Appendix B.5

Ore Shear Strength Test Data

Appendix B.5.1

Cresson Ore Shear Strength Test Results (1996)

Golder Associates Inc.

200 Union Boulevard, Suite 500
Lakewood, CO USA 80228
Telephone (303) 980-0540
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Golder Associates

January 9, 1996

Our Ref: 943-2847.001

Cripple Creek & Victor Gold Mining Company
2755 State Highway 67
Victor, CO 80860

Attention: Mr. Ron Roberts

RE: SHEAR STRENGTH TESTING RESULTS FOR CRESSON ORE

Dear Ron,

The shear strength of the Cresson Ore was determined from tests performed on samples of Pad No. 2 material for the initial characterization . Ore from the Cresson Pit is currently available and the Cripple Creek & Victor Gold Mining Company (CC&V) requested that Golder Associates Inc. (Golder) evaluate the shear strength of the material that has been placed in the Phase I Heap Leach Pad. Golder would like to take this opportunity to present these results to CC&V.

The interface shear strength testing was performed in general accordance with the procedure developed for the American Society for Testing and Materials (ASTM) Standard Test Method D5321, "*Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method*". Tests were conducted at normal stresses ranging from 50 psi to 150 psi in a direct shear device containing an upper and lower shear box. The upper shear box measures 12 inches by 12 inches in plan and 3 inches in depth. The lower shear box measures 12 inches by 14 inches in plan and 3 inches in depth

Cresson Ore material was screened to remove material in excess of 1-1/2 inches. The screened ore was subjected to normal loads of 20 psi, 50 psi, 100 psi and 150 psi, and the shear strength required to fail the sample was measured. From this testing, a normal stress versus shear stress plot could be created in which the cohesion and friction angle for the Cresson ore could be determined.

Testing results from the Cresson ore is presented in Attachment A. Based on the linear regression performed on the four points, a friction angle of 38 degrees and a cohesion of 1275 psf were measured. Upon review of the data by Golder, a straight line was drawn through the origin and the Cresson Ore material was assigned a friction angle of 40 degrees and a cohesion value of 0 psf.

Golder appreciates the ongoing opportunity to provide engineering services for the Cresson Project. Please contact the undersigned with any questions.

Sincerely,

GOLDER ASSOCIATES INC.

Terry Mandziak
Project Engineer

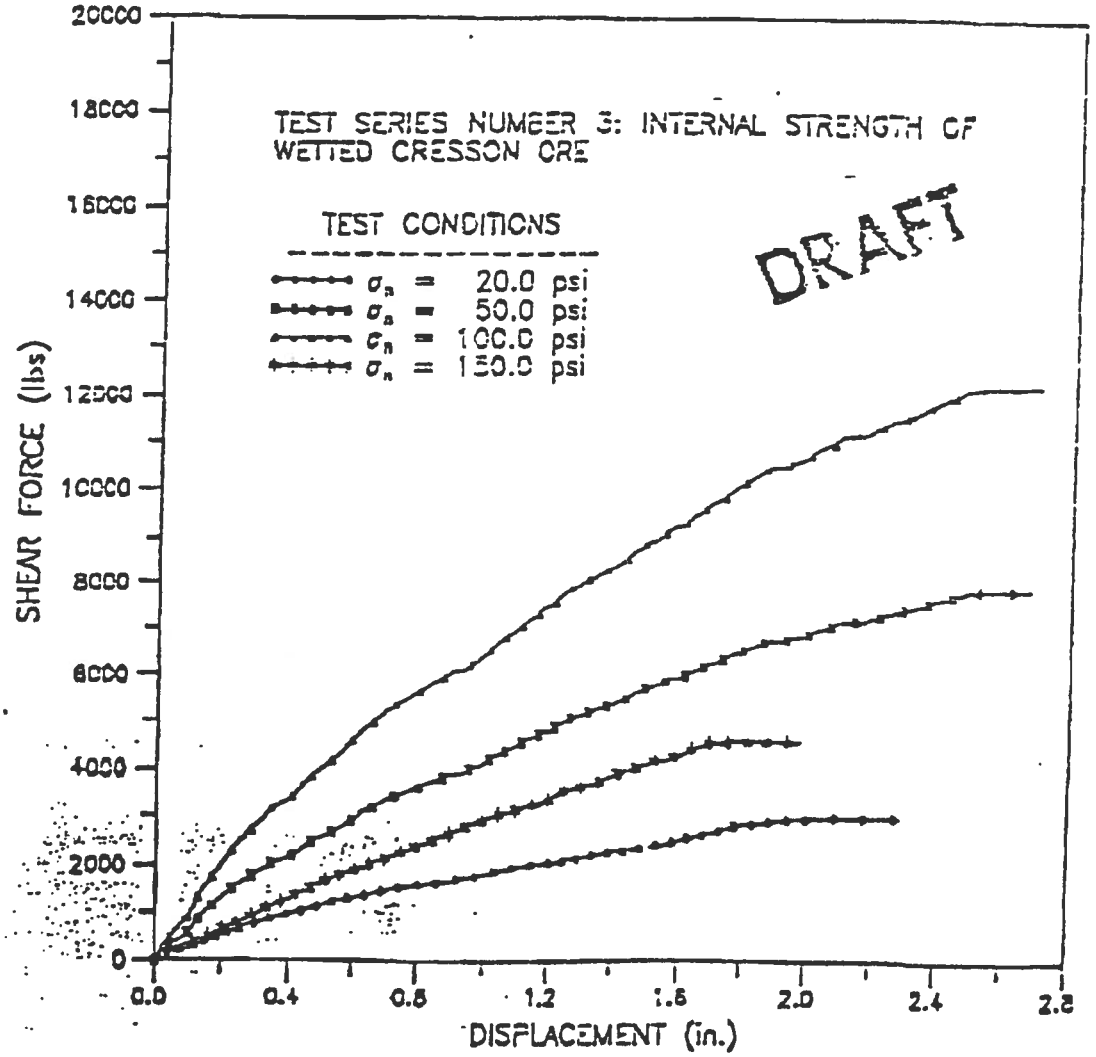
James M. Johnson, P.E.
Associate

TM/JJ/tm
2847001.ltr

cc: Mr. John Hardaway, CC&V
Mr. Jim Komadina, CC&V

ATTACHMENT A

GOLDER ASSOCIATES, INC.
DIRECT SHEAR TESTING



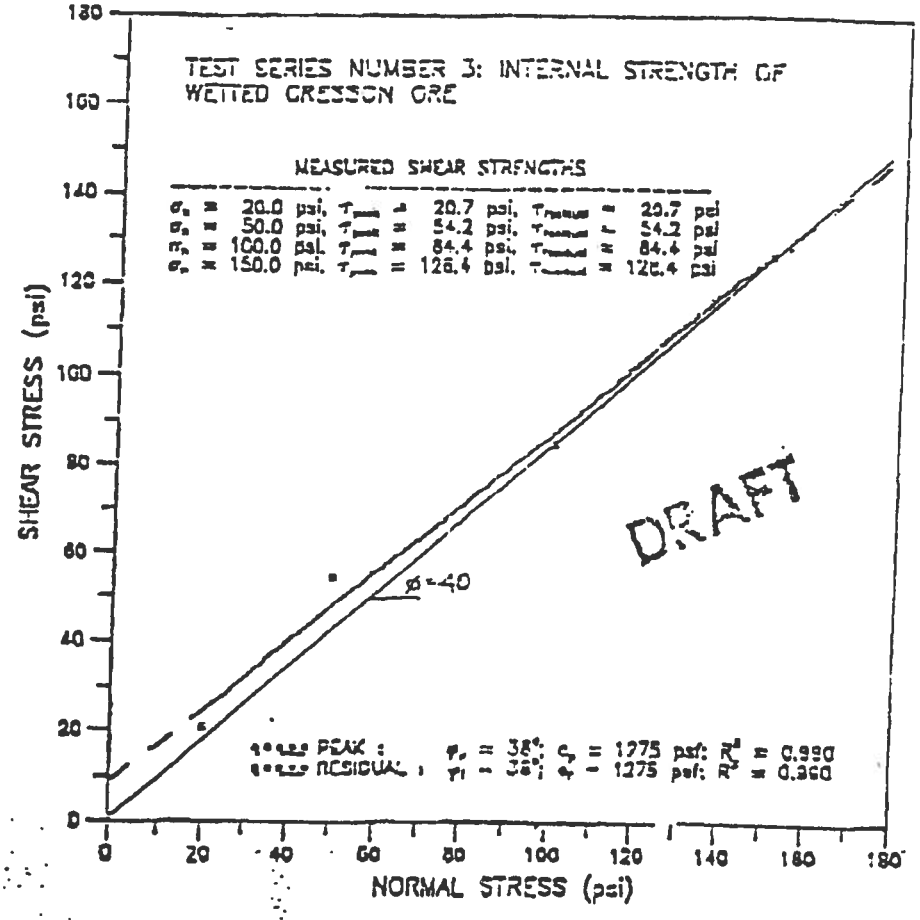
NOTE: The shear box size was 12 in. by 12 in. (300 mm by 300 mm) for tests conducted at normal stresses ranging from 20 to 100 psi, and 6 in. by 6 in. (150 mm by 150 mm) for the test conducted at the normal stress of 150 psi.

DATE TESTED: 4 TO 5 OCTOBER 1995

GeoSyntec Consultants
SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-1
PROJECT NO.	GL3520
DOCUMENT NO.	

GOLDER ASSOCIATES, INC.
DIRECT SHEAR TESTING



NOTE: The reported value of cohesion may not be the true cohesion of the soil specimen, and caution should be exercised in using this cohesion value for applications involving normal stresses outside the range of stresses covered by the test.

DATE TESTED: 4 TO 5 OCTOBER 1995

GeoSyntec Consultants
SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-2
PROJECT NO.	GU392C
DOCUMENT NO.	
FILE NO.	

GEOSYNTEC CONSULTANTS

Soil-Geosynthetic Interaction
Testing Laboratory
5775 Peachtree Dunwoody Road, Suite 11D
Atlanta, Georgia 30342 • USA
Tel. (404) 705-9500 • Fax (404) 705-9300

31 July 1998

Mr. Terry Mandziak
Golder Associates, Inc.
200 Union Boulevard, Suite 500
Lakewood, Colorado 80228

Subject: Final Report
Direct Shear Testing
East Cresson Ore Material
Golder Project No. 983-2348.121

Dear Mr. Mandziak:

GeoSyntec Consultants (GeoSyntec) is pleased to present the enclosed final report on the direct shear testing performed for Golder Associates, Inc. (Golder) for Golder project No. 983-2348.121. The testing program was conducted in accordance with the test procedures defined in the 23 June 1998 facsimile transmittal prepared by Mr. Terry Mandziak of Golder and transmitted to Mr. Robert H. Swan, Jr. of GeoSyntec. All of the testing was conducted at GeoSyntec's Soil-Geosynthetic Interaction Testing Laboratory located in Atlanta, Georgia.

GeoSyntec appreciates the opportunity to provide laboratory testing services to Golder for Golder Project No. 983-2348.121. Should you have any questions regarding the enclosed report, please do not hesitate to contact any of the undersigned.

Sincerely,

Zehong Yuan, Ph.D., P.E. (Georgia)
Assistant Program Manager

Robert H. Swan, Jr.
Laboratory Manager

Gary R. Schmertman, PhD., P.E. (Georgia)
Senior Project Engineer

Enclosure

GLI0603/SGI98073.LTR

Prepared for

Golder Associates, Inc.
200 Union Boulevard, Suite 500
Lakewood, Colorado 80228

FINAL REPORT
DIRECT SHEAR TESTING

EAST CRESSON ORE MATERIAL
GOLDER PROJECT NO. 983-2348.121

Prepared by

GeoSyntec Consultants
Soil-Geosynthetic Interaction Testing Laboratory
5775 Peachtree Dunwoody Road, Suite 11 D
Atlanta, Georgia 30342

Project Number GLI0603

31 July 1998

1. INTRODUCTION

This report was prepared by Mr. Robert H. Swan, Jr. and Dr. Zehong Yuan, P.E. (Georgia), both of GeoSyntec Consultants (GeoSyntec), Atlanta, Georgia. The report was reviewed by Dr. Gary R. Schmertmann, P.E. (Georgia), also of GeoSyntec, in accordance with the internal peer review policy of the firm. The laboratory testing program described in this report was performed at the request and authorization of Mr. Terry Mandziak of Golder Associates, Inc. (Golder), Lakewood, Colorado.

Golder authorized GeoSyntec to undertake a laboratory testing program to evaluate the shearing resistance of an East Cresson ore material for Golder project No. 983-2348.121. GeoSyntec understands that the sample preparation procedures and testing conditions used in the testing program were selected by Mr. Terry Mandziak of Golder to model anticipated field conditions. The direct shear testing was conducted at GeoSyntec's Soil-Geosynthetic Interaction Testing Laboratory located in Atlanta, Georgia.

2. TESTING PROGRAM

2.1 Scope

The testing program consisted of one direct shear test series. The direct shear test series consisted of three tests.

2.2 Testing Method

The direct shear tests were performed in accordance with the American Society for Testing and Materials (ASTM) Standard Test Method D 3080, "*Direct Shear Testing of Soils Under Consolidated Drained Conditions*". The tests were conducted in a large direct shear device containing an upper and lower shear box. The upper shear box measured 12 in. by 12 in. (305 mm by 305 mm.) in plan and 3 in. (75 mm) in depth. The lower shear box measured 12 in. by 14 in. (305 mm by 355 mm) in plan and 3 in. (75 mm) in depth.

2.3 Soil Material

The soil material used in the testing program is presented in Appendix A. The soil material was obtained from the project site by Golder and delivered directly to GeoSyntec for testing.

2.4 Test Configuration and Procedures

The configuration of the test specimens and the specific test procedures used to conduct each of the direct shear tests are presented in Appendix B. GeoSyntec understands that the test procedures and test conditions were selected by Mr. Mandziak of Golder to model anticipated field conditions.

3. TEST RESULTS

For each of the direct shear tests, the total-stress shearing resistance was evaluated for each applied normal stress. The test data were plotted on a graph of shear force versus horizontal displacement. The resulting plots are presented in Appendix C. The peak value of shear force was used to calculate the peak shear strength. For this report, the large displacement shear strength (τ_{LD}) was calculated using the shear force measured at the end of each test. No area correction was used when computing normal and shear stresses because each test was performed using a constant effective sample area (i.e., the area of the lower shear box was larger than that of the upper shear box).

The calculated shear strengths were plotted on a graph of shear stress versus normal stress and the results were used to evaluate total-stress peak and large displacement shear strength envelopes. A best-fit straight line was drawn through the data points from the test series to obtain total-stress peak and large displacement shear strength friction angles and cohesions. The coefficient of correlation (R^2), a standard statistical indicator of how well the best-fit line matches the test data, was obtained for each best-fit line. The summary plots of shear stress versus normal stress for the test series are also presented in Appendix C. The friction angles, cohesions, and R^2 values derived from the plotted test results are presented in Table 1.

For the test series, it is noted that the reported total-stress shear strength parameters of friction angle and cohesion were determined based on the best-fit straight line drawn through the test data on a plot of shear stress versus normal stress. Caution should be exercised in using these shear strength parameters for applications involving normal stresses outside the range of stresses covered by the test series.

4. CLOSURE

The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analyses unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. This testing report is submitted for the exclusive use of Golder.

TABLE 1

DIRECT SHEAR TEST RESULTS
MEASURED TOTAL STRESS SHEAR STRENGTH PARAMETERS
GOLDER ASSOCIATES, INC.
GOLDER PROJECT NO. 983-2348.121

Test Series Number	Soil Specimens Tested[1]	Normal Stress (psi)	Peak Strength[2]			Large Displacement Shear Strength[2,3]			Reference Appendix Figure Numbers
			Friction Angle	Cohesion (psf)	R^2	Friction Angle	Cohesion (psf)	R^2	
1	Internal Strength Of East Cresson Ore Under Wetted Conditions	50 to 150	39°	160	1.000	39°	160	1.000	C-1 and C-2

Notes: (1) See Appendix B for detailed test conditions and procedures.

(2) The reported total-stress shear strength parameters for the test series were determined from a best-fit line drawn through the test data. Caution should be exercised in using these shear strength parameters for applications involving normal stresses outside the range of stresses covered by the test series. The value of R^2, the coefficient of correlation, provides an indication of how well the best-fit shear strength parameters match the test data.

(3) The large displacement shear strength (τ_{LD}) was calculated using the shear force measured at the end of each test.

APPENDIX A

SOIL MATERIAL

Soil Material

An East Cresson ore material was used in the testing program. Bulk samples of the ore material were obtained from the project site by Golder and delivered to GeoSyntec for testing.

APPENDIX B

TEST PROCEDURES AND CONDITIONS

TEST PROCEDURES AND CONDITIONS
TEST SERIES NUMBER: 1

Test Specimen Configuration (from top to bottom) and Placement Conditions:

- rigid substrate;
- East Cresson ore material initially placed at a dry unit weight of 102.4 to 103.5 pcf and a moisture content of 2.6 to 3.5%. Final moisture content ranged from 10.2 to 11.8% for the test series; and
- rigid substrate

Test Interface: within the soil specimen

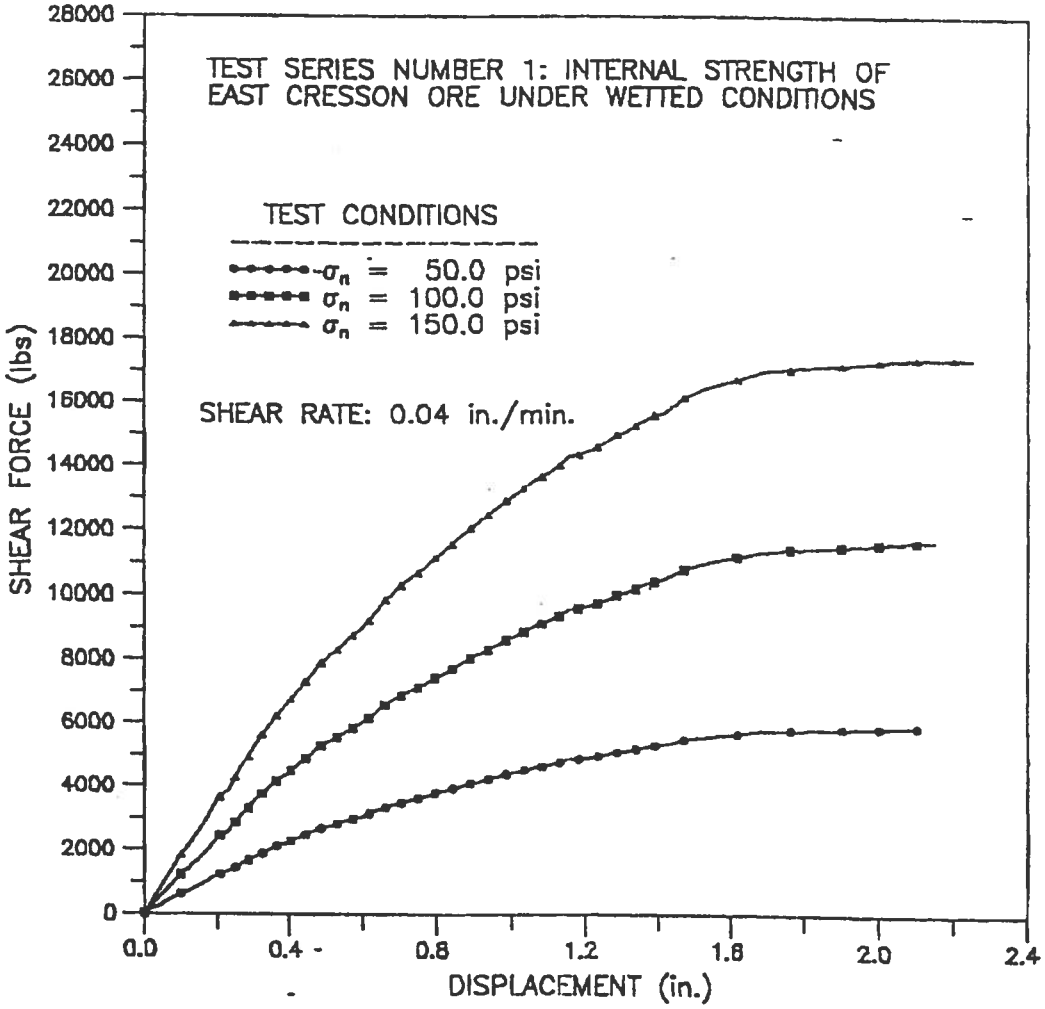
Test Procedures for Each Normal Stress Condition:

- A fresh specimen of the soil at its as-received moisture content was compacted in three 2-in. thick lifts within the lower and upper shear boxes, to form a 6 in. thick test specimen. Each lift was compacted by hand tamping to the reported dry unit weight. The initial target dry unit weight was not specified by Golder.
- Wetting Conditions: the soil specimen was wetted by pouring tap water into the upper shear box and allowing the water to drain through the gap between the upper and lower shear box.
- Test normal stresses: 50, 100, or 150 psi.
- Constant shear displacement rate: 0.04 in/min.
- Each test was sheared until a minimum total shear displacement of 2 in. was achieved.

APPENDIX C

TEST RESULTS

GOLDER ASSOCIATES, INC.
DIRECT SHEAR TESTING



NOTE: The shear box size was 12 in. by 12 in. (300 mm by 300 mm), and the contact area remained constant throughout the entire test.

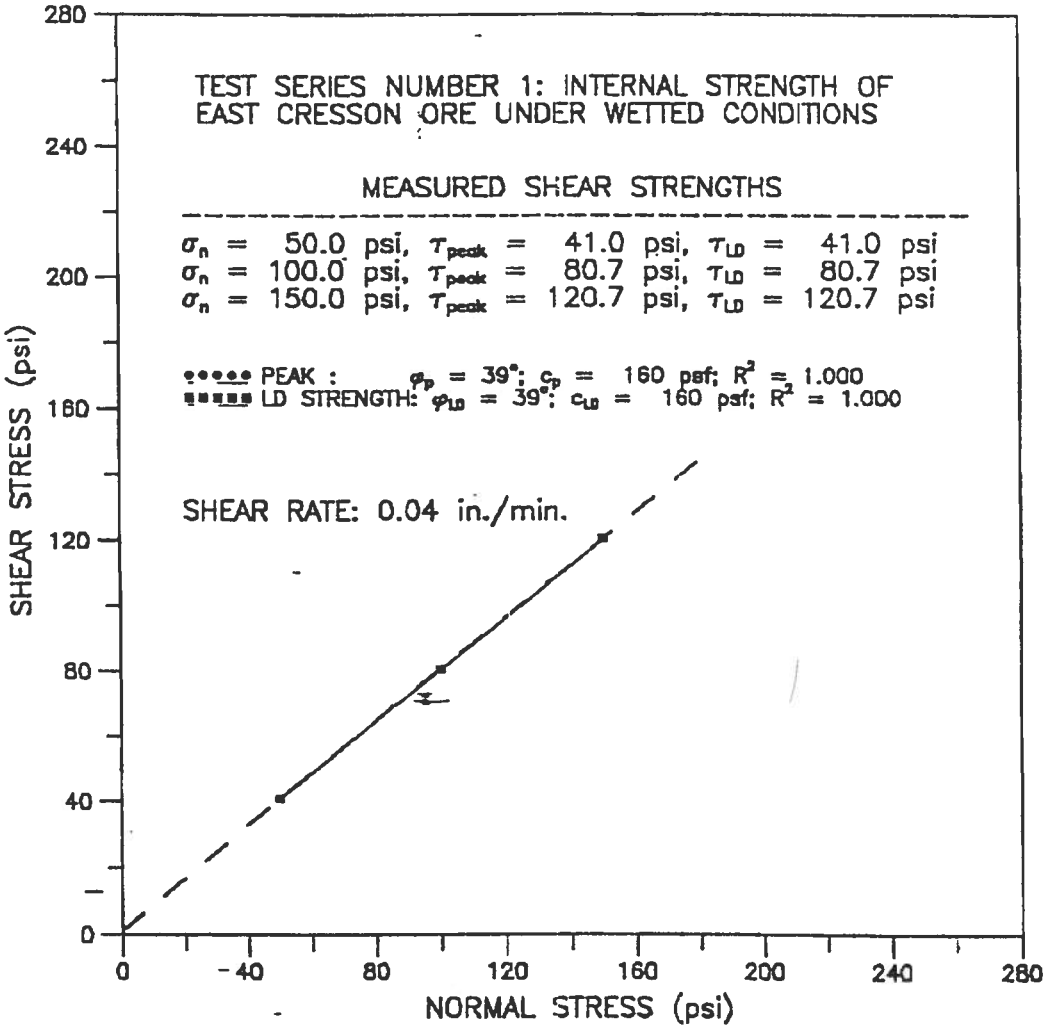
DATE TESTED: 26 TO 27 JUNE 1998

GeoSyntec Consultants

SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-1
PROJECT NO.	GLI0603
DOCUMENT NO.	SGI98073
FILE NO.	

GOLDER ASSOCIATES, INC.
DIRECT SHEAR TESTING



NOTES: (1) The reported total-stress shear strength parameters of friction angle and cohesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of stresses covered by the test series.
(2) The large displacement shear strength (τ_{LD}) was calculated using the shear force measured at the end of the test.

DATE TESTED: 26 TO 27 JUNE 1998

GeoSyntec Consultants
SOIL-GEOSYNTHETIC INTERACTION TESTING LABORATORY

FIGURE NO.	C-2
PROJECT NO.	GI10603
DOCUMENT NO.	SGI98073
FILE NO.	