |                                  | (2)<br>Depth<br>(m) | (2)(4)<br>Water Level<br>(m) | (5)<br>Water Flow<br>(Lps) | (6)<br>Other | (2)(7)<br>Water Level<br>(m) | (8) Hydraulic Conductivity |             |  |
|   |                                  |                     |                              |                            |              |                              | Test Type                  | Value (m/s) |  |
| Ground level                                    | P1 P2 S3<br>157mm                |                     |                              |                            |              |                              |                            |             | STICK-UP:<br>P1 = 0.60 m<br>P2 = 0.78 m<br>S3 = 0.78 m |
| 54.0  |                                  |                     |                              |                            |              |                              |                            |             |  |
| COAL - D SEAM (?) (1747.62)<br>56.4<br>(1545.2) |                                  |                     |                              |                            |              |                              |                            |             |  |
| 60  |                                  |                     |                              |                            |              |                              |                            |             |  |
| 72.4  |                                  |                     |                              |                            |              |                              |                            |             |  |
| COAL - E1 SEAM (?) (1529.2)<br>(15256) 76.0     |                                  |                     |                              |                            |              |                              |                            |             |  |
| (15240) 77.6                                    |                                  |                     |                              |                            |              |                              |                            |             |  |
| COAL - E2 SEAM (?)<br>80.2<br>(1521.4)          |                                  |                     |                              |                            |              |                              |                            |             |  |
| 80  |                                  |                     |                              |                            |              |                              |                            |             |  |
| 90  |                                  |                     |                              |                            |              |                              |                            |             |  |

Contractor: \_\_\_\_\_  
 Date started: \_\_\_\_\_  
 Date finished: \_\_\_\_\_

Logged by: PMG  
 Checked by: \_\_\_\_\_  
 Date: AUG 5/87

SCALE: Vertical 1: \_\_\_\_\_ approximate  
 Horizontal - N.T.S.

\*Bracketed numbers refer to notes following the logs



**PITEAU & ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

# HYDROGEOLOGIC LOG (Continued)

DRILLHOLE No QHR87023

Sheet 2 of 2

PROJECT QUINTETTE - TRANSFER PIT

Reference elevation 1501.62 m-asl

Job No. 81339-CT

| (1)(2)*<br>Lithology                              | (2) (3)<br>Completed Construction   | During Drilling |                        |                      |                             | After Drilling              |                                 |                                 | Comments                    |
|---|---|-----------------|------------------------|----------------------|-----------------------------|-----------------------------|---------------------------------|---------------------------------|-----------------------------|
|   |   | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other                   | (2)(7) Water Level (m)      | (8) Hydraulic Conductivity      |                                 |                             |
|   |   |                 |                        |                      |                             | Test Type                   | Value (m/s)                     | Depth (m)                       |                             |
| (1504.4) 97.2<br>COAL - F SEAM                    | <p>S3<br/>104.8<br/>(1498.82)</p> <p>P2<br/>130.5<br/>(1471.12)</p> <p>P1<br/>169.5<br/>(1432.12)</p> |                 |                        |                      |                             |                             |                                 |                                 |                             |
| 100<br>103.0<br>(1498.6)                          |   |                 |                        |                      |                             | 22.56<br>1577.66<br>19/7/87 |                                 |                                 | 3.05 m SLOTS                |
| 110<br>120  |   |                 |                        |                      |                             |                             |                                 |                                 |                             |
| (1473.2) 128.4<br>COAL - G SEAM                   |   |                 |                        |                      |                             | 81.61<br>1520.71<br>19/7/87 | +                               | 2.5x10 <sup>-9</sup><br>19/7/87 | 2.70 m SLOTS<br>58 m POCKET |
| 130<br>132.0<br>(1468.8)                          |   |                 |                        |                      |                             |                             |                                 |                                 |                             |
| 140<br>147.6<br>(1454.0)<br>COAL - J, K1, K2 SEAM |   |                 |                        |                      |                             |                             |                                 |                                 |                             |
| 150<br>158.2<br>(1443.4)                          |   |                 |                        |                      |                             |                             |                                 |                                 |                             |
| 160<br>170<br>HOLE BOTTOM 173.0<br>(1428.6)       |   |                 |                        |                      | 81.68<br>1525.54<br>19/7/87 | +                           | 2.5x10 <sup>-9</sup><br>19/7/87 | 3.0 m SLOTS<br>7.0 m POCKET     |                             |
| 180   |   |                 |                        |                      |                             |                             |                                 |                                 |                             |

Logged by PMG Checked by \_\_\_\_\_

\* Bracketed numbers refer to notes following the logs

SCALE: Vertical 1: \_\_\_\_\_ approximate  
Horizontal - N.t.s.



**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY



# HYDROGEOLOGIC LOG (Continued)


DRILLHOLE No QHR87024

Sheet 2 of 2

PROJECT QUINETTE - TRANSFER PIT

Reference elevation 1564.25 m-asl

Job No. 81539-GT

| (1)(2)*<br>Lithology                   | (2)(3)<br>Completed Construction   | During Drilling     |                              |                            |              | After Drilling               |                            |                                 | Comments                    |
|--|--|---------------------|------------------------------|----------------------------|--------------|------------------------------|----------------------------|---------------------------------|-----------------------------|
|  |  | (2)<br>Depth<br>(m) | (2)(4)<br>Water Level<br>(m) | (5)<br>Water Flow<br>(Lps) | (6)<br>Other | (2)(7)<br>Water Level<br>(m) | (8) Hydraulic Conductivity |                                 |                             |
|  |  |                     |                              |                            |              |                              | Test Type                  | Value (m/s)                     |                             |
| 87.0<br>COAL - G SEAM (1477.25)<br>90  |  |                     |                              |                            |              |                              |                            |                                 |                             |
| 91.6<br>(1472.65)                      |  |                     |                              |                            |              | 40.95<br>1524.10<br>19/1/87  | f                          | 1 x 10 <sup>-9</sup><br>19/7/87 | 3.4 m SLOTS<br>8.6 m POCKET |
| 106.6<br>COAL - J1, K1, K2 SEAM<br>110 |  |                     |                              |                            |              |                              |                            |                                 |                             |
| 116.0<br>(1448.25)                     |  |                     |                              |                            |              |                              |                            |                                 |                             |
| 131.0<br>HOLE BOTTOM (1433.25)         |  |                     |                              |                            |              |                              |                            |                                 |                             |

Logged by PMG Checked by \_\_\_\_\_

\* Bracketed numbers refer to notes following the logs

SCALE: Vertical 1: \_\_\_\_\_ approximate  
Horizontal - N.t.s.



**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHR87033

Sheet 1 of 2

## PROJECT QUINTETTE - TRANSFER PIT

Purpose of hole SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Reference elevation 437.70 m - asl

Coordinates:

E 621273.37 Angle from horizontal 90°

Type of drilling AIR ROTARY

N 6095148.03 Bearing — Azimuth

Rig

Drilling fluid AIR

Elevation type:  Surveyed  
 Allimeter  
 From map

Casing stick up \_\_\_\_\_ m - above ground

Job No. 81339-GT

| (1)(2)*<br>Lithology                         | (2) (3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling         |                            |             | Comments                              |
|--|-----------------------------------|-----------------|------------------------|----------------------|-----------|------------------------|----------------------------|-------------|---------------------------------------|
|  |                                   | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m) | (8) Hydraulic Conductivity |             |                                       |
|  |                                   |                 |                        |                      |           |                        | Test Type                  | Value (m/s) |                                       |
| Ground level                                 | PI S2                             |                 |                        |                      |           |                        |                            |             |                                       |
| COAL - F SEAM                                | 137 mm                            |                 |                        |                      |           |                        |                            |             | STICK-UP:<br>F1 = 0.45m<br>S2 = 0.48m |
| 8.8<br>10 (1428.9)                           |                                   |                 |                        |                      |           |                        |                            |             |                                       |
| 30<br>31.2<br>COAL - G SEAM (1428.5)         |                                   |                 |                        |                      |           |                        |                            |             |                                       |
| 37.2<br>40 (1430.5)                          |                                   |                 |                        |                      |           |                        |                            |             |                                       |
| 60<br>60.4<br>COAL - J, K1, K2 (1337.3) SEAM |                                   |                 |                        |                      |           |                        |                            |             |                                       |
| 70<br>72.4<br>(1325.3)                       | S2<br>71.6<br>(1326.10)           |                 |                        |                      |           | 54.93<br>(1382.77)     |                            |             | 3.05 m Slots                          |
| 80   |                                   |                 |                        |                      |           | 19/7/87                |                            |             |                                       |

Contractor \_\_\_\_\_  
 Date started \_\_\_\_\_  
 Date finished \_\_\_\_\_

Logged by PAE  
 Checked by \_\_\_\_\_  
 Date Aug 2, 87

SCALE: Vertical 1: \_\_\_\_\_ approximate  
 Horizontal - N.T.S.

\* Bracketed numbers refer to notes following the logs



**PITEAU & ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER • CALGARY

**HYDROGEOLOGIC LOG** (Continued)

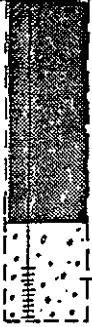
DRILLHOLE No QHR87033

Sheet 2 of 2

PROJECT QUINTETTE - TRANSFER PIT

Reference elevation 1437.70 m-asl

Job No. 81329 GT

| (1)(2)*<br>Lithology   | (2)(3)<br>Completed Construction   | During Drilling     |                              |                            |              | After Drilling               |                            |                      | Comments |                  |                              |
|--|--|---------------------|------------------------------|----------------------------|--------------|------------------------------|----------------------------|----------------------|----------|------------------|------------------------------|
|  |  | (2)<br>Depth<br>(m) | (2)(4)<br>Water Level<br>(m) | (5)<br>Water Flow<br>(Lps) | (6)<br>Other | (2)(7)<br>Water Level<br>(m) | (8) Hydraulic Conductivity |                      |          |                  |                              |
|  |  |                     |                              |                            |              |                              | Test Type                  | Value<br>(m/s)       |          | (2) Depth<br>(m) |                              |
| <div style="position: absolute; left: -60px; top: 20px;">90</div> <div style="position: absolute; left: -60px; top: 230px;">90</div> <div style="position: absolute; left: -60px; top: 310px;">100</div> <div style="position: absolute; left: -60px; top: 395px;">110</div> <div style="position: absolute; left: -60px; top: 475px;">120</div> <div style="position: absolute; left: -60px; top: 555px;">130</div> <div style="position: absolute; left: -60px; top: 635px;">140</div> <div style="position: absolute; left: -60px; top: 715px;">150</div> <div style="position: absolute; left: -60px; top: 795px;">160</div><br>HOLE BOTTOM 99.0<br>(1338.7) | <br>PI<br>95.9<br>(1341.80) |                     |                              |                            |              | 51.84<br>(1385.86)           | f                          | $4.5 \times 10^{-8}$ | 19/1/87  | 19/1/87          | 3.10 m SLOTS<br>5.2 m POCKET |

Logged by PMG Checked by \_\_\_\_\_

SCALE: Vertical 1 : \_\_\_\_\_ approximate  
 Horizontal - N.t.s.



**PITEAU & ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

\* Bracketed numbers refer to notes following the logs

# HYDROGEOLOGIC LOG

DRILLHOLE No. QHD86006

Sheet 1 of 2

## PROJECT QUINTETTE - TRANSFER PIT

Purpose of hole: SUBSURFACE INVESTIGATION - GEOLOGY & HYDROGEOLOGY

Coordinates:

E 62178.59 Angle from horizontal -60°  
 N 6095648.46 Bearing 220 °Azimuth

Type of drilling: DIAMOND

Rig: \_\_\_\_\_  
 Drilling fluid: WATER/MUD

Reference elevation: 1325.06 m - asl

Elevation type:  Surveyed  
 Allimeter  
 From map

Casing stick up: \_\_\_\_\_ m - above ground

Job No. 81339-GT

| (1)(2)*<br>Lithology                                    | (2)(3)<br>Completed Construction | During Drilling |                        |                      |           | After Drilling                |   |                               | Comments  |
|---|----------------------------------|-----------------|------------------------|----------------------|-----------|-------------------------------|---|-------------------------------|---|
|   |                                  | (2) Depth (m)   | (2)(4) Water Level (m) | (5) Water Flow (Lps) | (6) Other | (2)(7) Water Level (m)        | (8) Hydraulic Conductivity<br>Test Type Value (m/s) (2) Depth (m) |                               |   |
| Ground level  | P1 P2 S3<br>157 mm               |                 |                        |                      |           |                               |   |                               |   |
| 10 (1315.88) 10.6<br>COAL - F SEAM<br>(1311.20) 16.0    |                                  |                 |                        |                      |           |                               |   |                               | STRA - 110°<br>P1 = 2.14 m<br>P2 = 0.92 m<br>S3 = ? |
| 20  |                                  |                 |                        |                      |           |                               |   |                               |   |
| 30  |                                  |                 |                        |                      |           |                               |   |                               |   |
| 40 (1289.03) 41.6<br>COAL - G SEAM<br>(1285.22) 46.0    | S3<br>38.7<br>(1291.54)          |                 |                        |                      |           |                               |   |                               | 2.0 USGFM FLOW<br>3.05 m SLOTS<br>10/7/87           |
| 50  |                                  |                 |                        |                      |           |                               |   |                               |   |
| 60  |                                  |                 |                        |                      |           |                               |   |                               |   |
| 70 (1269.29) 64.4<br>COAL - J, K1, K2<br>(1258.72) 76.6 | P2<br>69.3<br>(1265.04)          |                 |                        |                      |           | 15.52<br>(1331.50)<br>21/7/87 | P   | 7x10 <sup>-8</sup><br>21/7/87 | 0.05 USGFM FLOW<br>1.22 m SLOTS<br>7.8 m SOCKET     |
| 80  |                                  |                 |                        |                      |           |                               |   |                               |   |

Contractor: \_\_\_\_\_ Logged by: PMG  
 Date started: \_\_\_\_\_ Checked by: \_\_\_\_\_  
 Date finished: \_\_\_\_\_ Date: AUG 5/87

SCALE: Vertical 1: \_\_\_\_\_ approximate  
 Horizontal - N.T.

\*Bracketed numbers refer to notes following the logs



**PITEAU & ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY



**HYDROGEOLOGIC LOG** (Continued)

DRILLHOLE No QHD86006

Sheet 2 of 2

PROJECT QUINTETTE - TRANSFER PIT

Reference elevation \_\_\_\_\_ m-asl

Job No. 81332 - CT

| (1)(2)*<br>Lithology   | (2)(3)<br>Completed Construction | During Drilling     |                              |                            |              | After Drilling                |                            |             | Comments  |
|--|----------------------------------|---------------------|------------------------------|----------------------------|--------------|-------------------------------|----------------------------|-------------|---|
|  |                                  | (2)<br>Depth<br>(m) | (2)(4)<br>Water Level<br>(m) | (5)<br>Water Flow<br>(Lps) | (6)<br>Other | (2)(7)<br>Water Level<br>(m)  | (8) Hydraulic Conductivity |             |   |
|  |                                  |                     |                              |                            |              |                               | Test Type                  | Value (m/s) |   |
| <p>90</p> <p>94.2</p> <p>100 (1232.15)</p> <p>110</p> <p>120</p> <p>130</p> <p>140</p> <p>150</p> <p>160</p> |                                  |                     |                              |                            |              | <p>+1.93</p> <p>(1326.99)</p> |                            |             | <p>2.44 m SLOTS</p> <p>1.6 m SOCKET</p> <p>(1.93 is measured relative to ground elevation as opposed to top of the PVC tube).</p> |

Logged by PHG Checked by \_\_\_\_\_

SCALE: Vertical 1: \_\_\_\_\_ approximate  
Horizontal - N.Ts.



**PITEAU & ASSOCIATES**  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

\* Bracketed numbers refer to notes following the logs

TABLE D-I

SUMMARY OF CHEMICAL ANALYSES FOR GROUNDWATER  
 SAMPLES FROM THE GRIZZLY/TRANSFER AREA

|                              |                   | QHR87013-P2<br>JULY 21/87 | QHR87017-P2<br>JULY 21/87 | QHD86006-P2 <sup>2</sup><br>JULY 21/87 | RESAMPLE OF <sup>2</sup><br>QHD86006-P2<br>AUG. 22/87 |
|------------------------------|-------------------|---------------------------|---------------------------|--|---|
| <u>PHYSICAL PARAMETERS</u>   |                   |                           |                           |  |   |
| pH                           |                   | 8.14                      | 8.29                      | 12.5                                   | -12.  |
| Total Suspended Solids       |                   | 10.0                      | 4.0                       | -11.3                                  | <1.0  |
| Total Dissolved Solids       |                   | 425.                      | 585.                      | 5200.                                  | 8750  |
| Hardness                     | CaCO <sub>3</sub> | 205.                      | 272.                      | 3600.                                  | 2130  |
| Conductivity                 | umhos/cm          | 440.                      | 583.                      | 9010.                                  | 8960  |
| <u>ANIONS AND NUTRIENTS</u>  |                   |                           |                           |  |   |
| Alkalinity                   | CaCO <sub>3</sub> | 252.                      | 357.                      | 2210.                                  | 2340  |
| Chloride                     | Cl                | 2.04                      | 1.02                      | 549.                                   | 555   |
| Fluoride                     | F                 | 0.52                      | 0.74                      | 0.080                                  | 0.072   |
| Dissolved Sulfate            | SO <sub>4</sub>   | 5.99                      | <1.0                      | <1.0                                   | <1.0  |
| Dissolved Phosphorous        | P                 | 0.007                     | 0.020                     | 0.44                                   |   |
| Ortho Phosphorous            | P                 | 0.007                     | <0.005                    | <0.005                                 | 0.040   |
| Total Phosphorous            | P                 | 0.0013                    | 0.10                      | 7.58                                   |   |
| Ammonia Nitrogen             | N                 | 1.09                      | 1.39                      | 2.70                                   |   |
| Nitrate Nitrogen             | N                 | 0.12                      | 0.07                      | <0.50                                  |   |
| Nitrite Nitrogen             | N                 | <0.001                    | 0.001                     | <0.001                                 |   |
| Total Kjeldahl Nitrogen      | N                 | 1.09                      | 1.44                      | 1.22                                   |   |
| <u>OTHERS</u>                |                   |                           |                           |  |   |
| Chemical Oxygen Demand (COD) |                   | <25.                      | <25.                      | <25.                                   |   |
| Total Carbon                 | C                 | 39.                       | 56.                       | 11.                                    | 4.6   |
| Total Organic Carbon         | C                 | 5.5                       | 3.6                       | 10.                                    |   |
| Total Phenols (as Phenol)    |                   | <0.002                    | <0.002                    | <0.002                                 |   |

< = less than detection limit shown  
 Results are expressed as milligrams per litre.

- NOTES: 1. Analyses performed by ASL Laboratories, Vancouver, B.C.  
 2. Chemistry of water contaminated by Portland cement grout used to make seal in drillhole.

TABLE D-II

## SUMMARY OF LABORATORY ANALYSES FOR TOTAL AND DISSOLVED METALS

RESULTS OF ANALYSIS  
July 21, 1987File No. 4406A  
Page 3 of 3

| ELEMENT                 |     | QHRB7013 | QHRB7017 | QHDB6006 |
|-------------------------|-----|----------|----------|----------|
| <b>Total Metals</b>     |     |          |          |          |
| Aluminum                | Al  | 0.10     | 0.07     | <0.05    |
| Antimony                | Sb  | 0.0003   | 0.0013   | 0.0002   |
| Arsenic                 | As  | 0.0003   | 0.0006   | 0.0010   |
| Barium                  | Ba  | 0.96     | 4.33     | 7.66     |
| Beryllium               | Be  | <0.001   | <0.001   | <0.001   |
| Bismuth                 | Bi  | <0.2     | <0.2     | <0.2     |
| Boron                   | B   | 0.23     | 0.23     | 0.06     |
| Cadmium                 | Cd* | <0.001   | <0.001   | <0.001   |
| Calcium                 | Ca  | 59.0     | 62.1     | 1460.    |
| Chromium                | Cr  | <0.005   | <0.005   | <0.005   |
| Cobalt                  | Co  | <0.01    | <0.01    | <0.01    |
| Copper                  | Cu  | <0.001   | <0.001   | 5.99     |
| Iron                    | Fe  | 0.14     | 0.10     | 0.03     |
| Lead                    | Pb  | <0.01    | <0.01    | <0.01    |
| Magnesium               | Mg  | 25.4     | 28.8     | <0.1     |
| Manganese               | Mn  | 0.013    | 0.020    | <0.005   |
| Mercury                 | Hg  | <0.00005 | <0.00005 | <0.00005 |
| Molybdenum              | Mo  | 0.011    | 0.005    | 0.21     |
| Nickel                  | Ni  | <0.005   | <0.005   | <0.005   |
| Potassium               | K   | 3.40     | 3.35     | 89.5     |
| Selenium                | Se  | <0.0005  | <0.0005  | <0.0005  |
| Silicon                 | Si  | 3.37     | 3.31     | <0.05    |
| Silver                  | Ag  | <0.0005  | <0.0005  | <0.0005  |
| Sodium                  | Na  | 20.1     | 58.1     | 191.     |
| Strontium               | Sr  | 1.21     | 2.82     | 17.7     |
| Tin                     | Sn  | <0.02    | <0.02    | <0.02    |
| Titanium                | Ti  | <0.005   | <0.005   | <0.005   |
| Vanadium                | V   | <0.005   | <0.005   | <0.005   |
| Zinc                    | Zn  | <0.005   | <0.005   | <0.005   |
| <b>Dissolved Metals</b> |     |          |          |          |
| Aluminum                | Al  | 0.10     | <0.05    | <0.05    |
| Antimony                | Sb  | 0.0001   | 0.0011   | 0.0001   |
| Arsenic                 | As  | 0.0002   | 0.006    | 0.0002   |
| Barium                  | Ba  | 0.88     | 3.10     | 7.64     |
| Beryllium               | Be  | <0.001   | <0.001   | <0.001   |
| Bismuth                 | Bi  | <0.2     | <0.2     | <0.2     |
| Boron                   | B   | 0.10     | 0.17     | <0.01    |
| Cadmium                 | Cd* | <0.001   | <0.001   | <0.001   |
| Calcium                 | Ca  | 41.1     | 16.6     | 1440.    |
| Chromium                | Cr  | <0.005   | <0.005   | <0.005   |
| Cobalt                  | Co  | <0.01    | <0.01    | <0.01    |
| Copper                  | Cu  | <0.001   | <0.001   | 0.051    |
| Iron                    | Fe  | 0.06     | <0.03    | <0.03    |
| Lead                    | Pb* | <0.01    | <0.01    | <0.01    |
| Magnesium               | Mg  | 24.7     | 28.5     | <0.1     |
| Manganese               | Mn  | <0.005   | <0.005   | <0.005   |
| Mercury                 | Hg  | <0.00005 | <0.00005 | <0.00005 |
| Molybdenum              | Mo  | <0.005   | <0.005   | 0.21     |
| Nickel                  | Ni  | <0.005   | <0.005   | <0.005   |
| Potassium               | K   | 2.70     | 2.86     | 85.6     |
| Selenium                | Se  | <0.0005  | <0.0005  | <0.0005  |
| Silicon                 | Si  | 3.33     | 3.16     | <0.05    |
| Silver                  | Ag  | <0.0005  | <0.0005  | <0.0005  |
| Sodium                  | Na  | 15.2     | 46.9     | 190.     |
| Strontium               | Sr  | 1.19     | 2.26     | 16.2     |
| Tin                     | Sn  | <0.02    | <0.02    | <0.02    |
| Titanium                | Ti  | <0.005   | <0.005   | <0.005   |
| Vanadium                | V   | <0.005   | <0.005   | <0.005   |
| Zinc                    | Zn  | <0.005   | <0.005   | <0.005   |

&lt; = less than detection limit shown

Results are expressed as milligrams per litre

\* Detection limit elevated due to required dilution prior to analysis

Note: Analyses performed by ASL Laboratories, Vancouver, B.C.

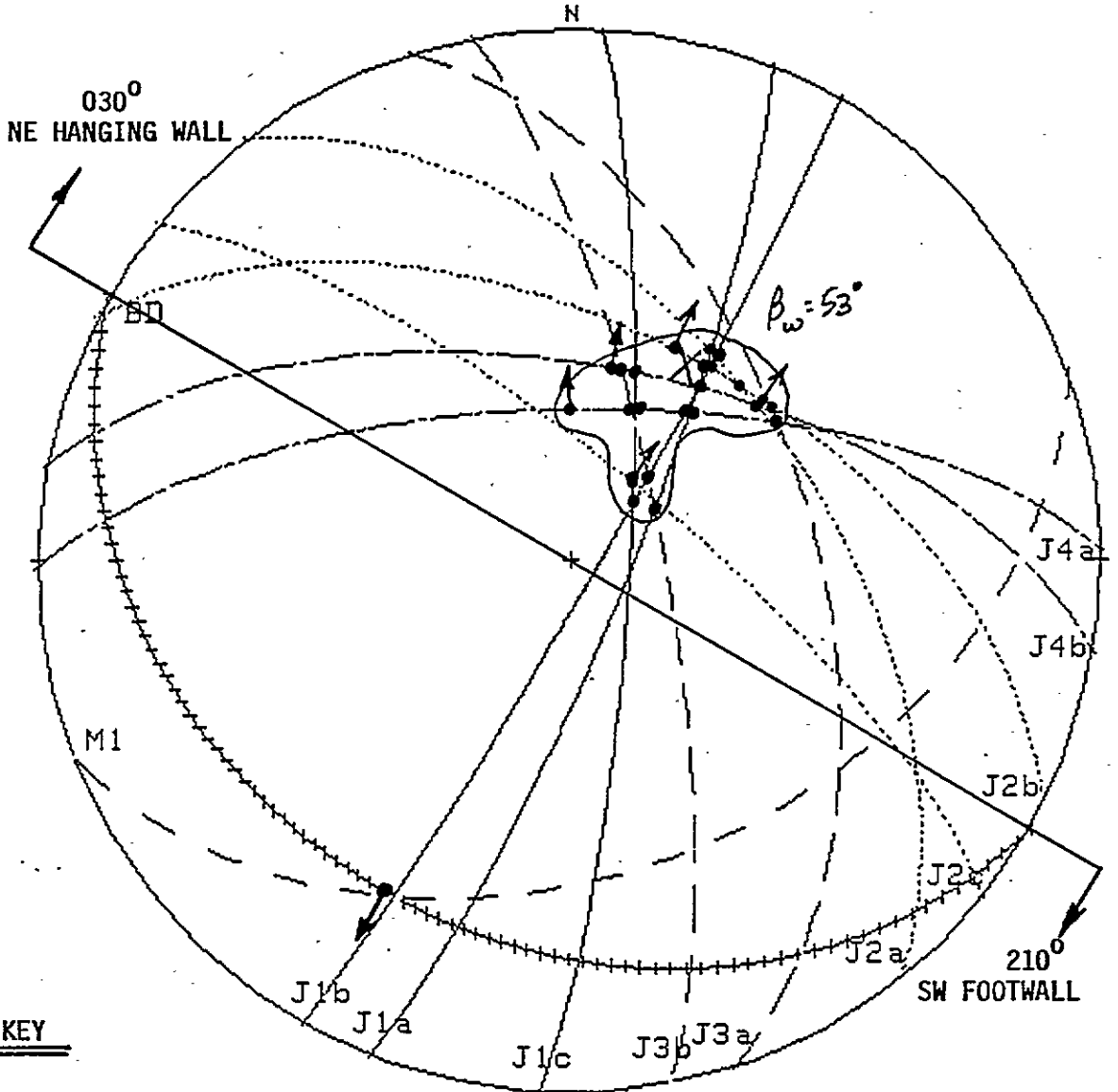
APPENDIX E

LOWER HEMISPHERE EQUAL AREA PROJECTIONS  
ILLUSTRATING KINEMATICALLY POSSIBLE  
FAILURE MODES FOR VARIOUS PIT SLOPE AND  
BEDDING ORIENTATIONS

JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:  
 DATE:  
 STRUCTURAL DOMAIN: SW LIMBS BD 30



**KEY**

- BD — BEDDING
- J2a — PEAK ORIENTATIONS OF JOINT SETS
- J3a — PEAK ORIENTATIONS OF JOINT SETS
- J1c — PEAK ORIENTATIONS OF JOINT SETS
- PIT SLOPE ORIENTATION
- $\beta_w = 53^\circ$  — APPARENT PLUNGE OR DIP OF FAILURE CONSIDERED TO CONTROL BENCH STABILITY
- POTENTIAL WEDGE FAILURE
- POTENTIAL PLANE FAILURE
- LOCUS OF POTENTIAL FAILURE MODES

|   |                             |  |
|---|-----------------------------|--|
| QUINTETTE COAL LIMITED<br>GRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES  |                             | <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER                      CALGARY |
| LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING<br>PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN I<br>RELATIVE TO A BEDDING DIP OF 30° SW | BY: <b>PMH</b><br>APPROVED: | DATE: <b>SEPT 87</b><br>DWG: <b>E-1</b>  |

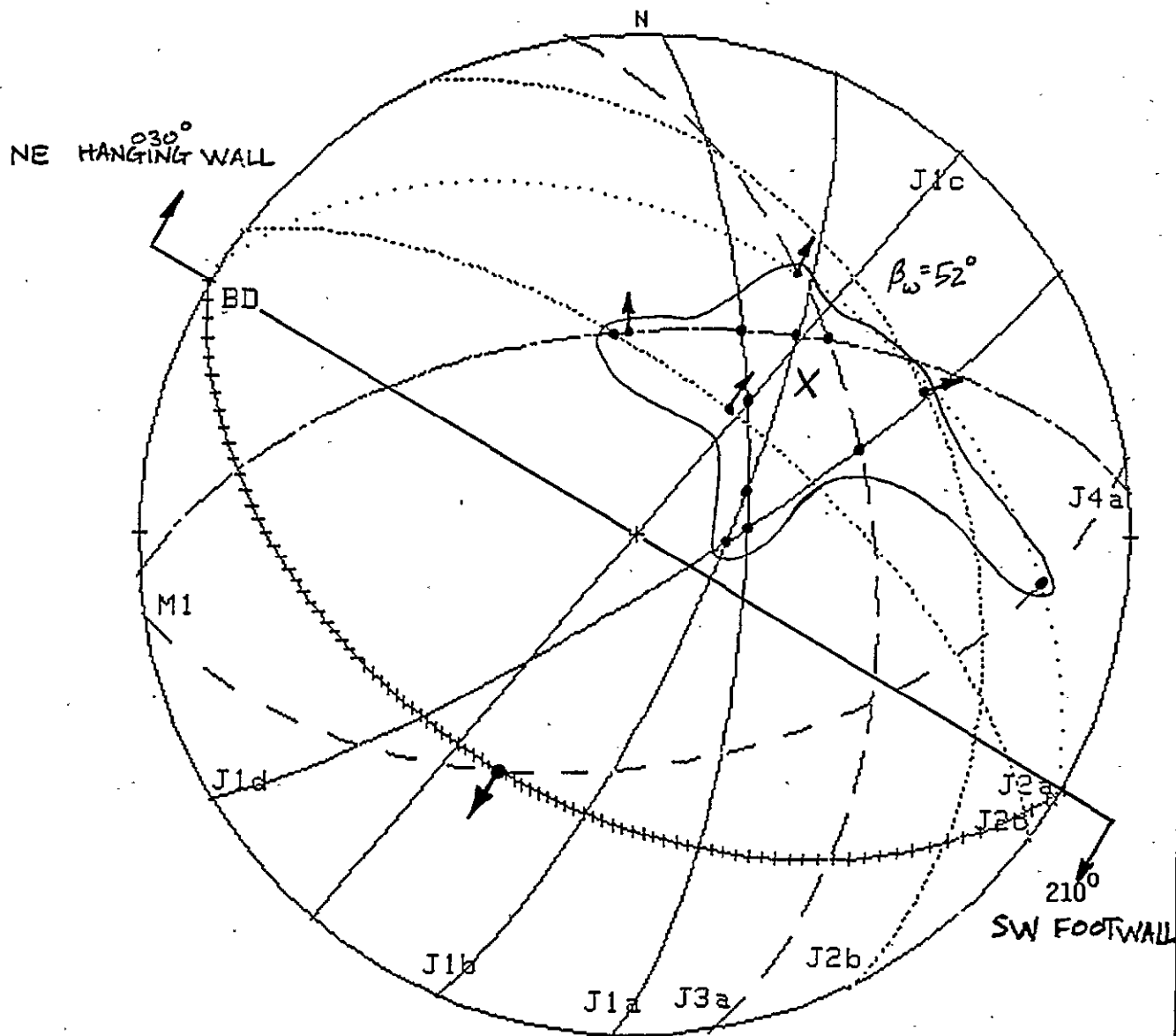
JOB NUMBER

# GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: SW LIMBS BD 45



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN I  
 RELATIVE TO A BEDDING DIP OF 45°SW

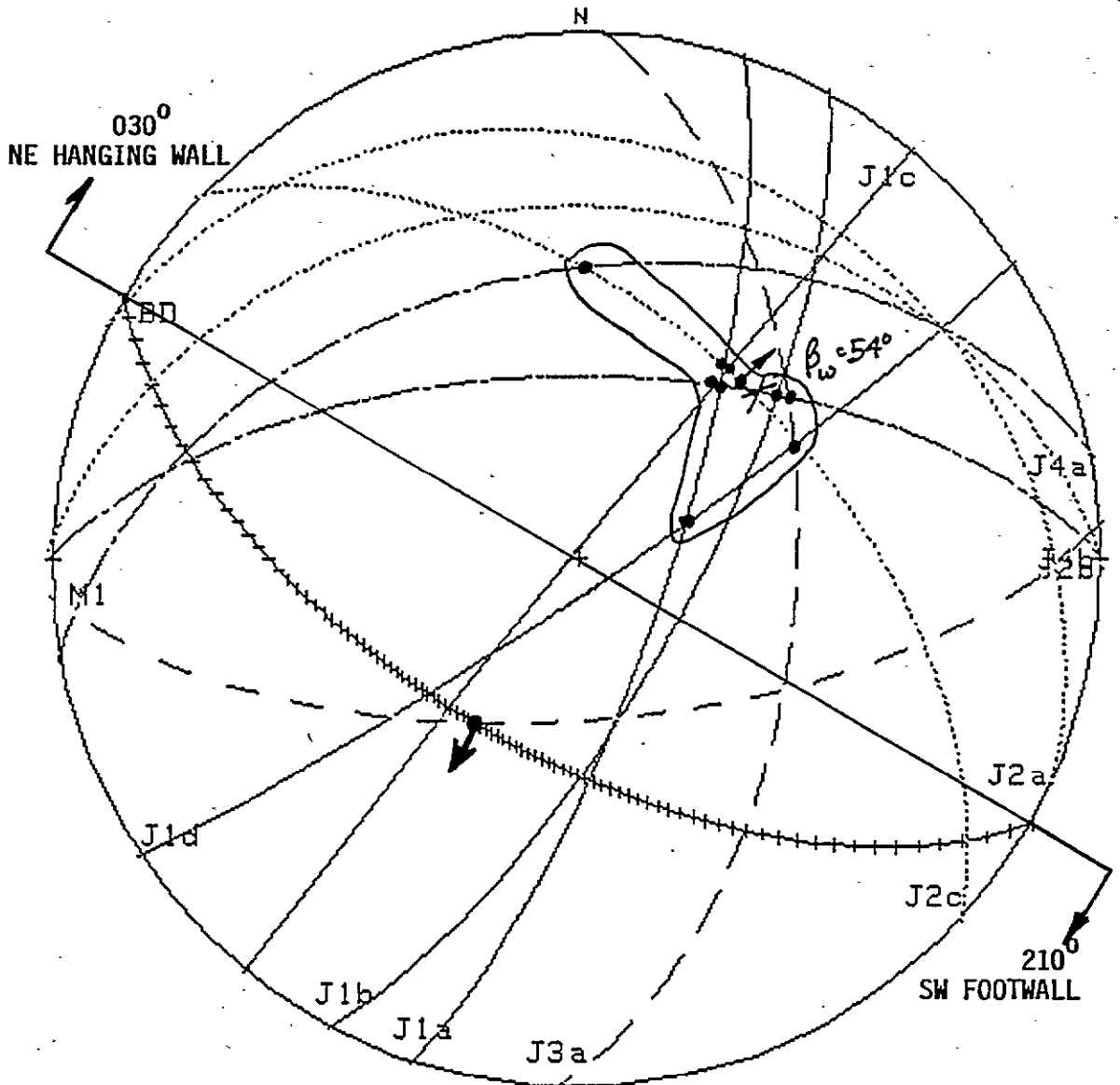
|                          |                  |
|--------------------------|------------------|
| BY:<br>PMH               | DATE:<br>SEPT 87 |
| APPROVED:<br>[Signature] | DWG:<br>E-2      |

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: SW LIMBS BD 60



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
GRIZZLY-TRANSFER PROJECT  
GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
GEOTECHNICAL CONSULTANTS  
VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN }  
RELATIVE TO A BEDDING DIP OF 60° SW

|                        |                  |
|------------------------|------------------|
| BY:<br>PMH             | DATE:<br>SEPT 87 |
| APPROVED:<br><i>MA</i> | DWG:<br>E-3      |

JOB NUMBER

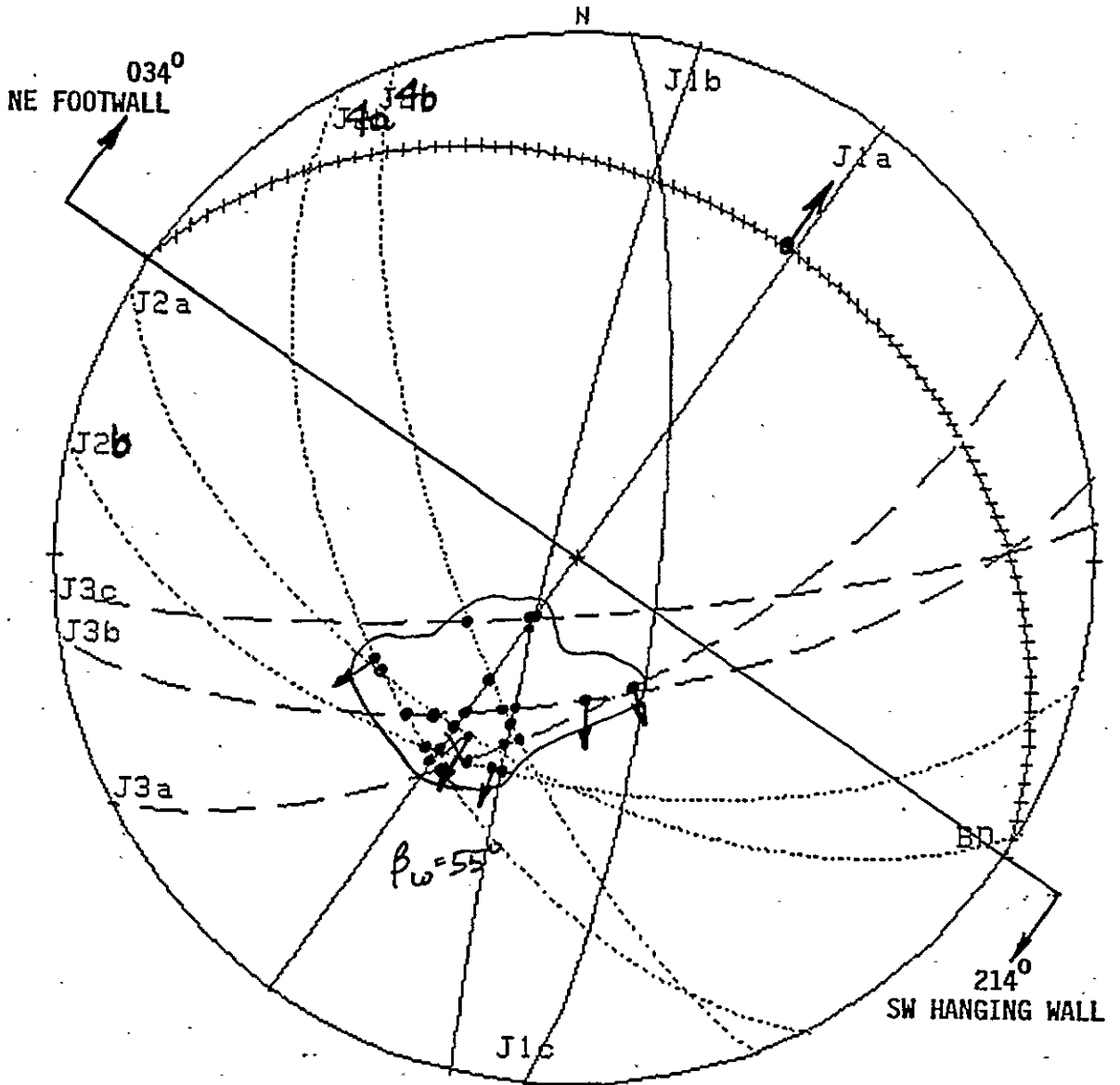
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: NE LIMBS BD 38



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 2  
 RELATIVE TO A BEDDING DIP OF 30°NE

|                        |                  |
|------------------------|------------------|
| BY:<br>PMH             | DATE:<br>SEPT 87 |
| APPROVED:<br><i>MM</i> | DWG:<br>E-4      |



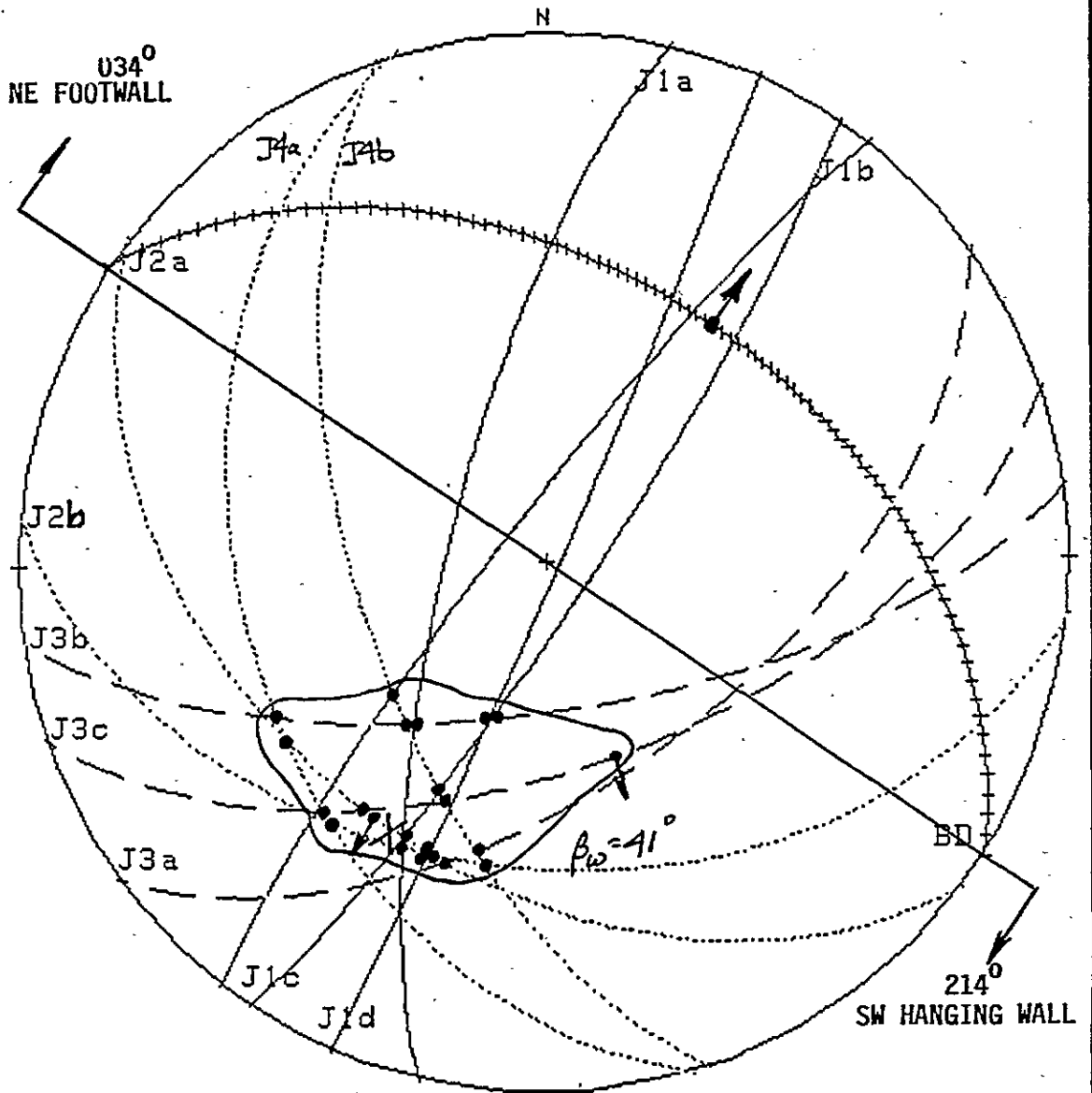
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: NE LIMBS BD 45



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER · CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 2  
 RELATIVE TO A BEDDING DIP OF 45° NE

|                        |                  |
|------------------------|------------------|
| BY:<br>PMH             | DATE:<br>SEPT 87 |
| APPROVED:<br><i>MA</i> | DWG:<br>E-5      |

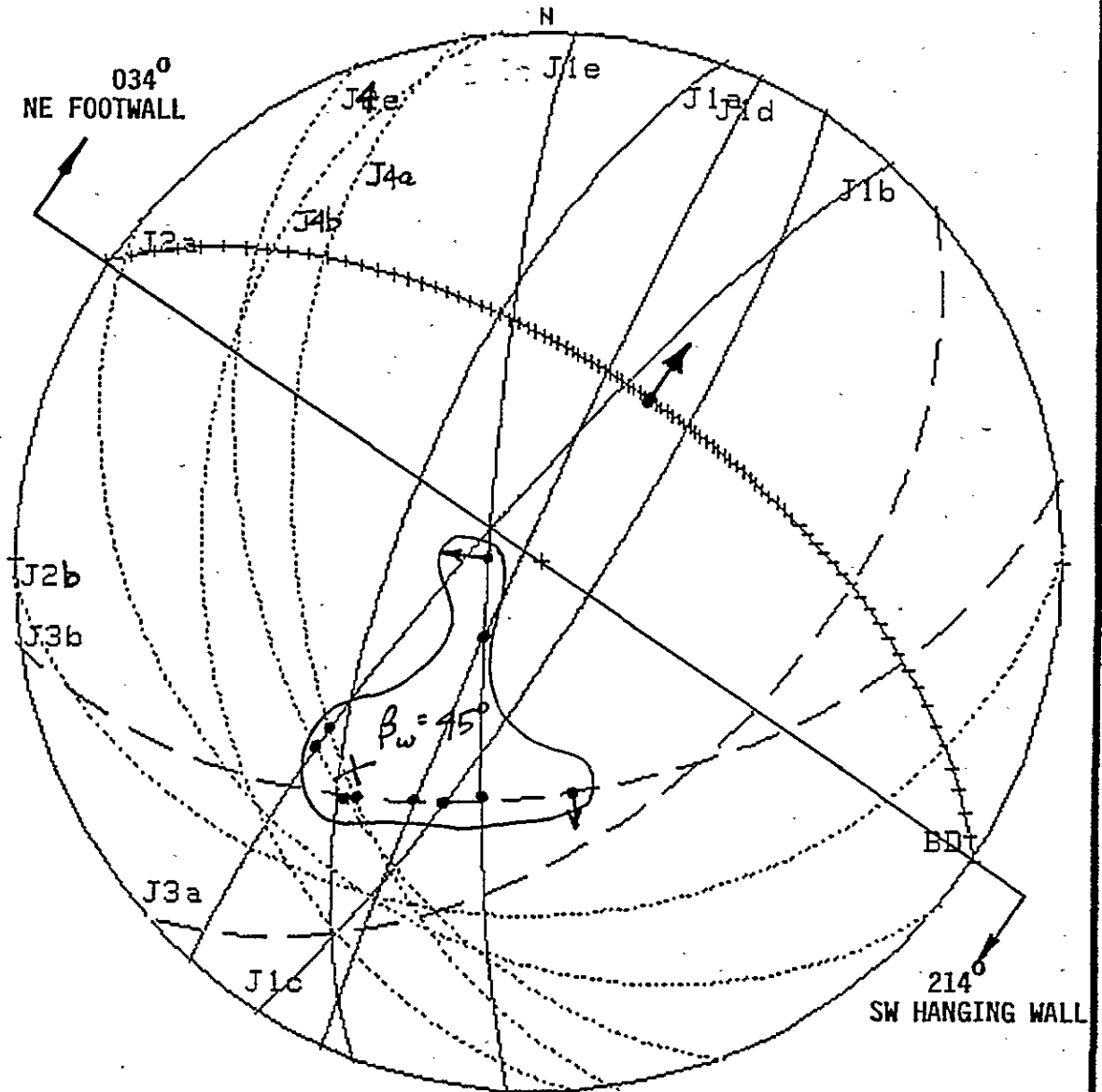
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: NE LIMBS BD 60



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 2  
 RELATIVE TO A BEDDING DIP OF 60° NE

|                        |                  |
|------------------------|------------------|
| BY:<br>PMH             | DATE:<br>SEPT 87 |
| APPROVED:<br><i>MA</i> | DWG:<br>E-6      |

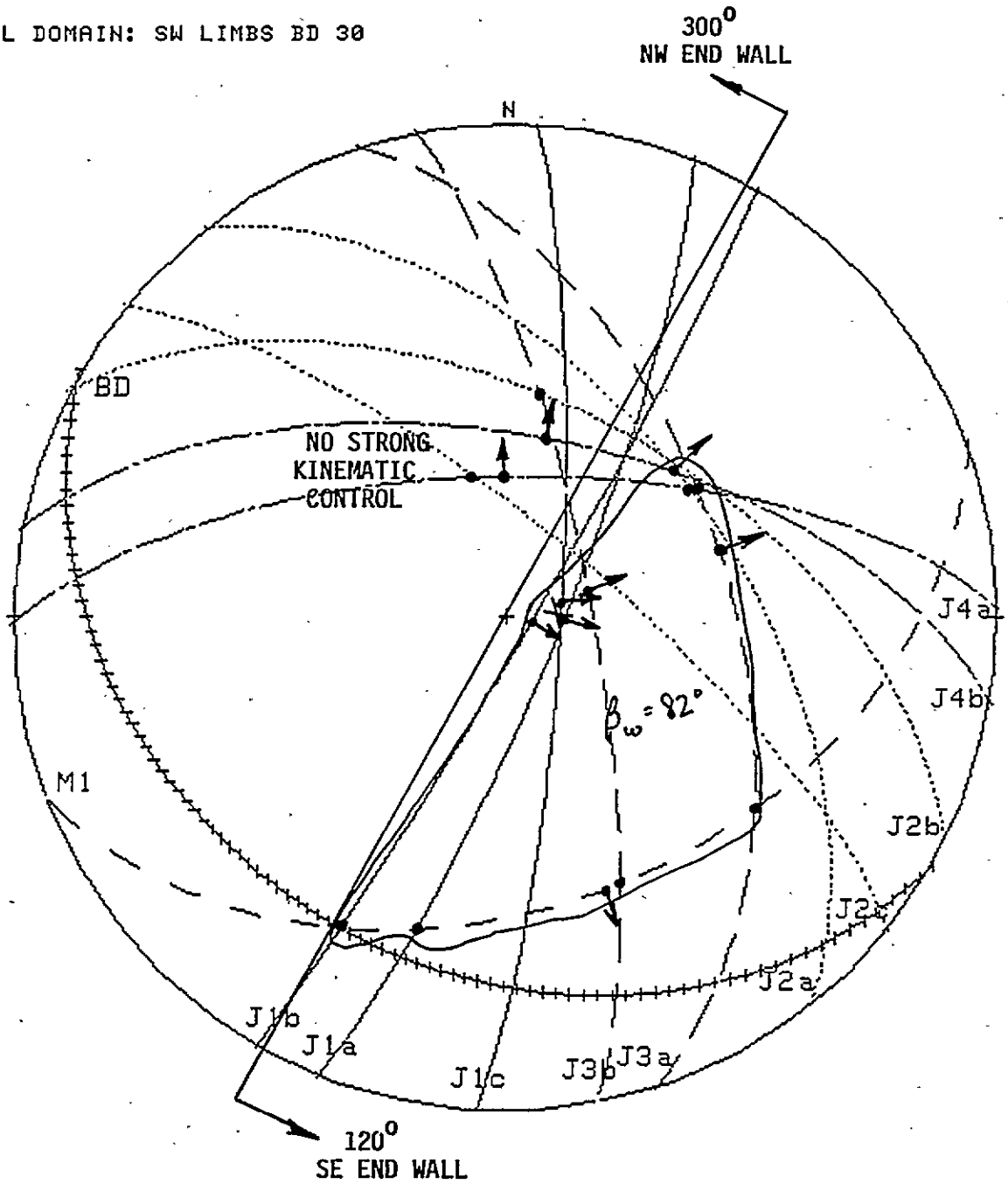
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: SW LIMBS BD 30



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



**PITEAU ASSOCIATES**  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN  
 RELATIVE TO A BEDDING DIP OF  $30^\circ$  SW

|                         |                  |
|-------------------------|------------------|
| BY:<br>PMH              | DATE:<br>SEPT 87 |
| APPROVED:<br><i>PMH</i> | DWG:<br>E-7      |

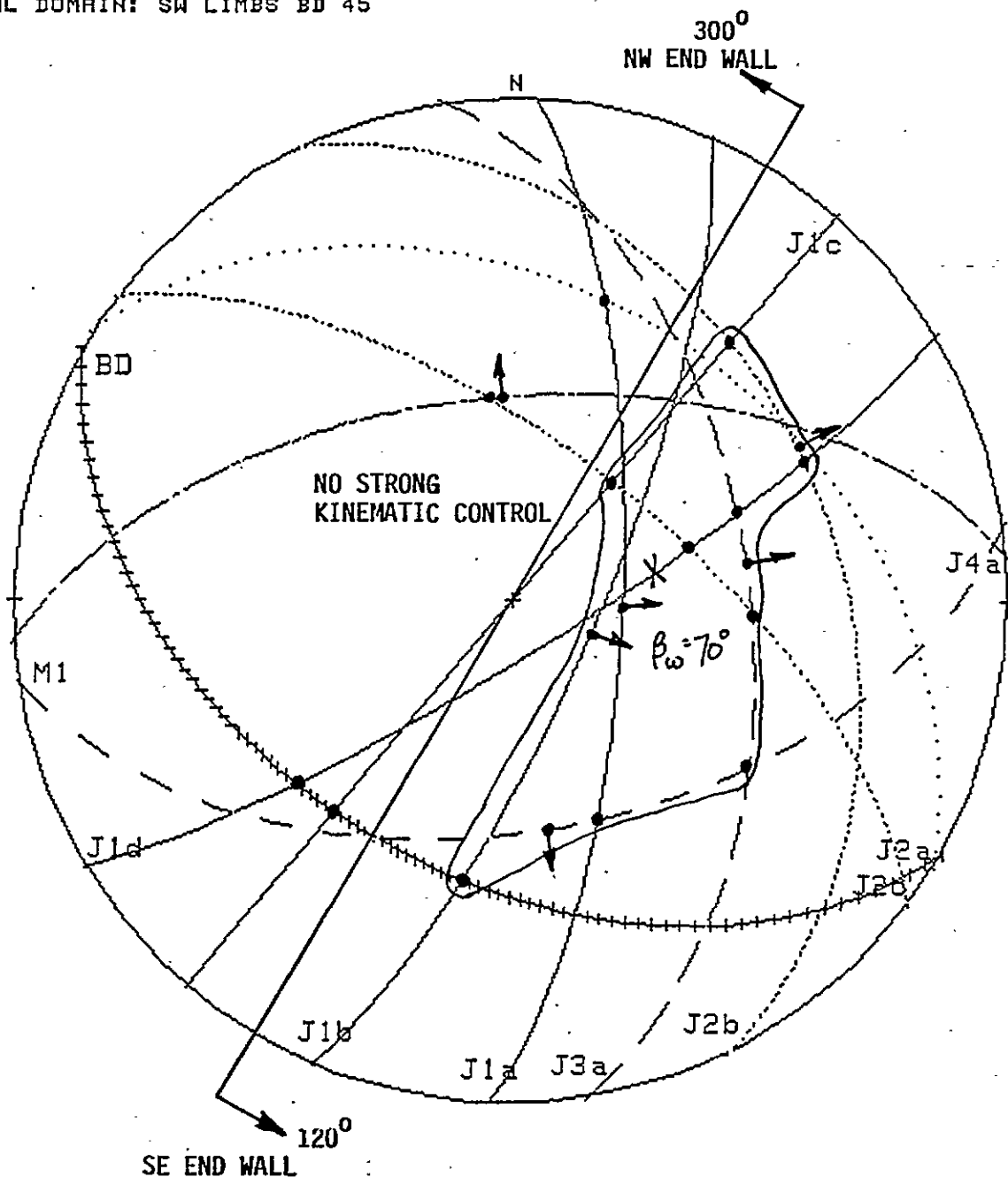
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: SW LIMBS BD 45



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN I  
 RELATIVE TO A BEDDING DIP OF  $45^\circ SW$

|                        |                  |
|------------------------|------------------|
| BY:<br>PMH             | DATE:<br>SEPT 87 |
| APPROVED:<br><i>MA</i> | DWG:<br>E-8      |

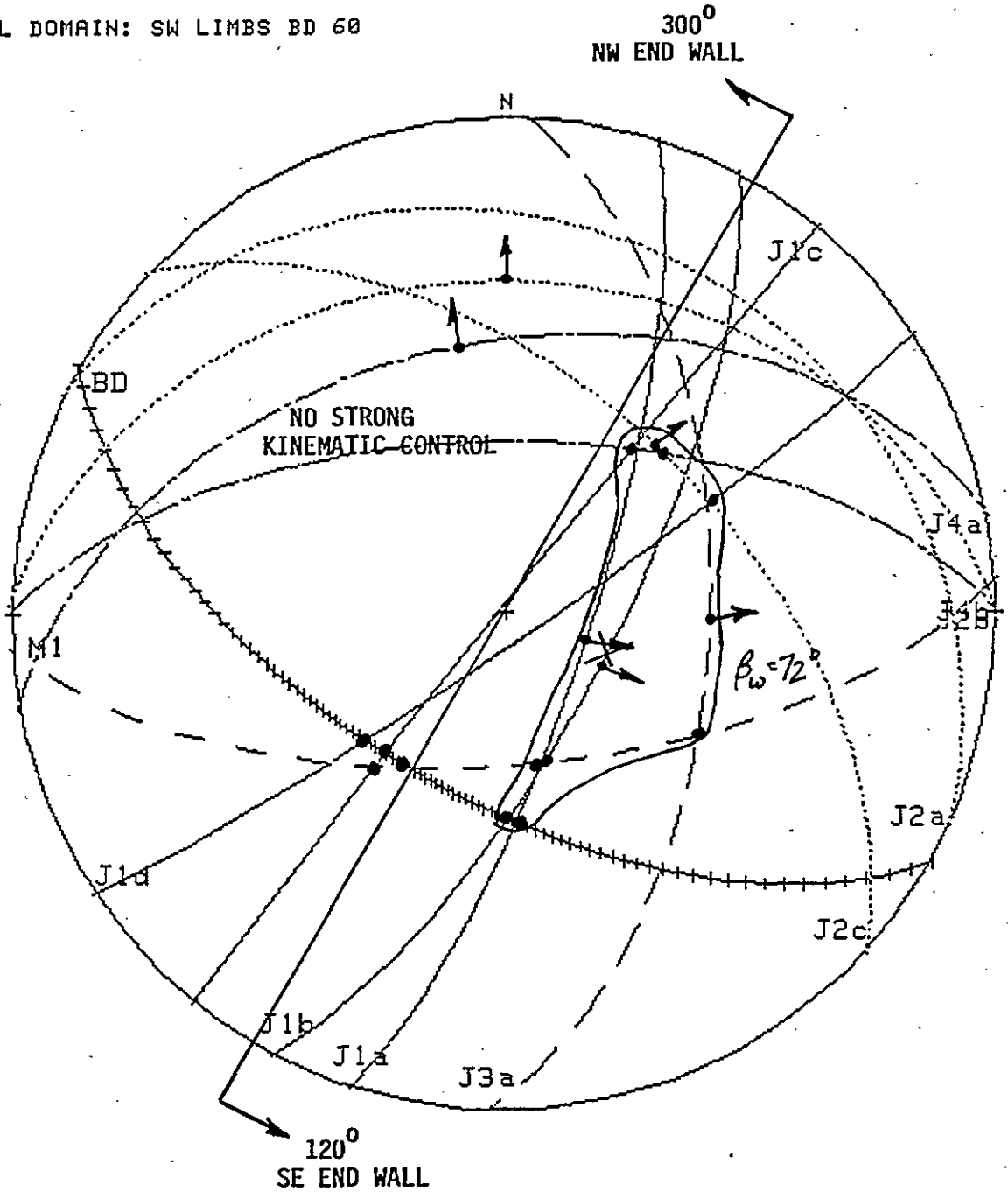
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: SW LIMBS BD 60



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 1  
 RELATIVE TO A BEDDING DIP OF 60° SW

|                         |                  |
|-------------------------|------------------|
| BY:<br>PMH              | DATE:<br>SEPT 87 |
| APPROVED:<br><i>PMH</i> | DWG:<br>E-9      |

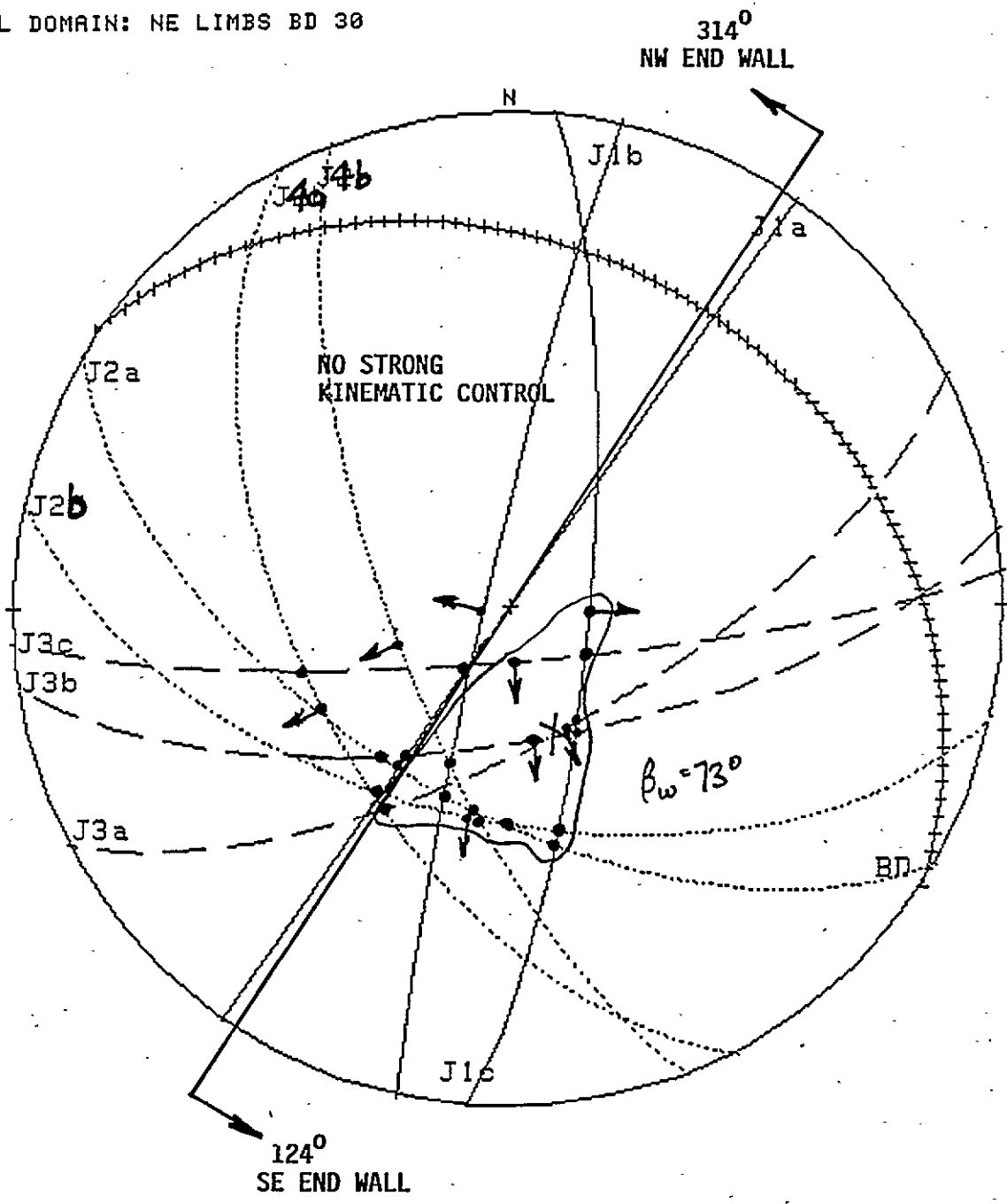
JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:

DATE:

STRUCTURAL DOMAIN: NE LIMBS BD 30



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

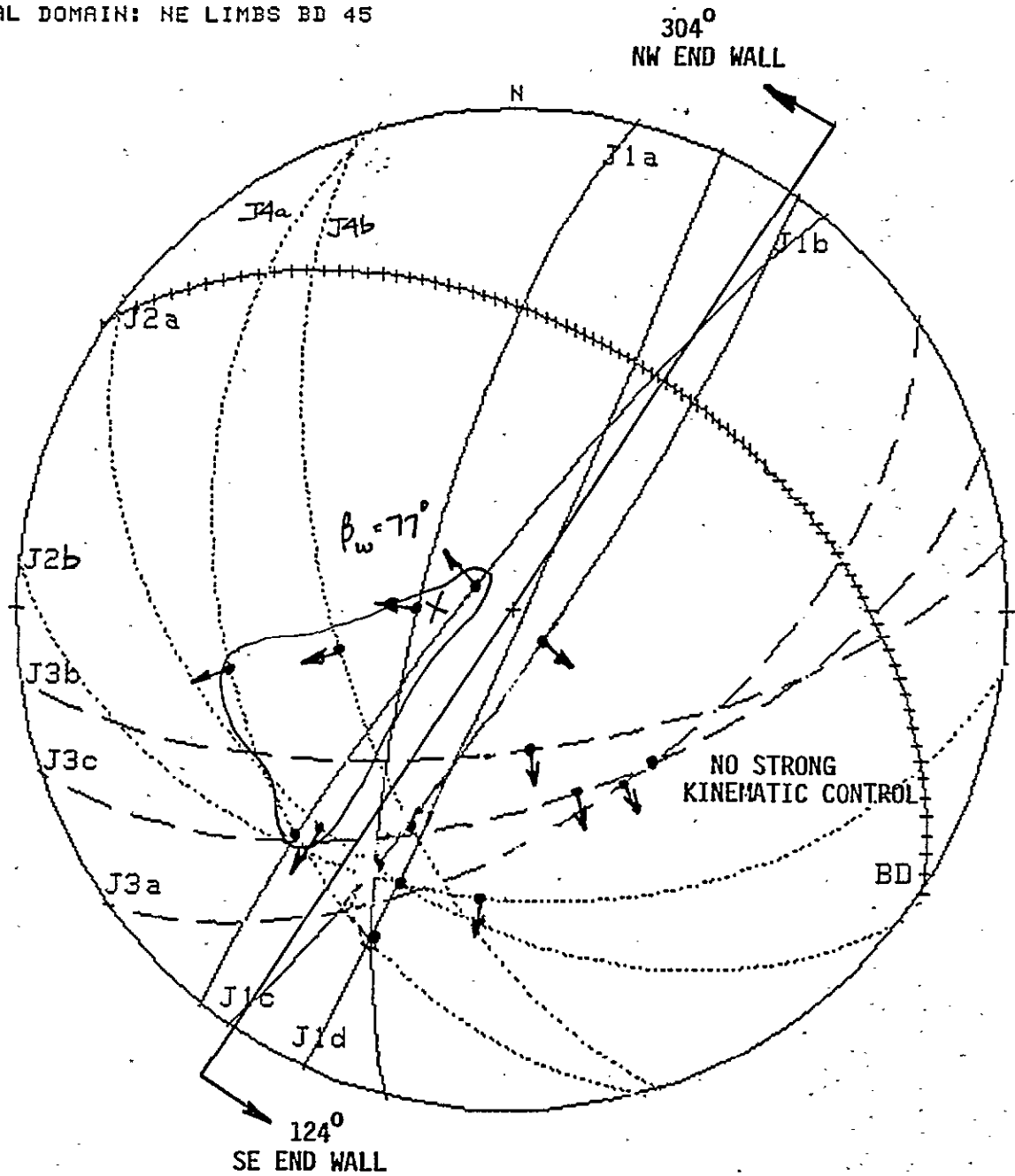
LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 2  
 RELATIVE TO A BEDDING DIP OF 30°NE

|                        |                  |
|------------------------|------------------|
| BY:<br>PMH             | DATE:<br>SEPT 87 |
| APPROVED:<br><i>MA</i> | DWC:<br>E-10     |

JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:  
 DATE:  
 STRUCTURAL DOMAIN: NE LIMBS BD 45



NOTE: SE FIG. E-1 FOR KEY

QUINETTE COAL LIMITED  
 GRIZZLY-TRANSFER PROJECT  
 GEOTECHNICAL/HYDROGEOLOGICAL STUDIES



PITEAU ASSOCIATES  
 GEOTECHNICAL CONSULTANTS  
 VANCOUVER CALGARY

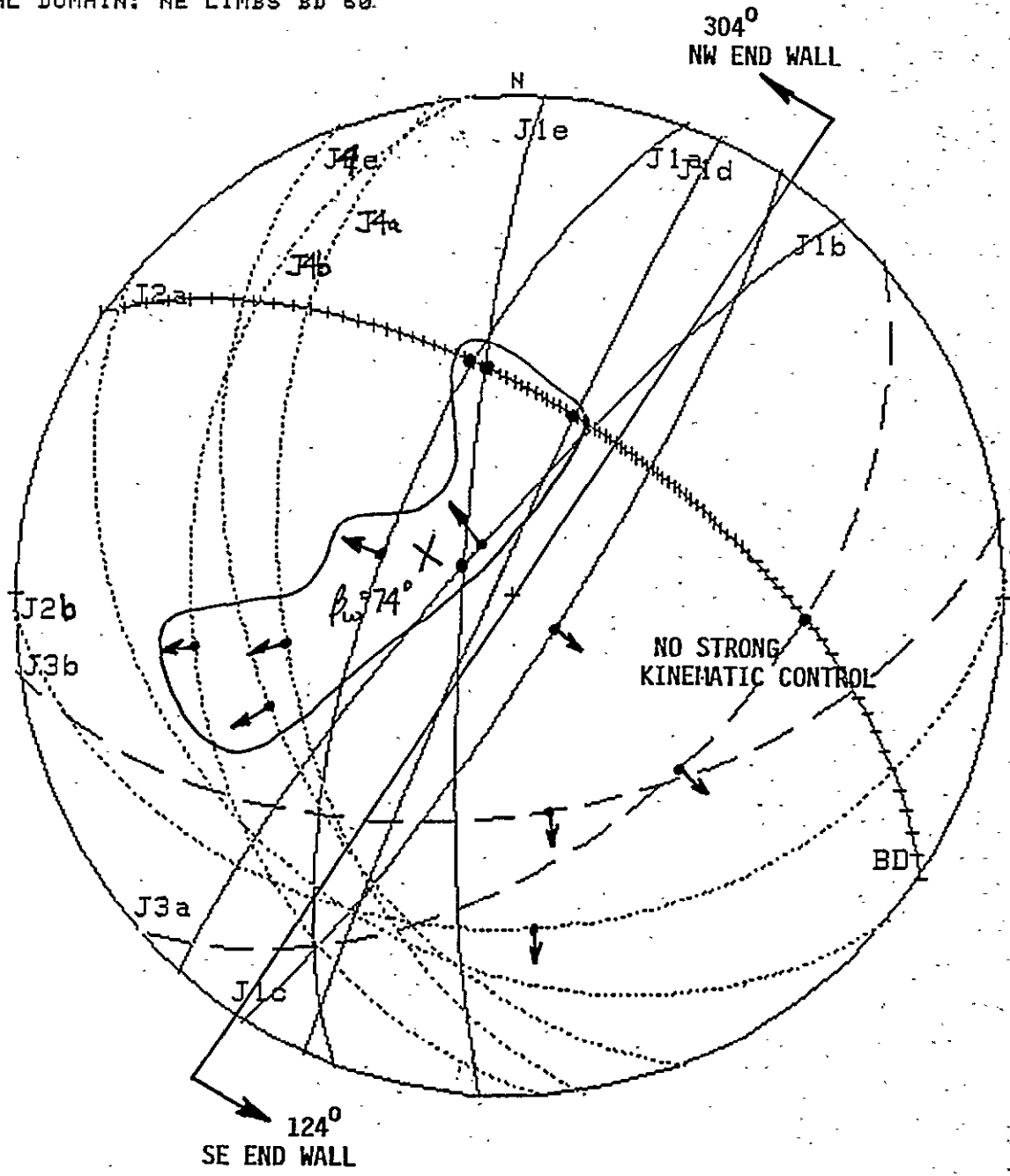
LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING  
 PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 2  
 RELATIVE TO A BEDDING DIP OF 45° NE

|                                |                  |
|--------------------------------|------------------|
| BY:<br>PMH                     | DATE:<br>SEPT 87 |
| APPROVE:<br><i>[Signature]</i> | DWG:<br>E-11     |


JOB NUMBER

GEOPLN - LOWER HEMISPHERE EQUAL AREA PROJECTION OF PLANES

PROJECT:  
 DATE:  
 STRUCTURAL DOMAIN: NE LIMBS BD 60.



NOTE: SE FIG. E-1 FOR KEY

|  |  |            |                  |                        |              |
|--|--|------------|------------------|------------------------|--------------|
| QUINTETTE COAL LIMITED<br>GRIZZLY-TRANSFER PROJECT<br>GEOTECHNICAL/HYDROGEOLOGICAL STUDIES   |  <b>PITEAU ASSOCIATES</b><br>GEOTECHNICAL CONSULTANTS<br>VANCOUVER                      CALGARY |            |                  |                        |              |
| LOWER HEMISPHERE EQUAL AREA PROJECTIONS OF PLANES REPRESENTING<br>PEAK ORIENTATIONS OF JOINT SETS IN STRUCTURAL DOMAIN 2<br>RELATIVE TO A BEDDING DIP OF 60°NE | <table border="1"> <tr> <td>BY:<br/>PMH</td> <td>DATE:<br/>SEPT 87</td> </tr> <tr> <td>APPROVED:<br/><i>MA</i></td> <td>DWG:<br/>E-12</td> </tr> </table>                          | BY:<br>PMH | DATE:<br>SEPT 87 | APPROVED:<br><i>MA</i> | DWG:<br>E-12 |
| BY:<br>PMH   | DATE:<br>SEPT 87   |            |                  |                        |              |
| APPROVED:<br><i>MA</i>   | DWG:<br>E-12   |            |                  |                        |              |