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January 31, 2006

Hand Delivered

Mr. David Ohori Mining and Minerals Division Energy, Minerals and Natural Resources 1220 South St. Francis Drive Santa Fe, New Mexico 87505

Dear Mr. Ohori:

Re: Supplemental Borrow Materials Investigation Report, Condition L.5, Permit No. GR010RE

Please find attached an Addendum to the Golder Associates report dated October 31, 2005, Preliminary Borrow Source Materials Investigation Leach Ore and Waste Rock Stockpiles. This addendum to that report finalizes the study as required under the above-referenced permit and condition.

Please contact Mr. Greg Schoen (505) 574-6359, if you have any questions or comments.

Very truly yours,

Ned Hall

E. L. (Ned) Hall, Manager Environment, Land & Water New Mexico Operations

ELH:gs Attachment 20060124-100

c Clint Marshall

Golder Associates Inc.

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ADDENDUM TO PRELIMINARY BORROW SOURCE MATERIALS INVESTIGATION LEACH ORE AND WASTE ROCK STOCKPILES DP-1341 CONDITION 79

Submitted to:

Phelps Dodge Tyrone, Inc. P.O. Box 570 Tyrone, NM 88065

Submitted by:

Golder Associates Inc. 4910 Alameda Blvd. NE, Suite A Albuquerque, NM 87113

Distribution:

8 Copies – Phelps Dodge Tyrone Inc.

3 Copies - Golder Associates Inc., Albuquerque

January 30, 2006



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Soil Hydraulic Properties Laboratory Report

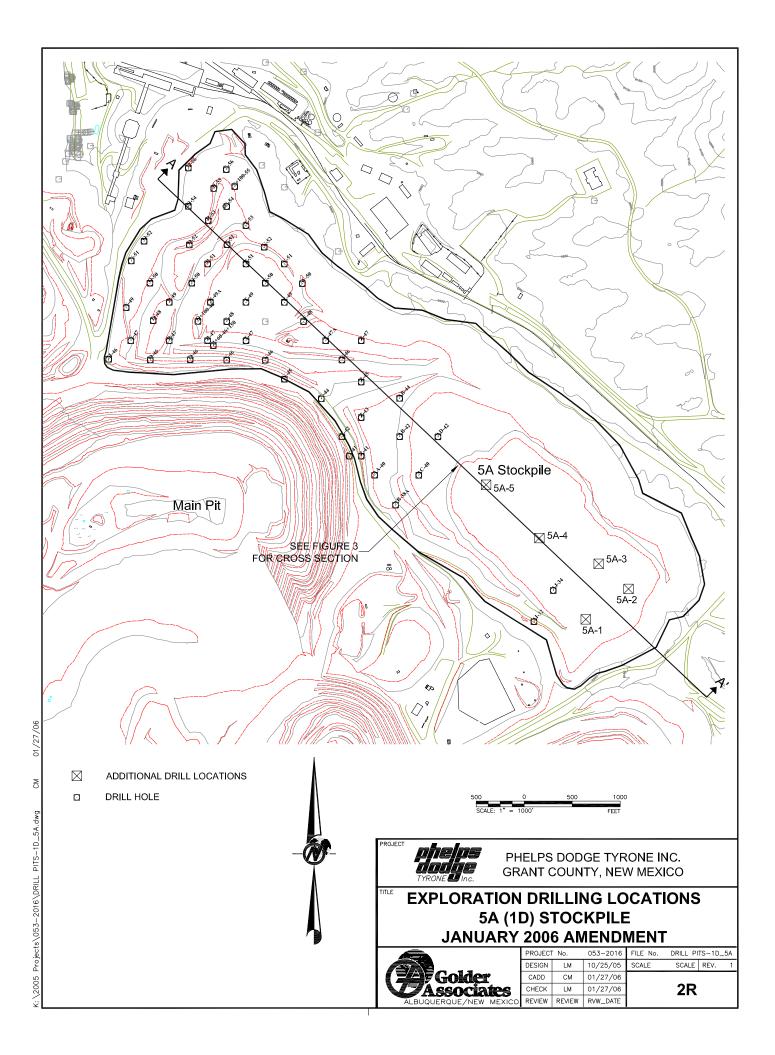
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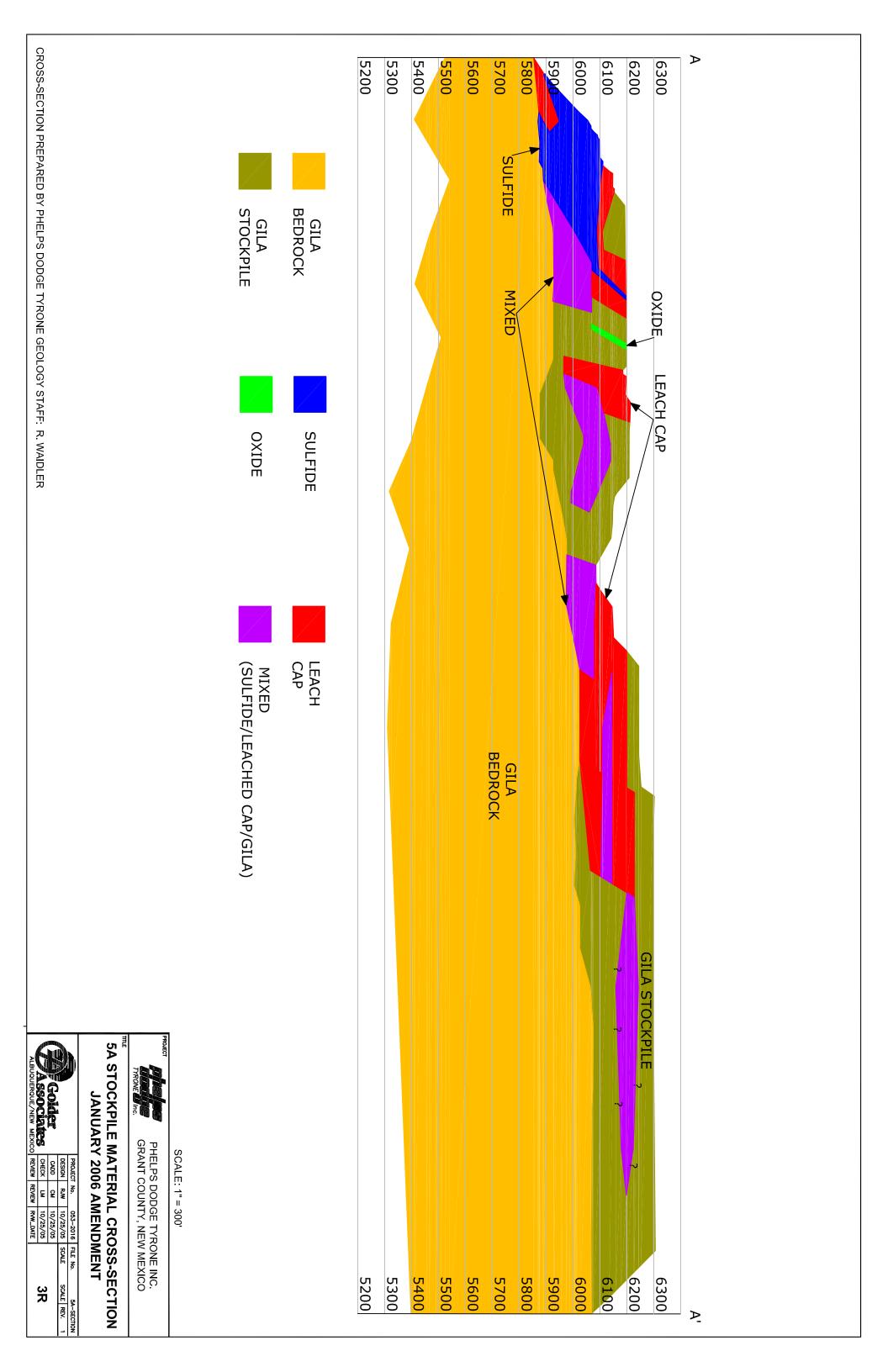
This document represents a transmittal of data that is intended to fill data gaps in the *Preliminary Borrow Source Materials Investigation Leach Ore and Waste Rock Stockpiles* (SMBI), which was submitted to the New Mexico Environment Department (NMED) and Mining and Minerals Division (MMD) in October 2005. The SBMI is intended to fulfill Condition 79 of DP-1341 and Condition L.5 of the Permit Revision 01-1 to Permit No. GR010RE. In the October 2005 SBMI report, Phelps Dodge Tyrone, Inc. (Tyrone) committed to providing additional drilling and soil hydraulic analyses by January 31, 2006. Specifically, this addendum provides:

- 1) Revised drill hole location map showing the actual location of the drill holes (Figure 2R),
- 2) Revised cross-sections for the 5A Stockpile based on newly acquired drilling and geologic descriptions (Figure 3R),
- 3) Drill logs prepared by the Tyrone geology staff (Appendix D) and ,
- 4) Additional soil hydraulic properties data (Appendix E).

These data are intended to augment the October 2005 SBMI. The supplemental drilling on the 5A stockpile indicates that materials with mixed character (Gila Conglomerate, leached cap, and sulfides) may occur within the stockpile. The far southern end of the stockpile appears to be relatively free of mixed materials and suggests that additional volume could be recovered in this area. However, because of the uncertainty of the exact distribution and character of the materials in the lower lifts of the 5A stockpile, Tyrone does not intend to modify the October 2005 estimates of the volume of cover materials at this time. The potential occurrence of mixed materials, which could be acid-forming, suggests that field monitoring should be implemented during the excavation of the 5A Stockpile for cover materials.







APPENDIX D DRILL LOGS - 5A STOCKPILE

Pheips Dodge Tyrone Mine - Geological Services Drill Hole Logging Form Project: 5A COUER MATERIAL Hole Number: 5A-L North Northing: 12900.137 Easting: 16738.532 C.E. 6299.521 Date Drilled: 11-08-05 Type: RC-0RY Hole Depth: 250 Orientation: - 90 Logged by: RJW Interval Drill Loa Graphic Log Graphic Log Notes Alteration Mineralization (vol%) Enrich Tcu OxCu QLT Elev. Ft. H₂O Rock Cade WC YC OS Otz Ksp Chi FeQx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Qxide (Rock Description, Alteration, Mineralization, Structure) ANGULAR COARSE SAND & GRAVEL CONSTING \mathcal{O} SALT: OF FRAGINEATS OF GRAHO-DIDRITE, M.P. & MOSTLY GILA CONG ICLAY: GRANITE NO VISIBLE SULFIDES. TRACE
OF BLACK CO OKIGE - 5% CLAY. MYMOR GT
STAINING LIGHT BERWA COLOR 0 10 PALT: ALGULAR COARSE SANOS GRAVELOF TRACE SULFIDE SALT: MP & GRAHME TRACES OF CC CLAY: ~5% CLAY /YEDIUM BROWN 20 COLOR. NO FRAGMENTS OVER 1/2" LCAP: MOST SAND-SIZED 20 PALT: ANGGLAR SAMOX GRAVEL~ 10% CLAN TRACE SULLIUM SALT: MP (MOSTLY) MINUTE TRACES OF CC GRANCE UP TO I'M ACROSS - MOSTLY 30 COARSE SAND. MENUM DROWN COLOR LCAP: ANGULAR COARSE SANDE GRAVELY.
MOSTRY SAME MP W/ TRACES OF
ENRICHEDICC) PY ~ 10% CLAY PALT: 30 SALT: CLAY: 40 MEDIUM BROWN COLOR MIMORGI LCAP: STAILING. PALT: MEDIUM- BROWN COAKSE SAND & 40 MOSTLY GILAMAG SALT: COKINGL- PIECES UP TO 1/2" DIA. 150 CLAY: FRAGMENTS OF MP & GD TRACES OF BLACK CO OXIDES. LCAP: omposite: <5% CLAY 50 PALT: MEDIUM BROWN LANGULAR COAKSE GRANGO SAND & GRAVEL FRAGMENTS SALT: GILA CONG. UP TO 3/4" DIA. < 5% CLAY CLAY: 100 TRACKS OF BL. CU DYIDES ON SOME LCAP: FRAGMENTS, MP& GD FRAGMENS PALT: KEDDISH- BROWN SAND-CLAYN 1576 6 SALT: W/ SOME GRAVEL - FRAGMENTS OF CLAY: GD W/TRACES OF BLACK CO DXIDES NO VISIBLE SULFIDES, LOCK-POUDGE 10 LCAP: PALT: REDDISH-BROWN COARSE ANGULAR 10 SALT: SAUG ~ 15% CLAY- OCCASSIONAL CLAY: PREBLES. SAND GRAINS ANGULAR 80 DUARTZ FRAGMENTS NO VISIBLE LCAP: SULFICES. 80, PALT: REDDISH-BROWN CLAY COORSE SAND SALT: WI UERY OCCASSIONIN PERBUES CLAY: LOCER & FOUNDERY- NO VISIBLE در. و درو 90 SULFIDES, 15% - 2010 CLAY. LCAP: 90' PALT: KENDISH-BROWN LOOSE POWDERY GILA COPG. SALT: CLAY, ANGULAR SAND-FEW VERY FEW CLAY: PERBUS NO VISIBLE SULFIDES. 15%-20%-CLAY. LCAP:

Orill Hole Logging Form ⊃roiect: Hole Number: 5A-1 Northing: Easting: Date Drilled: 11-08-05 Type: Logged by: RJW Hole Depth: Orientation: Drill Loa Alteration Graphic Log Graphic Log Notes Mineralization (vol%) Enrich Notes Tou OxCu Q! T Elev. Ft. H₂O Rock Code WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure), KEDDISH-BROWN) CLAH BALWING 100 GILA CONG. SALT: W/MINDR SAMBALMOST NO PERELE 180 /5 CLAY: MO UISIBLESULFIDES CLAY CONTENT 110 MCREENE WIDEPTH. LCAP: PALT: REDDISH-BROWN LOOSE POWDERY CLAY 110 SALT: ANGULAR SAND-FEW PREBLES ~ 15% CLAY: CLAY- CLAY SUGHTLY LESS THAN 120 ABOUT. MO VISIBLE SULLIGES LCAP: PALT: MEDIUM- BROWN ANGULAR COARSE OLI SALT: SAND CLAT (~ 10%) & PEBBLES NO CLAY: MORE GRAVEL - UP TO 1/2" DIA VISIBLE ANGULAR FRAGMENTS, TRACE SULFIDA 30 LCAP: BLACK OXIDE ON SOME PERRIES. PALT: LIGHT BROWN LOASE HOWDERY 130 SALT: ANGULAR SAMO, CLAY & GRAVEL FRAGMENTS OF GD. AD VISIBLE CLAY: Q.D. SULFIDES - NO SECONDAPY MYGRAIS LCAP: ~10% CLAY PALT: MEDIUM BROWN COARSE ANGULAR 140 SALT: SAMO MINOR CLAY: ANGULAR CLAY: GRAVEL-GD NO VISIBLE SULFIDES 19 OR SECONDARY ANNIRALIZATION LCAP: mposite: PALT 150 LIGHT BROWN COARSY ANGULAR SALT: SAMO. MINOR CLAY: GRAVEL UP TO 1/2 CLAY: DIA. FRAGMENTS OF GD & MP 160 SCATTEREL GRAINS OF TYRITE IN MP LCAP: FRAGMENTS. PALT: MEDIUM BROWN ANGULAR COARSE 160 SALT: SAME MUNDE CLAY & APAIL FRAGMENTS OF GD & MP TRACES OF BLACK OXISE CLAY: 170 ON MP FRAGMENTS LCAP: MO VISIBLE SULFILDES PALT: LIGHT TO MEDIUM BROWN ANGULAR 170 SALT: COARSE SAND MINOR CLAY SCATTERIN CLAY: GRAVEL FRAGMENTS-TRACES OF 180 FARICHEL PARTE. LCAP: PALT; MEDIUM BROWN MYGULAR COARSE 180 SALT: SPAD. MINOR CLAY & GRAVEL-SOME CLAY: FRAGMENTS WI BLACK OXIDES OIL SURFACE 190 NO VISIBLE SULFIDES LCAP: PALT: MECKUPY BROWN ANGULAR COARSE 100 GILA CONG. SALT: SAMO, PUNCE CLAY & GRAVEL CLAY: FRAGMENTS MINUTE TRACK OF ENFICYED PYRITE ON FRAGMENT OF GD LCAP: nposite:

Phelps Dodge Tyrone Mine - Geological Services Orill Hole Logging Form Project: 5A STOCKPILE COULE MATERIAL Hole Number: 5A-1 Northing:

Date Drilled: 11-08-05Type: PC-DAY Hole Depth: Easting: Logged by: RJW Orientation: Interval Drill Log Graphic Log Graphic Log Notes Alteration Mineralization (vol%) Enrich Notes Tcu OxCu CLT Elev. Ft. H₂O Rock WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide Code (Rock Description, Alteration, Mineralization, Structure) PALT: LIGHT TO MEDIUM BROWN ANGULAR SALT: CONRSE SAUD, MILLOR CLAY & GRAVEL GILA CONG. FRAGMENTS, POSSIBLE AVAILTE TRACE OF BLACK OXIDE ON FRAGMENTS. CLAY: 120 LCAP: MO VISIBLE SOLFIDES. PALT: MEDIUM BROWN AMGULAR COARSE SAND 1010 SALT: MULLING CLAY & GRAVEL FRAGMENTS OF GO. MY MUTE TRALE OF FYRME. CLAY: 1 000 LCAP: PALT: LIGHT BROWN LOOSE POWDER! 720 SALT: ANGULAR SAND, CLAY & MIYOR GRAVEL FRAGMENTS. < 10% CLAY CLAY: 030 MO VISIBLE SULFIDES. LCAP: PALT: 19501 FIGHT BROWN LOOSE FOUNDED ANGULAR SANG, CLAY & GRAVEL SALT: FRAGMENTS < 10% TO 15% CLAY CLAY: NO VISIBLE SULFIDES OF SECONUMPY (41) LCAP; MAKERNIS. PALT: LIGHT BROWN LOOSE FOWERS 740 GILA CONG. SALT: ALGULAR SAMA, CLAY(1070-1570) CLAY: AND ANGULAR GRAVEL FRAUMENTS ×0 140 VISIBLE SULFIDES OR SMONDARY LCAP: MINERAUZATION omposite: F.DH. PALT; SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP:

Phelps Dodge Tyrone Mine - Geological Services Driff Hole Logging Form Project: SA DUMP CHARACTERIZATION Hole Number: 5A-2 RE-DRILLED Northing: 13215.409

Date Drilled: 11-08-05 Type: RC-DRY Hole Depth: 250 C.E.: 6297.334 Easting: 17184.008 Orientation: - 90° Logged by: RJW Alteration Mineralization (vol%) Analysis Interval Drill Log Graphic Loo Graphic Log Notes Code WC YC QS Qtz Ksp Chl FeOx FeSt CuOx CuSt Py PySt | Cc | CcSt | Cpy | CpySt | Omin1 | Omin2 | Other | Oxide (Rock Description, Alteration, Mineralization, Structure) Tcu OxCu QLT Elev. Ft. H2O Rock COARSE ANGULAK SAND & GRAVEL < 5% CLAY MEDIUM BROWN COLOR GILA CONG. SALT: NO VISIBLE SULFIDES - MINUTE TRACES DRY CLAY: OF BLACK DUDGES ON GRAVEL FRACEVERS LCAP: GDX MP. MEDIUM BROWN ANGULAR COARSE SAND PALT: & GRAVEL UP TO I" DIA FRAGIMENTS OF 10 SALT: RD HOLVISBLE SULFIDES VERY MAUTE CLAY: TRACE OF BLACK OXIDE COATINGS. LCAP MEDIUM BROWN ANGULAR COARSE SAND, PALT: 20 CRAVEL & MINOR CLAY ~ 5% VERY SALT: MINUTE TRACE OF PYRITE & BLACK OKIDE CLAY: COATING ON GO FRAMENTS. 30 LCAP: LIGHT BROWN ANGULAR COARSE SAND PALT: CRAVEL & < 5% CLAY VERY MIMUTE 30 SALT: TRACES OF BLACK OKIDES MO VISIBLE CLAY: SULFINES GO FRAGMENTS UP TO I'' 40 LCAP: IN DIA. MEDIUM BROWN ANGULAR COARSC SAND PALT: 40 GRAVEL & < 5% CLAY HO UISIBLE SALT: SULFIDES GD FRAGMENTS UP TO CLAY: 3/4" IN DIA. 50 LCAP: Composite: LIGHT BROWN ANGULAR COARSE SAND, GRAVEL & - 59. CLAY, GO FRAGMENTS. NO UISIBLE BULFIDES SALT: CLAY: a_{3} LIGHT REDDISH BROWN ANGULAR SAND PALT: & GRAVEL WIVERY MINDER CLAY THO VISIBLE SULFIDES. LARGE Q SALT: CLAY: FRAGMENTS ARE GO FINER SAMON LCAP: FEWER GRAVEL FRAGMENTS. LIGHT REDDISH BROWN ANGULAR PALT: FINE TO COARSE SAND, CLAY & MINOR GRAVEL LOOSE POWDERY ~ 107, TO 15% CLAY 10 SALT: CLAY: NO VISIBLE SULFIDES. LCAP: LIGHT BROWN LOOSE POWDERY FINE TO PALT: COARSE SAND, ~ 10% CLAY & MINOR ଖଠ SALT: P GRAVEL, TRACE OF PYRITE ON CLAY: ACCASIONAL FRAGMENTS do LCAP: LIGHT REDDISH BROWN LOSSE POWDERY PALT: 90 FINE TO COARGE SAND, MINOR CLAY-5% & SOME GRAVEL, MYNUTE TRACES OF PYRITE GILA CONG SALT: CLAY: GD FRAGMENTS. 100 LCAP: Composite:

Phelps Dodge Tyrone Mine - Geological Services Page: 2 of 3 Drill Hole Logging Form Project: 5A DUMP CHARACTERIZATION Hole Number: 5A-2 BE-DRILLED Northing: Easting: Type: RC-DR1 Hole Denth: Logged by: RJW Orientation: Interval Drill Log Graphic Log Graphic Log Notes Alteration Mineralization (vol%) Enrich Notes Tou OxCu OLT Elev. Ft. H2O Rock Code WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) PALT: MEDUM REDDISH BROWN LOOSE FOUNTAIN GILA CONG. FINE 30 COARSC SAND MINOR CLAY SOME GRAVEL FRAGMENTS : MINUTE CLAY: TRACE OF SULFIDE- CC- ON FRAGMENT .CAP: PALT: VERY RED LOOSE POWDERY FILLE & 0)3 SALT: COARSE ANGULAR SAND ~ LOTO CLAY VERY OCCASSIONAL GRAVEL FRADUKNIS CLAY: UKRY MINUTE TRACES OF CC ON LCAP: SCATTERED FRAGMENTS. PALT: 120 DARK RED POWDER FINE TO COARSE SALT: SAND, CLAY ~ 1070, AND VERY OCCASIONAL GRAVEL FRACHENTS W/TRACES OF CC CLAY: 130 40 VISIBLE PYRITE LCAP: PALT: 130 DARK RED POWDER! FINE TO COARSE SALT: SAND, CLAY~10% & UERY OCCASSIONAL GRAVEL FRAGMENTS. TRACES OF CC ON CLAY: OCCASSIONAL FRAGMENTS OF GD NO LCAP: VISIBLE PYRITE. PALT: 140 MEDIUM REDDISH BROWN ANGULAR FINE SALT: TO COPRSE SAND MYNOR CLAY~ 5% & CLAY: GRAVEL-FRAGMENTS ARE CO-MINUTE 150 TRACES OF CC HO VISIBLE PYRITE LCAP: Composite: MEIDUM BROWN FOUNDERY FINE TO COARSE SAND, CLAY (~ 1090) & CIRAVEL GD FRAGMENTS + SOME W/VERY 50 SALT: CLAY: W MINUTE TRACES OF SULFIDE LCAP: MEDIUM REDDISH BROWN POWDERY 160 SALT: FIXE SAND, COARSE SAND MYNOR CLAY ~ 10% & OCCASSIONAL GRAVEL CLAY: FRAGMENTS OF GD MOUISIBE SULFIDES LCAP: PALT: MEDIUM REDDISH BROWN POWDERY FINE SALT: TO COARSE SAND, CLAY - 10961 & OCASSIGNAL CLAY: GRAVEL FRAGMENTS & GN NO VISIBLE 180 SULFIDES. LCAP: PALT: MEDIUM BROWN POWDERY FINE TO 180 SALT: COARSE SAND, CLATIONO & GRAVEL FRAGMENTS, MINUTE TRACES OF CLAY: 190 SULFIDE ON SOME GO FRAUNENTS LCAP: DARK RED POWDERY FINE TO CORSEISHAD GILA CONG. SALT: -100 15% CLAY, OCCASIONAL GRAVEL FRAUMENTS OF GO AND USIBLE PIRITE GRAVEL FRAGMENTS SMALL.

CLAY:

900

Composite:

Phelps Dodge Tyrone Mine - Geological Services Drill Hole Logging Form Project: Hole Number: 5A-2 REDRILLED Easting: C.E.: Type: RC-DRY Hole Depth: Orientation: Logged by: Interval Drill Log Analysis Graphic Log Graphic Log Notes Alteration Mineralization (vol%) Enrich Tou OxCu QLT Elev. Ft. H2O Rock WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide Code (Rock Description, Alteration, Mineralization, Structure) PALT: MEDIUM REDDISH BROWN FOUNDERLY 200 GILA CONG. SALT: FINE SAND, COARGE SAND, MYNOR CLAY CLAY: ~10% X OCCASSIONAL FRAGMENTS OF GD NO VISIBLE SULFIDES. LCAP: PALT: DARK RED POWDERY FINE & COARSE No SALT: SAND, ~ (0% CLAY, OCCASSIOOR) CLAY: FRAGMENTS OF GD. NO VISIBLE po SOLFIDES LCAP: PALT: REDOISH MEDIUM BROWN GRAVEL WI SALT: GD FRAUMENTS, COARSE TO MINE SAND CLAY: & MINOR CLAY~ 10% NO VISIBLE SULFIDES. LCAP: PALT: MEDIUM BROWN ANGULAR COAKSE TO SALT: FINE SAND, GRAVEL AND MYMOR CLAY (5%-10%) GD GRAVEL FRAGMENTS NO VISIBLE SOLFINES CLAY: LCAP: 140 PALT: MEDIUM TO LIGHT BROWN POWDERY GILA CONG. SALT: FILE TO COARSE SAND, MNOR CLAY 570- LOTO & VERY DOCASIONAL GRAVEL FRAGMENTS OF GD MO VISIBLE SULFIDES 1 CLAY: LCAP: Composite: F.O.H PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY:

LCAP:

Composite:

Phelps Dodge Tyrone Mine - Geological Services Page: (of $\stackrel{\textstyle >}{\sim}$ Drill Hole Logging Form Project: DUMP CHERECTERIZATION

Hole Number: 5A-3 (RE-DRILLED) Northing: 13477.208

Date Drilled: 11-12-05 Type: RC-DRY Hole Depth: 250' c.E.: 6298.220 Easting: 16873.702 Orientation: -90 Logged by: RJW Analysis Interval Drill Log Graphic Log Notes Alteration Graphic Log Mineralization (vol%) Enrich Notes Tcu OxCu OLT Elev. Ft. H₂O Rock Cade WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) PALT: MEDIUM TO DARK BROWN GRAVEL, 0 GILA CONG. SALT: COARSE TO MEDIUM SAND- VERY MUNICE TRACES OF BLACK OXIDE CLAY: 10 NO UISIBLE SULFIDES GILACONGL. LCAP: PALT: MEDIUM BROWN ANGULAR COARSETO FINE SAND & GRAVEL VERY MUNDE 10 SALT: TRACES OF CC GRAINS NO VISIBLE PYRME CLAY: LCAP: PALT: MEDIUM BROWN ANGULAR COARSE 20 SALT: TO FINE SAND & GRAVEL NO VISIBLE SULFIDES - MOSTLY COARSE SAND. CLAY: 20 LCAP: MEDIUM BROWN (SUGHTLY REDOISH) PALT: 30 SALT: ANGULAR COARSE TO FINE SAND- <5% CLAY MIMOR GRAVEL- MOSTLY COARSE CLAY: SAND NO VISIBLE SULFICES. 40 LCAP: MEDIUM BROWN MAGULAR COARSE PALT: цO TO FINE SAND 25% CLAY, MINOR GRAVEL - MOSTLY COARSE SAND NO SALT: CLAY: 13 VISIBLE SULFIDES. GD ROCK LCAP: Composite: PALT: MEDIUM BROWN ANGULAK COAKSE TO 50 SALT: MANE SAME 4590 CLAY: MINOR GRAVE MOSTLY COARSE SAND , NO VISIBLE CLAY: SUIFIDES POSSIBLE TRACE OF BLACK LCAP: OKIDE. PALT: LIGHTAN POWACRY COARSE TO FINE 60 SALT: ANGULAR SAMO, MINOR OLAY~5% TO 10% MUNOR GRAVEL TRACES OF PYRITE CLAY: GRAINS . LCAP; PALT: MEDIUM REDDISH BROWN COARSE TO ₹0 CLAY MNOR GRAVEL GO FRAGMENTS GILA CONG SALT: CLAY: 80 NO VISIBLE SULFIDES. LCAP: TAN COAKSE TO FINE ANGUMR Ω SAMO ~ 5 TO 10% CLAY MYHOR GRAVEL TRACE SULFIDES TIMY GRAINS OF PYRITE IN SOME CLAY: 90 PORPHYRY FRAGMENTS. PALT: LIGHT BROWN COARSE TO FINE ANGULAR 90 TRACE SULMOES SALT: 5AMD ~590 TO 1070 CLAY, MNOK GRAVEL TIMY DISSEMINATED GRANS OF PYRITE ON SAME LARGER ERHOMENTS MINIOR EMPRICHMENT CLAY: Composite:

Drill Hole Logging Form Project: 5A DUMP CHARACTERIZATION Hole Number: 5A-3 Northing: C.E.: Easting: Type: RC-DRY Hole Depth: 250 Orientation: -90° Date Drilled: Logged by: RJW Interval Drill Log Alteration Analysis Graphic Log Graphic Log Notes Mineralization (vol%) Enrich Tcu OxCu QLT Elev. Ft. H2O Rock Code WC YC OS Otz Ksp Chi FeOx FeSt CyOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) MEDIUM TAN COARSE TO FILL ANGUAR PALT: SALT: TRACE SOUFIDES SAND ~ 5% TO LOG CLAY MINOR GRAVEL 1110/02/ VERY SPARSC DISSEMINATED THAY CLAY: GRAINS OF HYRITE ON SOME LARGER CAP: FRAGMENTS OF GO. PALT: LIGHT TO MEDIUM BROWN COARSE TO o_{IJ} MINOR GRAVEL. BIOTITE FLAKES TRACE SULFIDES SALT: CLAY: 120 EXTRIMELY SPARSE SCATTERED GRAWS LCAP: OF FYRMS. PALT: TAN-BROWN COARSE TO FINE ANOUNT GILA CONG SALT: SAND ~ 5% TO LOTO CLAY, MUNICE GRAVEL CLAY: BIOTITE FLAKES GO FRAGMENTS NO MSIBLE SULFIDES LCAP: PALT: LIGHT TAN COARSE TO FINE ANGULAR 130 SALT: SAMP ~ 5% TO LOTO CLALY MYHOR 1/40/04/1 GRAVEL, GD FRAGMENTS BIOTHEFLAKES CLAY: MO VISIBLE SULFIDES. LCAP: PALT: TAN-KAKHI COARSE TO FINE ANGULAR υμο SAND ~5% TO 10% CLAY MUNORGRAVEL SALT: 150/04/ GD FRAGMENTS BIOTITE FLAKES CLAY: NO UISIBUE SULMARS. LCAP: Composite: PALT: TAN POWDERY COARSC TO FINE 19 SALT: ANGULAR SAHD ~5% TO 10% CLAY MINIOR GRAVEL GO FRAGMENTS MO CLAY: 160 UISIBLE SULFIDES; BIOTITE FLAKES. LCAP: PALT: REDDISH MEDIUM BROWN COARSE TO 160 SALT: FINE SAND ~5% TO 10% CLAY MUNOR GRAVEL GD FRAGMENTS BIOTHEFLAKES CLAY: 110 NO VISIBLE SULFIDES. LCAP: PALT: DARK KEDDISH COARSK TO FINE 110 SALT: PANGULAR SAND ~5% TO 10% CLAY MIMOR GRAVEL BIOTHE FLAKES CLAY: 180 NO VISIBLE SULFIDES. LCAP: PALT: MEDIUM BROWN CORRESTO FINE 180 SALT: SAND ~ 5% TO 10% CLAY: MIMOR GRAVEL GO FRAGMENTS BOTHE CLAY: FLAKES NO VISIBLE SULFICES. LCAP: MEDIUM BROWN COARSE TO FINE SAND PALT: Job. GILA COMG. SALT: ~5% TO 10% CLAY! MINOR GRAVEL. CO FRAGMENTS BIOTITE FLAKES CLAY: 90 140 VISIBUS SULFIDES. LCAP: Composite:

Phelps Dodge Tyrone Mine - Geological Services Drill Hole Logging Form Project 5A DUMP CHARACTORIZATION Hole Number: 5A-3 Easting: C.E.: Type RC-DRY Hole Depth: 250 Orientation: -90° Date Drilled: Logged by: Drill Log Interval Graphic Log Notes Alteration Mineralization (vol%) Analysis Graphic Log Enrich Notes Tcu OxCu QLT Elev. Ft. H₂O Rock Code WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) MEDIUM TO LIGHT BROWN COARSE TO PALT: FINE ANGULAR SAND ~5% TO 10% CLAY. GD FRAGMENS BIOTHE FLAMES GILA CONG. SALT: CLAY: MO VISIBLE SULFIDES LCAP: 12/01 MEDIUM BROWN, COARSE TO FINE PALT: SAND (ANGULAR) ~5% TO 10% CLAY SALT: GRAVEL. GO FRAGMENST. BIOTITE
FLAKES. MAUNITHE GRAVILLE FEW)
NO VISIBLE SULFIDES.
LIGHT BROWN COARSE TO FINE CLAY: LCAP: PALT: MAGULAR SAMO. ~5% TO LOTO CLAY
MUNDE GRAVEL SCATTERED FLAKES
OF BIOTITE & GRAMS OF MAGNETITE SALT: CLAY: LCAP: NO VISIBLE SULFIDES. LIGHT GROWN COARSETO FINE PALT: SALT: ANGULAR SAND. GD FRAGMENTS SCATTERED FLAKES OF BIOTHES CLAY: SCARTERED GRANS OF MAGNETITE NO LCAP: VISIBLE SOUPIDES. PALT; LIGHT BROWN COARSE TO HAVE ANGULAR SAMO ~5% TO 10% CLAY MUNOR GRAVEL GD FRAGMENTS BCATTERED FLAKES & GRAINS OF BLOTTTE GILA CONG. SALT: CLAY: LCAP: & MAGNETIE NO VISIENCE SULFIDES EAH Composite: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: PALT: SALT: CLAY: Composite:

Project: Northing: 13746.329N Easting: 16254.615 CE: 6299.719 Hole Number: 5A-4 Logged by: RJ WAIDLER Orientation: -90° Date Drilled: 16-13-05 Type: RC-DRY Hole Depth: 250 Notes Enrich Mineralization (vol%) Alteration Interval Drill Log Graphic Log Graphic Log Notes Code WC YC QS Qtz Ksp Chl FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) Tcu OxCu QLT Elev. Ft. H2O Rock MEDIUM BROWN MIXED COARSETO PALT: FINE SAND, GRAVEL AND TRACE CLAY GILA CONG. SALT: FRAGMENTS CONSIST OF GD. MO CLAY: VISIBLE SOLFIDES OR SCOONDARY CU Q MINERALS. CILA MEDIUM BROWN MIXED COARSETO LCAP: PALT: FINE ANGULAR SAND, GRAVEL TRACE CLAY, TRACES OF CC & BLACK ORDES 10 SALT: CLAY: ON LARGER FRACMENTS. HE VISIBLE 20 LCAP: PYRITE, QILA MEDIUM BROWN MIXED COARSE TO PALT: FINE ANGULAR SAND VERY MINOR CLAY SALT: SOME GRAVEL FRAGMENTS TRACES OF ENRICHED PYRICE GRAINS GILA CLAY: 30 LCAP: XXEDIUM BROWN MIXED COARSE TO PALT: 30 FINE ANGULAR SAND, OCCASSIONAL SALT: GRAVEL FRAGMENTS: MYNOR CLAY NO CLAY: USIBLE SULFIDE VERY MINUTETRACE OF BLACK OXIDE. GILA LCAP: LIGHT MEDIUM BROWN COARSE TO FINE PALT: 40 ANGULAR SAND OCCASIONAL GRAVEL SALT: FRAGMENTS MUNIOR CLAY: TRACES OF PYRITE CLAY: GRAINS; UERY MUNUTE TRACES OF BLACK 50 LCAP: Oane. GILA Composite: LIGHT TO MEDIUM BROWN COARSE TO PALT: 50 FINE ANGULAR SAND, SOME CRAVEL GILA CONG. SALT: FRAGMENTS WILDRICLAY BIOTITE FLAKES CLAY: VERY MAINTE-MOTOR TRACES OF BLACK 60 LCAP: OKIDE GILA. LIGHT BROWN COARSE TO FINE ANGULAR SAND SOME GRAVEL FRAGS MINOR CLAY, SCAMERED GRAVE OF PALT: 8 TRACE SULFICE SALT: CLAY: PYRITE IN SAND & IN FRAGMENTS. 10 LIGHT REDDISH BROWN FINETO COARSE SAND; OCCASSIONAL GRAVEL PALT: TRACE SULFIDE SALT: FRAGMENTS ~5% TO 10% CLAY WIDELY CLAY: SCATTERD GRAINS OF PYRITE. CAP: EINE TO COARSE SAND ~570 TO 1070 CLAY PALT: 80 TRACESULIDE OCTASSIONAL GRAVEL FRACKENTS CLAY: SCATTERED FYRME GRAINS IN SAIL AS 90 WILL AS OPIN GRAVEL FRAGMENTS (SOME) LCAP: -{+}+}+ MEDIUM TO DARK REDDISH BROWN FINE PALT: TO COOKSE PINGULAR SAND; OCCASSIONAL OO TRACE SULFICE SALT: GRAVEL FRAGMENTS: 5%-10% CLYT TRACES OF PYRITE PRESENT ON/M CLAY: LCAP: LARGER FRAGMENTS. Composite:

Phelps Dodge Tyrone Mine - Geological Services

Drill Hole Logging Form

Drill Hole Logging For	rm							•				•										
Project:			•																			ŀ
Hole Number: 5A-	-4	Northing:		Easting:				C.E	Ξ.;												•	
Date Drilled:	Type: RC-DRY	Hole Depth: 25	\circ'	Orientation	n:			Log	gged by:	RJI	N											
	Interval Drill Log	Graphic Log	Graphic Log Notes	Alteration	,	Altera	tion.					λ.	Aineraliz:	ation (vol	l%)				Enrich		Notes	
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Drill Hole Logging Form			
Project: Hole Number: 5A-4 Northing:	Easting:	C.E.:	·
Date Drilled: Type: Hole Depth: 250	Casung: Orientation:	Logged by: ROW	,
	Graphic Log Notes Alteration Alteration	Mineralization (voi%) Enrich	Notes
Tcu OxCu QLT Elev. Ft. H ₂ O Rock	Code WC YC QS Qtz Ksp Chi	FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide	(Rock Description, Alteration, Mineralization, Structure)
	PALT:		MEDIUM TO LIGHT BROWN COARSE TO
200 21 3	ILA CONG. SALT:		FINE SAMPIANGULAR) 5% TO 10% CLAY SOME GEROUT. EXPENSELY SPRESE
	CLAY:		SCATTERED TIMY GRAIMS OF FYRME: NO
	LCAP:		SECONDARY OU MUMERALS.
20 7	PALT:		LIGHT TAN COARSE TO FINE SAND: 5%, TO 10% CLAN SOME GRAVEL; TIMY
	RACE SULFIDES SALT:		DISSEMINATED GRAINS OF PYRITE IN
			FRAGMENTS AND SAND NO SECONDARY
	LCAP:		CU MARRALS.
	PALT:		LIGHT TANMISH GRAY COAKS TO FINE SOUD: 590 TO 1090 CLAY: SOME GRAVEL
	CLAY:		SAMD; 5% to 10% CLAY; SOME GRAVEL TIMY DISSEMINATED GRAINS OF PYRITE
	I CAP:		IN FRAGMENTS & SANDING VISIBLE
	PALT: HHHHHHHHHHHHHHHHH		SECONDARY CU MYNERALS. MEDIUM TO DARK BROWN COARSE
1 1254 F Gen	GIAIAL SOIL SALT:		TO FINE SPND: 15% to 20% CLAY SOME CRAVEL. 'NO VISIBLE SULFICES
	ORIZON ? CLAY:		SOME ORAIGL. 'NO UISIBLE SULFIDES
	LCAP:		OR SECONDAPY CU MUNICIPALIZATION
71.50	PALT:		MEDIUM BROWN COARSE TO FINE
2000	SALT:		SAMD 5% TO 10% CLAY SOME GRAVEL NO VISIBLE SULFIDES OF SECONDARY
	CLAY:		CU MINERALS PLAKES OF BIOTITE
Composite:	LCAP:		E.O.H.
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CLU CRICES ACHINE MAIN ACHINE	Phelps Dodge Tyrone Mine - Geological Services Drill Hole Logging Form			Page: j of 3
Table Part	Hole Number: 5A-5 Northing: 14300.878	Easting: 15700.451 Orientation: - 90°	C.E.: 6295.904 Logged by: RJW 12-13-05	
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omposite: 1 BLACK OXIDES,	omposite:			BLACK OXIDES.

Drill Hole Lagging Form Project: Hole Number: 5A-5 Northina: Easting: Logged by: RJW 12-13-05 Type: RC-DRY Hole Depth: Orientation: Date Drilled: Interval Drill Log Graphic Log Notes Alteration Analysis Graphic Log Mineralization (vol%) Enrich Tcu OxCu QLT Elev. Ft. H₂O Rock Code WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) LIGHT TO MEDIUM REDDISTI BROWN LEACH CAP SALT: COARSE TO FINE SUB-ANGULAR SAME & GRAVEL 5 TO 10% CLAY, WHOLELY SCATTERED GRAVAS OF PHETE & EXPICITED DUMP MATERIAL CLAY: 110 CAP: PYRME TRACES OF BLACK DRIDES PALT: MEDIUM REDDICH BROWN COMPS TO 110 LEACH CAP SALT: FINE SUB-ANGULAR SAND & GRAVEL DUMP MATERIAL 5 TO 10% CLAY WIDELY SCATTERED GRAINS OF PYETIE, ENEIGHED PHETIE 120 TRACES BLACK OXIDES. PALT: MEDIUM REDDISH BROWN COARSETO 120 LEACH CAP FINE SUB-ANGULAR SAND & GRAVEL 5 SALT: TO 1070 CLAY, SPORSE WIDELY SCAMERIN DUMP MATERIAL CLAY: GRANNS OF PARICE-RARIOHED PYRITE 30 TRACES BLACK OXIDE. PALT: LIGHT REDDISH BROWN CORESE TO (30 SALT: FINE SUB-MAIGULAK SPAID & GRAVEL I FACH CAP 5 TO 10% CLAY VERY WIDELY SCATTERED DUMP MATERIAL CLAY: CRAIMS OF PYRITE TRACES OF BLACK 140 LCAP: OKINES. LIGHT TAN-BADWAI COARSE TO FINE 140 SUB-ANGULAR SAMO & GRAVEL 5 TO 10% CLAY NO VISIBLE SULFIORS; LEACH CAP SALT: 127 DUMP MOTERIAL CLAY: 150 TRACES OF BLACK OXIDES. LCAP: Composite: LIGHT TAN- BROWN COAKOE TO PINE PALT: 50 HERY WEAK SULFIDE SALT: SUB-MUGULAR SAMP & GRAVEL 5 TO DUMP MATERIAL 10% CLAY WIDELY SCATTERED GRAINS PO OF PYEME & ENRICHED PYRITE TRACE LCAP: OF BLACK OXIDES LIGHTMEDIUM BROWN COARSETO 190 VERY WEAK SULFICE FINE SUB-AUGULAR SAAN & GRAVEL M 5 to 10% CLAY. WIDELY SCATTEDED CLAY: GRAINS OF PYRITE, EVERCHED PYRITE LCAP: MO VISIBLE BLACK OXIDES. PALT: LIGHT TAN- BROWN COARSE TO FINE 190 VERY WEAR SULFICE SUB-ANGULAR SANDE GRAVEL ~ 5% CLAY WIDELY SCATTERED GRAINS CLAY: 190 / OF HYRME, GARICHED PYRITE, NO VISIEU CAP-EMACK OKIDES. LIGHT MEDIUM BROWN COARSE TO $g_{\mathcal{G}}$ VERY WEAK SULFICE SALT: FINE SUBANGULAR SAND & GRAVEL ~5% CLAY, WIDELY SCATERED CLAY: CO GRAINS OF PYRTE, ENRICHED PARTE LCAP: MO UISIBLE BRACK OXIDES. PALT: LIGHT BROWN COARSE TO FIME CO VFRY WEAK SUFFICE SALT: SUB-ANGULAR SAND & GRAVEL~5% CLAY SCAMERED GRAINS OF PARTE. CLAY: Q_{Ω} ENRICHED PYRME NO VISIBLE BLACK LCAP: Composite: OKINES.

Phelps Dodge Tyrone Mine - Geological Services Drill Hole Logging Form Project: Hole Number: 5A-5 Northina: Easting: Type: RC-DRY Logged by: RJW Hole Depth: 250 Date Drilled: Orientation: Interval Drill Log Graphic Log Notes Graphic Log Alteration Analysis Mineralization (vol%) Enrich Tcu OxCu QLT Elev. Ft. H₂O Rock WC YC QS Qtz Ksp Chi FeOx FeSt CuOx CuSt Py PySt Cc CcSt Cpy CpySt Omin1 Omin2 Other Oxide (Rock Description, Alteration, Mineralization, Structure) PALT: MEDIUM REDOISH BROWN CORESC TO 100 LEACH CAP SALT: FINE SUB-ANGULAR SAND-POLLDERY DUMP MATERIAL TRACES OF BLACK OXIDES-WERY WIDELY SPACED GRAINS OF PYRITE CLAY: 910 LCAP: MEDIUM REDDISH BROWN COARSE TO PALT: 210 LEACH CAP FINE SUB-ANGULAR SAND-FOUNDRY SALT: DUMP MATERIAL 5 TO 10% CLAY. EXTREMICLY WIDELY CLAY: SCATTERED GRAND OF PYRITE, MARICHIO PYRITE TRACES OF BLACK OKIDE. 220 LCAP: PALT: LIGHT REDDISH BROWN COAKEE TO 20 LENCH CAP SALT: FINE SUBANGULAR SAND FOULDERY 570 1070 CLAY NO USBLE SULFIDES DUMP MATERIAL CLAY: TRACES OF BLACK OXIDES. LCAP: PALT: MEDIUM REDDISH BROWN CONFEE TO 230 LEACH CHP SALT: FINE SUB-ANGULAR SAND-FOUNDERY 5 TO LOTO CLAY, EXTREMELY WIDELY SCATTERED GRANNS OF ENEIGHED FYEITE DUMP MATERIAL CLAY: 240 TRACES OF BLACK OXIDE. !!!!}!!!!|!!!|!!!!!! MEDIUM REDDISH BROWN CORRECTO PALT: 240 LEACH CAP DUMP MATERIAL THAC SUB-ANGULAR SAME-POWERDY 5 TO 1040 CLAY. MO USIBLE SULFIDE SALT: M CLAY: 250 TRACES OF BLACK OXIDES. LCAP: EO.H. Composite: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP: -{}} PALT: SALT: CLAY: LCAP: SALT: CLAY: LCAP: PALT: SALT: CLAY: LCAP; omposite:

APPENDIX E SOIL HYDRAULIC PROPERTIES LABORATORY REPORT

Laboratory Report for Golder Associates, Inc.

Project # 053-2016

Tyrone Supp. Borrow Mat. Investigation

December 31, 2005



Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109



December 31, 2005

Mr. Doug Romig Golder Associates, Inc. 4910- A Alameda Blvd. NE Albuquerque, NM 87113

Re: DBS&A Laboratory Report for Golder Associates, Inc.

Project # 053-2016; Tyrone Supp. Borrow Mat. Investigation

Dear Mr. Romig:

Enclosed is the final report for the Golder Associates, Inc., Project # 053-2016; Tyrone Supp. Borrow Mat. Investigation samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed final report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the final report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Golder Associates, Inc. and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

LABORATORY / TESTING FACILITY

Joleen Hines

Laboratory Supervising Manager

Enclosure

Daniel B. Stephens & Associates, Inc.

Summaries



Summary of Tests Performed

Compaction Proctor Atterberg Limits Water Holding 1/3, 15 Bar Points and Capacity Permeability ₽ij Particle Density Effective Porosity Size⁴ DS:WS: H Particle Characteristics Hydraulic HC; PP; TH;WP; RH Conductivity Unsaturated × × × × × × Characteristics³ Moisture × × × Conductivity² Saturated Hydraulic × × × Properties¹ (θ, ρ_δ, φ) Initial Soil × × × Sample Number Laboratory TP5A21 TP5A7 TP5A8

 1 θ = Initial moisture content, ρ_{d} = Dry bulk density, ϕ = Calculated porosity

² CH = Constant head, FH = falling head

³ HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box ⁴ DS = Dry sieve, WS = Wet sieve, H = Hydrometer



Summary of Sample Preparation

Target Remold

	Densities	· A	Actual Remold Data				
Sample Number	Maximum Dry Bulk Density (g/cm³)	Gravimetric Moisture Content (%, g/g)	Dry Bulk Density (g/cm³)	Percent of Target Dry Bulk Density (%)			
TP5A7	1.40	10.9	1.39	99.3%			
TP5A8	1.40	10.5	1.39	99.5%			
TP5A21	1.40	10.3	1.40	100%			



Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

	Initial Moisture Content		Dry Bulk	Wet Bulk	Calculated
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm³)	Density (g/cm ³)	Porosity (%)
TP5A7	10.9	15.2	1.39	1.54	47.5
TP5A8	10.5	14.6	1.39	1.54	47.4
TP5A21	10.3	14.4	1.40	1.54	47.3



Summary of Saturated Hydraulic Conductivity Tests

	K_{sat}	Method of Analysis		
Sample Number	(cm/sec)	Constant Head	Falling Head	
TP5A7	3.4E-03	×		
TP5A8	1.8E-02	X		
TP5A21	2.2E-02	X		



Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	lpha (cm ⁻¹)	N (dimensionless)	θ_{r}	θ_{s}
TP5A7	0.0765	1.2400	0.0000	0.3119
TP5A8	0.1113	1.2416	0.0000	0.3388
TP5A21	0.5936	1.2010	0.0000	0.4190



Summary of Calculated Unsaturated Hydraulic Properties with Gravel Corrections

Sample Number	Ksat	θ_{i}	$\theta_{\mathtt{s}}$	θ_{r}	_
TP5A7	1.8E-03	0.0811	0.1663	0.0000	
TP5A8	8.5E-03	0.0693	0.1609	0.0000	
TP5A21	9.8E-03	0.0641	0.1865	0.0000	

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm³/cm³)
TP5A7	0	31.2
	11	28.0
	41	22.2
	82	19.8
	510	13.5
	7547	6.5
	851293	1.9
TP5A8	. 0	33.4
5, 15	0 9	30.8
	42	21.5
	82	19.4
	510	13.4
	7750	6.6
	851293	2.1
TP5A21	0	41.9
11 37 21	0 9	29.4
	42	21.4
	82	19.0
	510	14.6
	8464	7.0
	851293	2.5

Laboratory Data and Graphical Plots

Initial Properties



Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

		Initial Moist	Initial Moisture Content		Wet Bulk	Calculated
Sample Number		Gravimetric (%, g/g)	Volumetric (%, cm³/cm³)	Density (g/cm ³)	Density (g/cm ³)	Porosity (%)
	TP5A7	10.9	15.2	1.39	1.54	47.5
	TP5A8	10.5	14.6	1.39	1.54	47.4
	TP5A21	10.3	14.4	1.40	1.54	47.3



Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A7 Ring Number: NA

Depth: NA

Test Date: 24-Oct-05

Field weight* of sample (g): 333.94

Tare weight, ring (g): 116.03

Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 196.46

Sample volume (cm³): 141.33

Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 15.2

Initial Gravimetric Moisture Content (% g/g): 10.9

Dry bulk density (g/cm³): 1.39

Wet bulk density (g/cm³): 1.54

Calculated Porosity (% vol): 47.5

Percent Saturation: 31.9

Comments:

* Weight including tares NA = Not analyzed

Laboratory analysis by: D. O'Dowd
Data entered by: T. Bowekaty



Data for Initial Moisture Content. Bulk Density, Porosity, and Percent Saturation

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A8 Ring Number: NA Depth: NA

Test Date: 24-Oct-05

Field weight* of sample (g): 337.90

Tare weight, ring (g): 121.52

Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 195.82

Sample volume (cm³): 140.52

Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 14.6

Initial Gravimetric Moisture Content (% g/g): 10.5

Dry bulk density (g/cm³): 1.39

Wet bulk density (g/cm3): 1.54

Calculated Porosity (% vol): 47.4

Percent Saturation: 30.9

Comments:

* Weight including tares NA = Not analyzed

Laboratory analysis by: D. O'Dowd

Data entered by: T. Bowekaty



Data for Initial Moisture Content. Bulk Density, Porosity, and Percent Saturation

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A21 Ring Number: NA

Depth: NA

Test Date: 24-Oct-05

Field weight* of sample (g): 339.45

Tare weight, ring (g): 121.92

Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 197.20

Sample volume (cm³): 141.12

Assumed particle density: 2,65

Initial Volumetric Moisture Content (% vol): 14.4

Initial Gravimetric Moisture Content (% g/g): 10.3

Dry bulk density (g/cm³): 1.40

Wet bulk density (g/cm³): 1.54

Calculated Porosity (% vol): 47.3

Percent Saturation: 30.5

Comments:

* Weight including tares NA = Not analyzed

Laboratory analysis by: D. O'Dowd

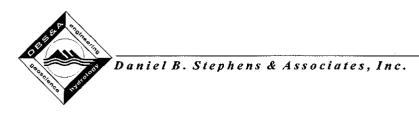
Data entered by: T. Bowekaty

Saturated Hydraulic Conductivity



Summary of Saturated Hydraulic Conductivity Tests

	K _{sat}	Method of	Method of Analysis		
Sample Number	(cm/sec)	Constant Head	Falling Head		
TP5A7	3.4E-03	×			
TP5A8	1.8E-02	×			
TP5A21	2.2E-02	X			



Saturated Hydraulic Conductivity Constant Head Method

Job name: Golder Associates, Inc.

Type of water used: TAP

Job number: LB05.0243.00

Collection vessel tare (g): 4.62

Sample number: TP5A7

Sample length (cm): 7.61

Ring Number: NA

Sample diameter (cm): 4.86

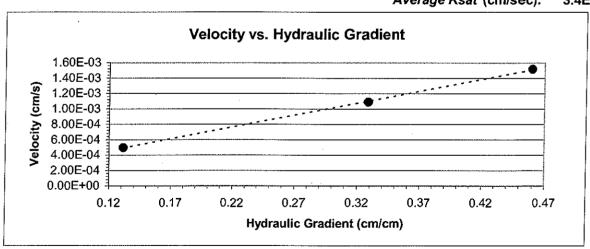
Depth: NA

Sample x-sectional area (cm²): 18.57

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm³)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1: 02-Nov-05 02-Nov-05	09:23:44 09:24:44	20.5	3.5	6.3	1.7	60	3.3E-03	3.3E-03
Test # 2: 04-Nov-05 04-Nov-05	13:53:21 14:03:09	21.0	1.0	10.0	5.4	588	3.8E-03	3.7E-03
Test # 3: 06-Nov-05 06-Nov-05	14:48:33 14:51:29	21.0	2.5	8.2	3.6	176	3.3E-03	3.2E-03

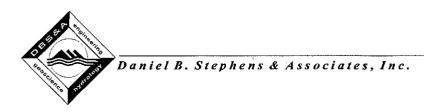
Average Ksat (cm/sec):

3.4E-03



Comments:

Laboratory analysis by: M. Carrillo Data entered by: M. Carrillo Checked by: J. Hines



Saturated Hydraulic Conductivity Constant Head Method

Job name: Golder Associates, Inc.

Type of water used: TAP

Job number: LB05.0243.00

Collection vessel tare (g): 11.54

Sample number: TP5A8

Sample length (cm): 7.64

Ring Number: NA

Sample diameter (cm): 4.84

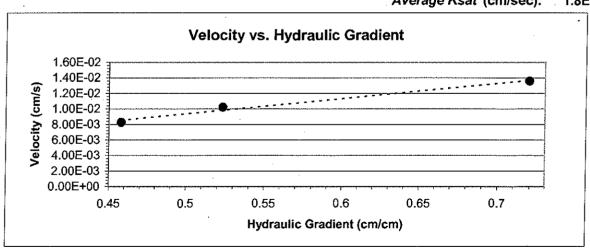
Depth: NA

Sample x-sectional area (cm²): 18.39

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm³)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
03-Nov-05	12:21:18	21,0	4.0	32.8	21.2	113	1.9E-02	1.9E-02
03-Nov-05	12:23:11							
Test # 2:								
04-Nov-05	09:19:49	20.5	5.5	20.5	9.0	36	1.9E-02	1.9E-02
04-Nov-05	09:20:25							
Test # 3:								
04-Nov-05	13:55:28	21.0	3.5	20.2	8.7	57	1.8E-02	1.8E-02
04-Nov-05	13:56:25							

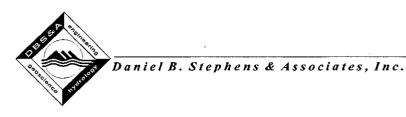
Average Ksat (cm/sec):

1.8E-02



Comments:

Laboratory analysis by: M. Carrillo Data entered by: M. Carrillo Checked by: J. Hines



Saturated Hydraulic Conductivity Constant Head Method

Job name: Golder Associates, Inc.

Type of water used: TAP

Job number: LB05.0243.00

Collection vessel tare (g): 11.30

Sample number: TP5A21

Sample length (cm): 7.65

Ring Number: NA

Sample diameter (cm): 4.85

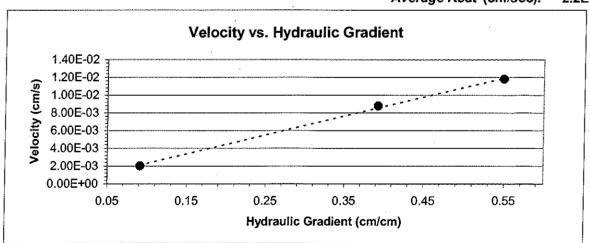
Depth: NA

Sample x-sectional area (cm²): 18.46

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm³)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1: 03-Nov-05 03-Nov-05	12:24:05 12:25:45	21.0	4.2	33.1	21.8	100	2.1E-02	2.1E-02
Test # 2: 03-Nov-05 03-Nov-05	16:12:10 16:13:40	21.0	3.0	25.9	14.6	90	2.2E-02	2.2E-02
Test # 3: 04-Nov-05 04-Nov-05	09:21:15 09:25:32	20.5	0.7	20.9	9.6	257	2.2E-02	2.2E-02

Average Ksat (cm/sec):

2.2E-02



Comments:

Laboratory analysis by: M. Carrillo Data entered by: M. Carrillo Checked by: J. Hines.

Unsaturated Hydraulic Conductivity



Summary of Calculated Unsaturated Hydraulic Properties

 Sample Number	a (cm ⁻¹)	N (dimensionless)	θ_{r}	θ_{s} .	
TP5A7	0.0765	1.2400	0.0000	0.3119	
TP5A8	0.1113	1.2416	0.0000	0.3388	
TP5A21	0.5936	1.2010	0.0000	0.4190	



Summary of Calculated Unsaturated Hydraulic Properties with Gravel Corrections

Sample Number	Ksat	θ_{i}	θ_{s}	θ_{r}	_
TP5A7	1.8E-03	0.0811	0.1663	0.0000	
TP5A8	8.5E-03	0.0693	0.1609	0.0000	
TP5A21	9.8E-03	0.0641	0.1865	0.0000	



Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm³/cm³)
TP5A7	0	31.2
	11	28.0
	41	22.2
	82	19.8
	510	13.5
	7547	6.5
	851293	1.9
TP5A8	0	33.4
	9	30.8
	42	21.5
	82	19.4
	510	13.4
	7750	6.6
	851293	2.1
TP5A21	0	41.9
· · · · · · · · · · · · · · · · · · ·	9	29.4
	42	21.4
	82	19.0
•	510	14.6
	8464	7.0
	851293	2.5



Moisture Retention Data Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: Golder Associates, Inc.

Dry wt. of sample (g): 196.46

Job Number: LB05.0243.00

Tare wt., screen & clamp (g): 25.33

Sample Number: TP5A7

Tare wt., ring (g): 116.03

Ring Number: NA

Tare wt., epoxy (g): 0.00

Depth: NA

Sample volume (cm3): 141.33

Saturated weight* at 0 cm tension (g): 381.87

Volume of water tin saturated sample (cm³): 44.05

Saturated moisture content (% vol): 31.17

Sample bulk density (g/cm3): 1.39

			Matric	Moisture
		Weight*	Potential	Content [†]
_	Date/Time	(g)	(-cm water)	(% vol)
Hanging column:	07-Nov-05 / 16:30	381.87	0.00	31.17
	14-Nov-05 / 10:30	377.34	10.50	27.96
	21-Nov-05 / 14:50	369.26	40.50	22.25
-	28-Nov-05 / 14:40	365.86	81.50	19.84
Pressure plate:	04-Dec-05 / 10:00	356.83	509.90	13.45

Sample Settling Information Note

Matric	Percent	Settled
Potential	Settled	Bulk Density
(-cm water)	(%)	(g/cm ³)
0.00	12.9%	1.57
10.50	NM	NM
40.50	14.5%	1.59
81.50	17.9%	1.64
509.90	17.9%	1.64

Note:

Sample settling was measured periodically following hanging column and pressure plate moisture retention points. These values were obtained by averaging several measurements of loss in sample length, measured with a hand caliper. Due to the uneven nature of samples as settling occurs, these values should be considered as estimates.

NS=No Settling NM=Not Measured

Laboratory analysis by: M. Carrillo Data entered by: T. Bowekaty Checked by: J. Hines

^{*} Weight including tares

[†] Assumed density of water is 1.0 g/cm³



Moisture Retention Data Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A7 Ring Number: NA

Depth: NA

Dry weight* of water activity meter sample (g): 243.48

Tare weight, jar (g): 198.78

Sample bulk density (g/cm3): 1.39

		Weight*	Matric Potential	Moisture Content ^T
	Date/Time	(g)	(-cm water)	(% vol)
Water Activity Meter:	07-Nov-05 / 13:57	245.56	7546.5	6.47

Dry weight* of relative humidity box sample (g): 67.16

Tare weight (g): 39.93

Sample bulk density (g/cm3): 1.39

	Date/Time	Weight*	Matric Potential (-cm w <i>a</i> ter)	Moisture Content ¹ (% vol)
•	Date/Time	(g)	(-Cili Water)	(70 VOI)
Relative humidity box:	08-Nov-05 / 12:20	67.54	851293	1.95

Comments:

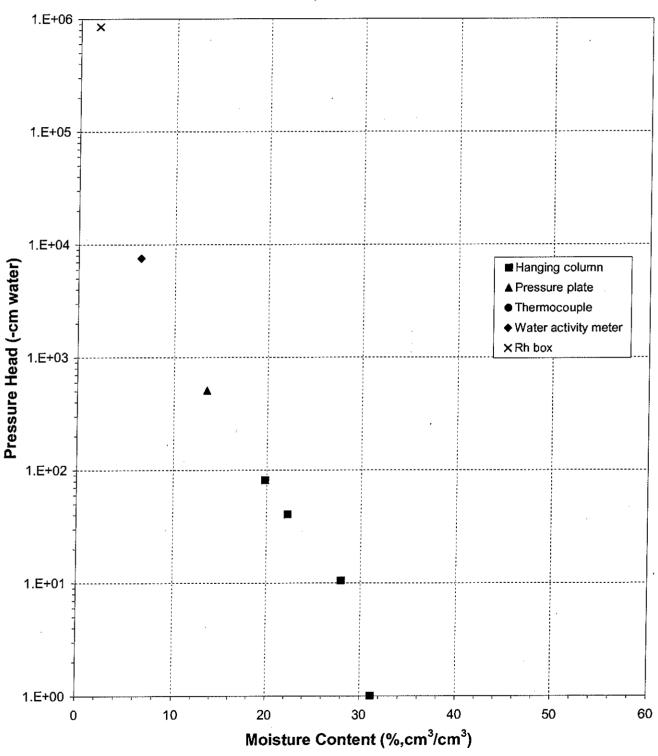
- * Weight including tares
- [†] Assumed density of water is 1.0 g/cm³

Laboratory analysis by: M. Carrillo/D. O'Dowd

Data entered by: T. Bowekaty Checked by: J. Hines

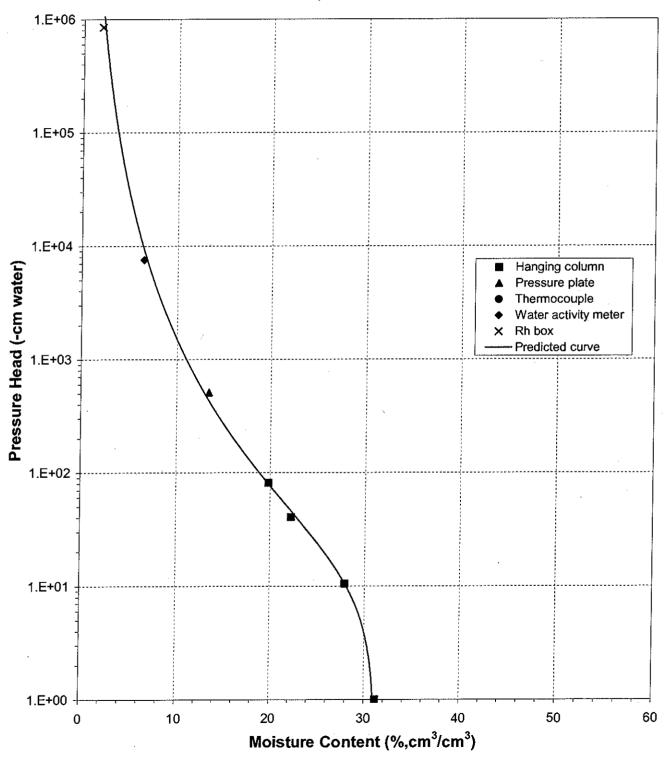


Water Retention Data Points



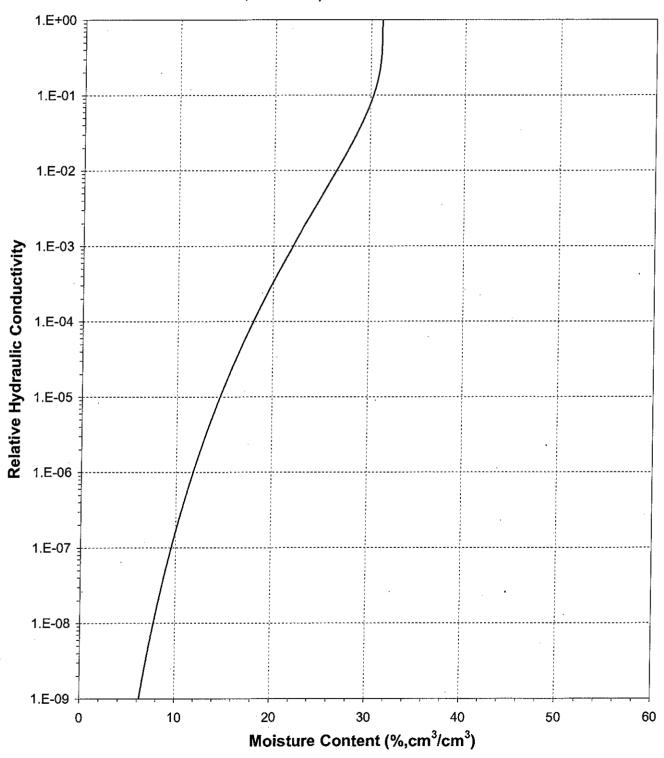


Predicted Water Retention Curve and Data Points



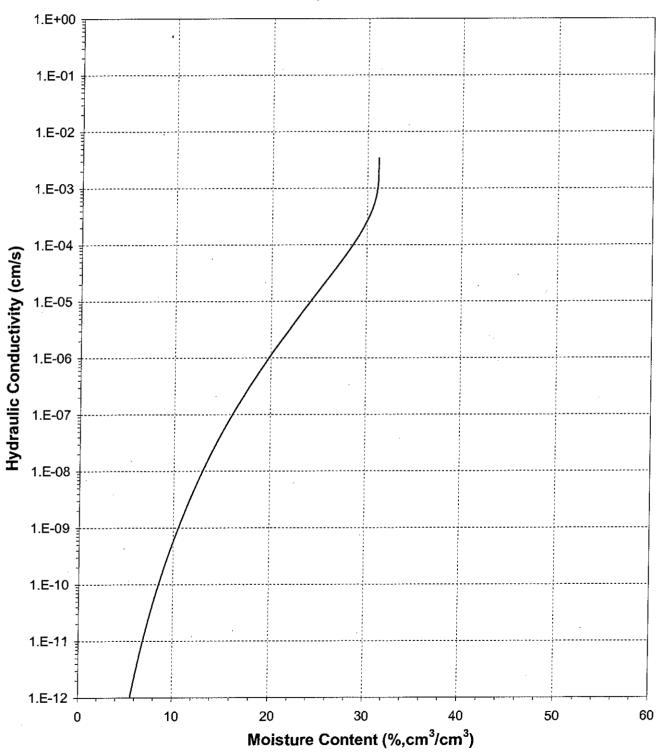


Plot of Relative Hydraulic Conductivity vs Moisture Content



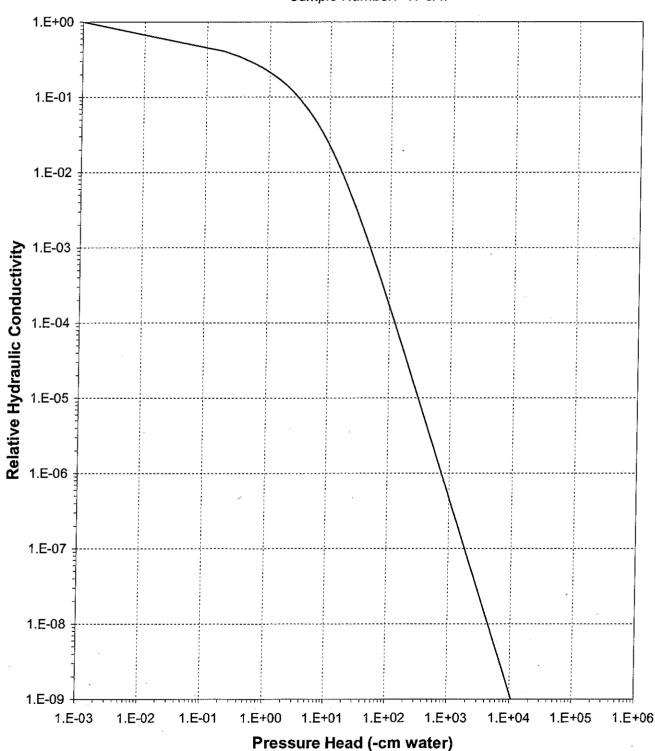


Plot of Hydraulic Conductivity vs Moisture Content



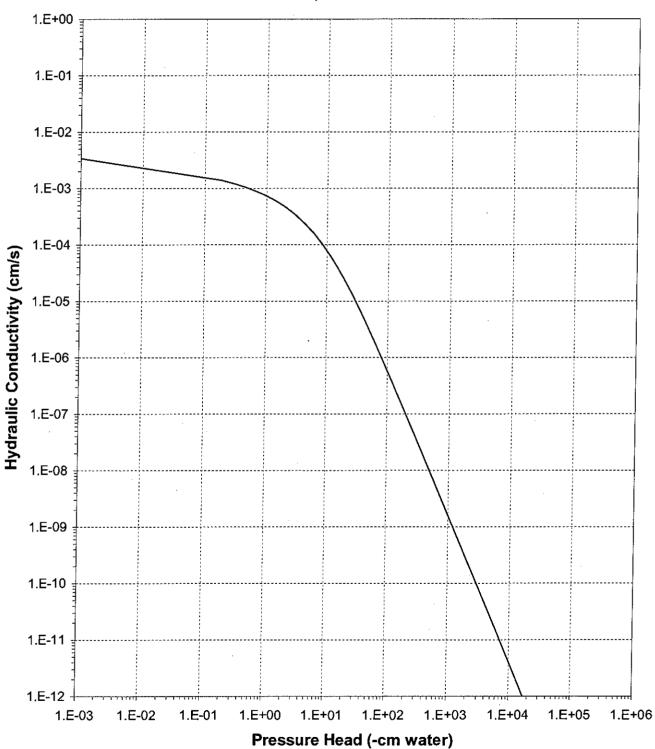


Plot of Relative Hydraulic Conductivity vs Pressure Head





Plot of Hydraulic Conductivity vs Pressure Head





Gravel Correction Data Sheet

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A7 (Gravel Corrected)

Ring Number: NA

Depth: NA

Split: #10 (2.00 mm)

Uncorrected input values

Corrected Values

Mass (coarse)(g): 3475

Mass (fines)(g): 2083

Dry bulk density (fines)(g/cm³): 1.39

[†]Density (coarse)(g/cm³): 2.65

Ksat value (fines)(cm/sec): 3.4E-03

Theta initial (fines): 0.1520

Theta saturated (fines): 0.3119

Theta residual (fines): 0.0000

*Theta initial (coarse): 0

*Theta saturated (coarse): 0

*Theta residual (coarse): 0

*Volume (coarse voids)(cm3): 0

Density (composite)(g/cm³): 1.98

Ksat composite(cm/sec): 1.8E-03

Theta initial composite: 0.0811

Theta saturated composite: 0.1663

Theta residual composite: 0.0000

Volumetric fraction of fines in composite: 0.533

Volumetric fraction of coarse in composite: 0.467

Volumetric fraction of voids in composite: 0.000

Volume (fines)(cm³): 1498.56

Volume (coarse)(cm³): 1311.32

Volume (composite)(cm³): 2809.88

Comments:

*Assumed to be 2.65, unless measured.

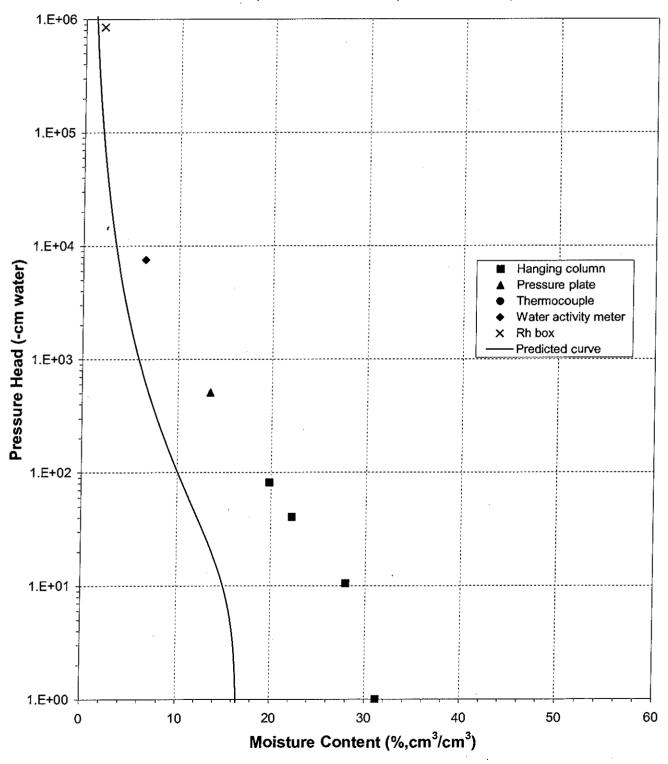
*Values will be zero if the coarse fraction is assumed to hold no water in pores.

Date: 30-Dec-05 Data entered by: D. O'Dowd



Predicted Water Retention Curve and Data Points

Sample Number: TP5A7 (Gravel Corrected)





Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: Golder Associates, Inc.

Dry wt. of sample (g): 195.82

Job Number: LB05.0243.00

Tare wt., screen & clamp (g): 25.82

Sample Number: TP5A8

Tare wt., ring (g): 121.52

Ring Number: NA

Tare wt., epoxy (g): 0.00

Depth: NA

Sample volume (cm3): 140.52

Saturated weight* at 0 cm tension (g): 390.15

Volume of water tin saturated sample (cm³): 46.99

Saturated moisture content (% vol): 33.44

Sample bulk density (g/cm³): 1.39

			Matric	Moisture
		Weight*	Potential	Content [†]
	Date/Time	(g)	(-cm water)	(% vol)
Hanging column:	04-Nov-05 / 17:25	390.15	0.00	33.44
	11-Nov-05 / 16:55	386.51	9.00	30.85
	18-Nov-05 / 15:40	373.44	41.50	21.55
	28-Nov-05 / 14:30	370.44	81.50	19.41
Pressure plate:	04-Dec-05 / 10:00	362.03	509.90	13.43

Sample Settling Information Note

Matric	Percent	Settled
Potential	Settled	Bulk Density
(-cm water)	(%)	(g/cm³)
0.00	8.6%	1.51
9.00	11.0%	1.55
41.50	17.4%	1.64
81.50	18.2%	1.65
509.90	18.2%	1.65

Note:

Sample settling was measured periodically following hanging column and pressure plate moisture retention points. These values were obtained by averaging several measurements of loss in sample length, measured with a hand caliper. Due to the uneven nature of samples as settling occurs, these values should be considered as estimates.

NS=No Settling NM=Not Measured

Laboratory analysis by: M. Carrillo Data entered by: T. Bowekaty Checked by: J. Hines

^{*} Weight including tares

[†] Assumed density of water is 1.0 g/cm³



Moisture Retention Data Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A8

Ring Number: NA

Depth: NA

Dry weight* of water activity meter sample (g): 257.77

Tare weight, jar (g): 197.28

Sample bulk density (g/cm3): 1.39

		Weight*	Matric Potential	Moisture Content [⊤]
_	Date/Time	(g)	(-cm water)	(% vol)
Water Activity Meter:	07-Nov-05 / 12:40	260.65	7750.5	6.63

Dry weight* of relative humidity box sample (g): 70.83

Tare weight (g): 41.09.

Sample bulk density (g/cm³): 1.39

		Weight*	Matric Potential	Moisture Content [™]
	Date/Time	(g)	(-cm water)	(% vol)
Relative humidity box:	08-Nov-05 / 12:20	71.28	851293	2.12

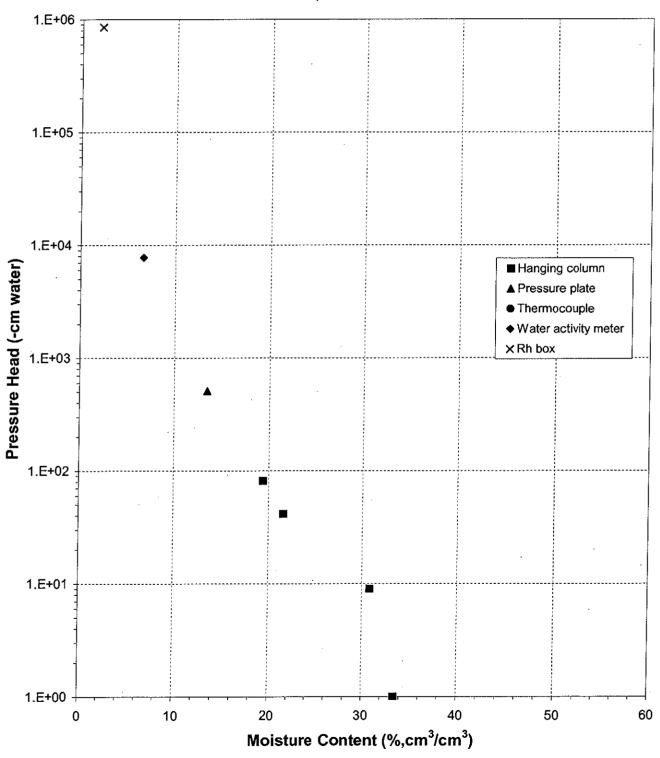
Comments:

- * Weight including tares.
- [†] Assumed density of water is 1.0 g/cm³

Laboratory analysis by: M. Carrillo/D. O'Dowd Data entered by: T. Bowekaty

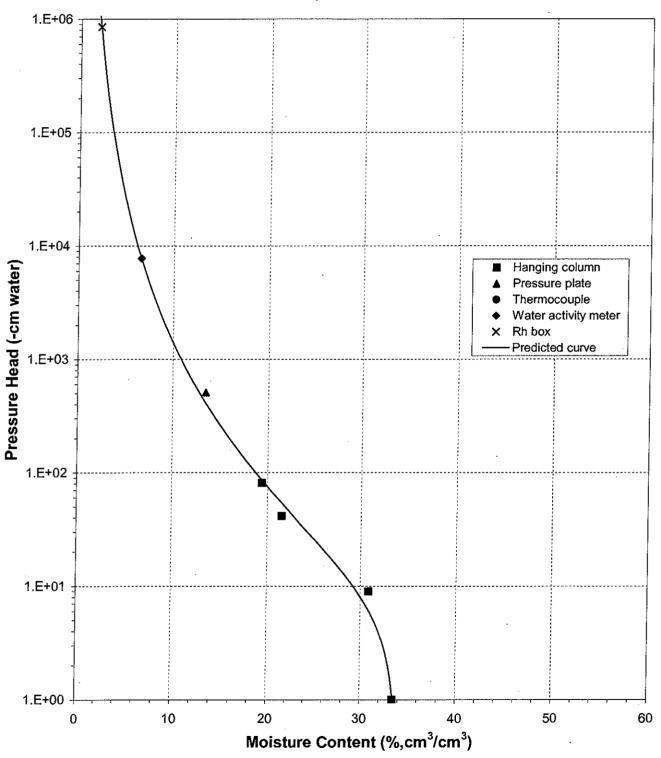


Water Retention Data Points



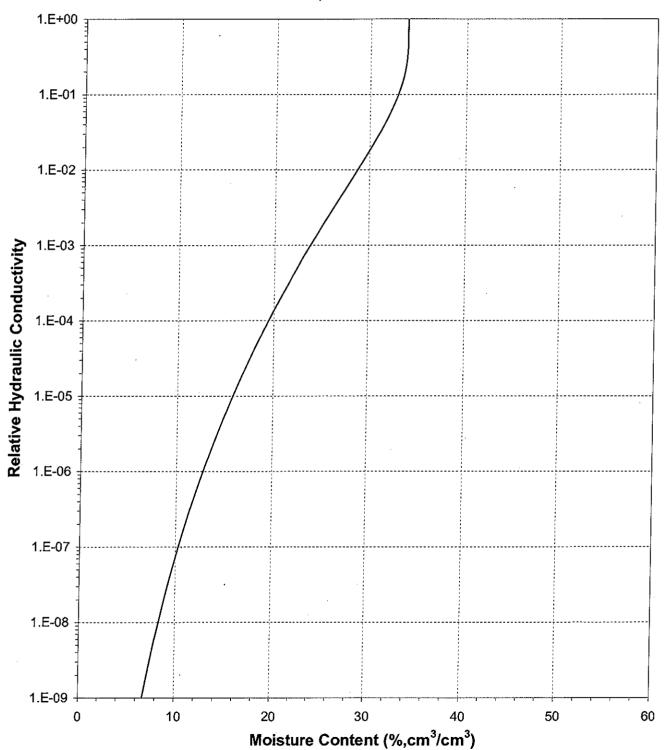


Predicted Water Retention Curve and Data Points



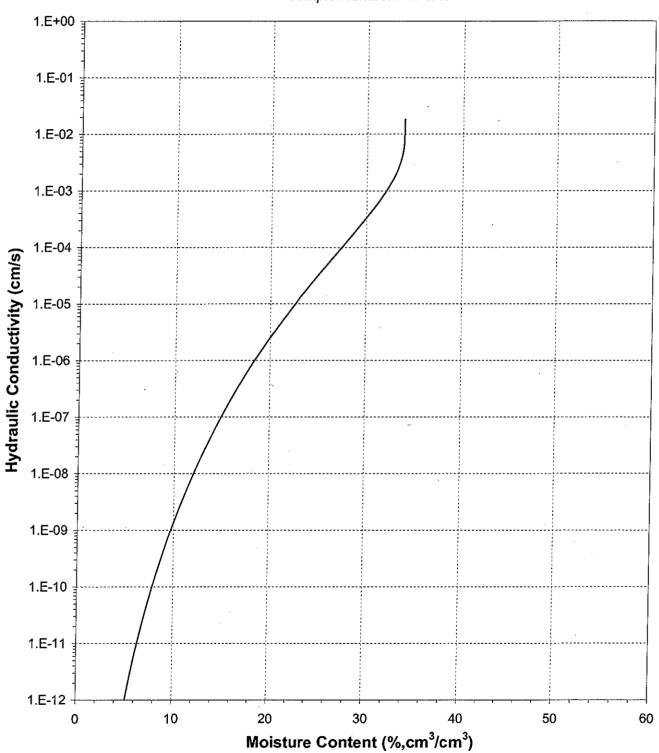


Plot of Relative Hydraulic Conductivity vs Moisture Content



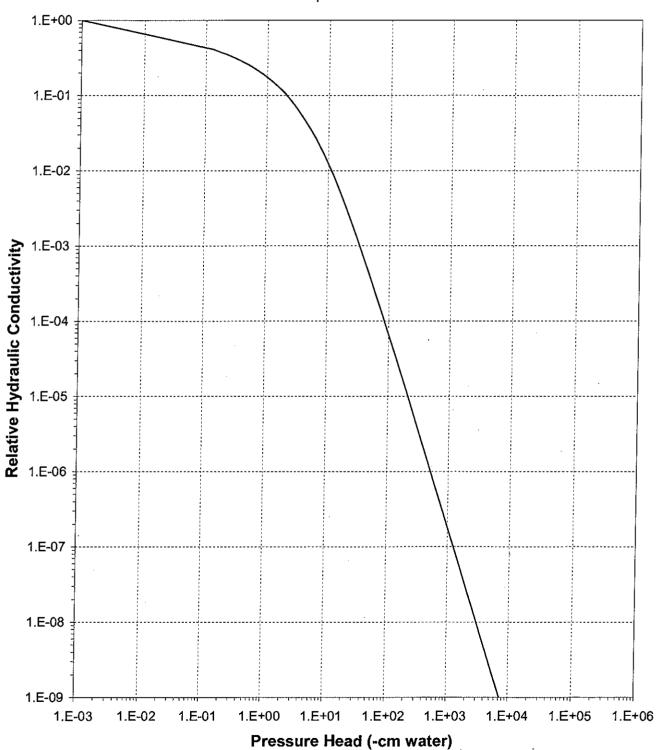


Plot of Hydraulic Conductivity vs Moisture Content



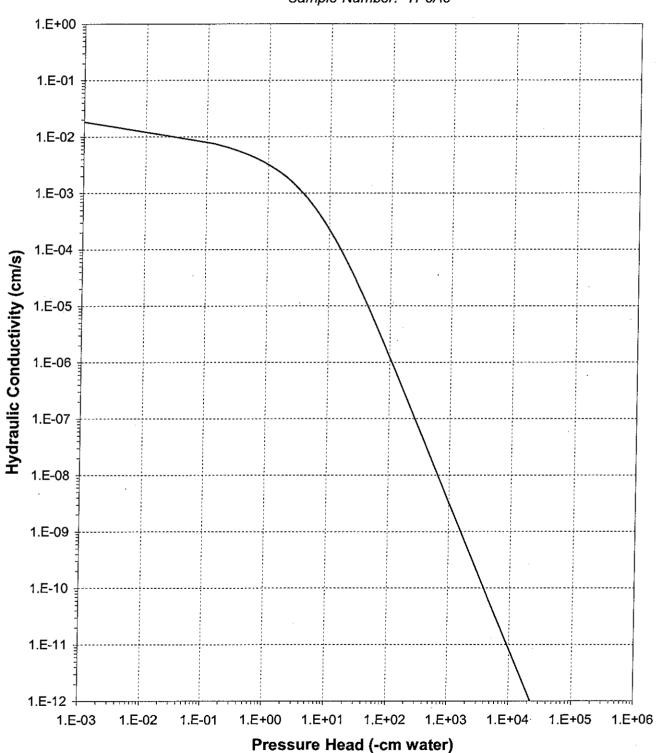


Plot of Relative Hydraulic Conductivity vs Pressure Head





Plot of Hydraulic Conductivity vs Pressure Head





Gravel Correction Data Sheet

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A8 (Gravel Corrected)

Ring Number: NA Depth: NA

Split: #10 (2.00 mm)

Uncorrected input values

Corrected Values

Mass (coarse)(g): 3571

Mass (fines)(g): 1694

Dry bulk density (fines)(g/cm³): 1.39

*Density (coarse)(g/cm³): 2.65

Ksat value (fines)(cm/sec): 1.8E-02

Theta initial (fines): 0.1460

Theta saturated (fines): 0.3388

Theta residual (fines): 0.0000

*Theta initial (coarse): 0

*Theta saturated (coarse): 0

*Theta residual (coarse): 0

*Volume (coarse voids)(cm3): 0

Density (composite)(g/cm³): 2.05

Ksat composite(cm/sec): 8.5E-03

Theta initial composite: 0.0693

Theta saturated composite: 0.1609

Theta residual composite: 0.0000

Volumetric fraction of fines in composite: 0.475

Volumetric fraction of coarse in composite: 0.525

Volumetric fraction of voids in composite: 0.000

Volume (fines)(cm³): 1218.71

Volume (coarse)(cm3): 1347.55

Volume (composite)(cm3): 2566.25

Comments:

[†]Assumed to be 2.65, unless measured.

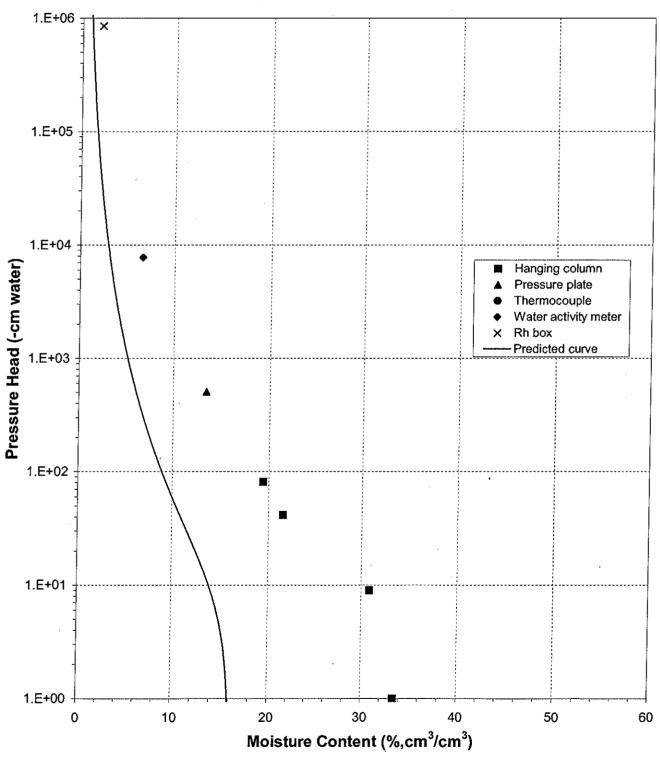
*Values will be zero if the coarse fraction is assumed to hold no water in pores.

Date: 30-Dec-05

Data entered by: D. O'Dowd

Predicted Water Retention Curve and Data Points

Sample Number: TP5A8 (Gravel Corrected)





Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: Golder Associates, Inc.

Dry wt. of sample (g): 197.20

Job Number: LB05.0243.00

Tare wt., screen & clamp (g): 23.23

Sample Number: TP5A21

Tare wt., ring (g): 121.92

Ring Number: NA

Tare wt., epoxy (g): 0.00

Depth: NA

Sample volume (cm3): 141.12

Saturated weight* at 0 cm tension (g): 401.48

Volume of water † in saturated sample (cm³): 59.13

Saturated moisture content (% vol): 41.90

Sample bulk density (g/cm3): 1.40

			Matric	Moisture
		Weight*	Potential	Content [†]
	Date/Time	(g)	(-cm water)	(% vol)
Hanging column:	04-Nov-05 / 11:30	401.48	0.00	41.90
	11-Nov-05 / 16:55	383.82	9.00	29.39
	18-Nov-05 / 15:40	372.51	41.50	21.37
	28-Nov-05 / 14:25	369.17	81.50	19.00
Pressure plate:	04-Dec-05 / 10:00	362.93	509.90	14.58

Sample Settling Information Note

Matric	Percent	Settled
Potential	Settled	Bulk Density
(-cm water)	(%)	(g/cm³)
0.00	7.6%	1.50
9.00	NM	NM
41.50	10.3%	1.54
81.50	10.9%	1.55
509.90	10.9%	1.55

Note:

Sample settling was measured periodically following hanging column and pressure plate moisture retention points. These values were obtained by averaging several measurements of loss in sample length, measured with a hand caliper. Due to the uneven nature of samples as settling occurs, these values should be considered as estimates.

NS=No Settling NM=Not Measured

Laboratory analysis by: M. Carrillo Data entered by: T. Bowekaty Checked by: J. Hines

^{*} Weight including tares

[†] Assumed density of water is 1.0 g/cm³



Moisture Retention Data Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A21

Ring Number: NA

Depth: NA

Dry weight* of water activity meter sample (g): 259.28

Tare weight, jar (g): 197.68

Sample bulk density (g/cm3): 1.40

,	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content ^T (% vol)
Water Activity Meter:	08-Nov-05 / 14:30	262.38	8464.3	7.03
•				

Dry weight* of relative humidity box sample (g): 74.51

Tare weight (g): 37.74

Sample bulk density (g/cm³): 1.40

		Weight*	Matric Potential	Moisture Content ^T
	Date/Time	(g)	(-cm water)	(% vol)
Relative humidity box:	08-Nov-05 / 12:20	75.16	851293	2.45

Comments:

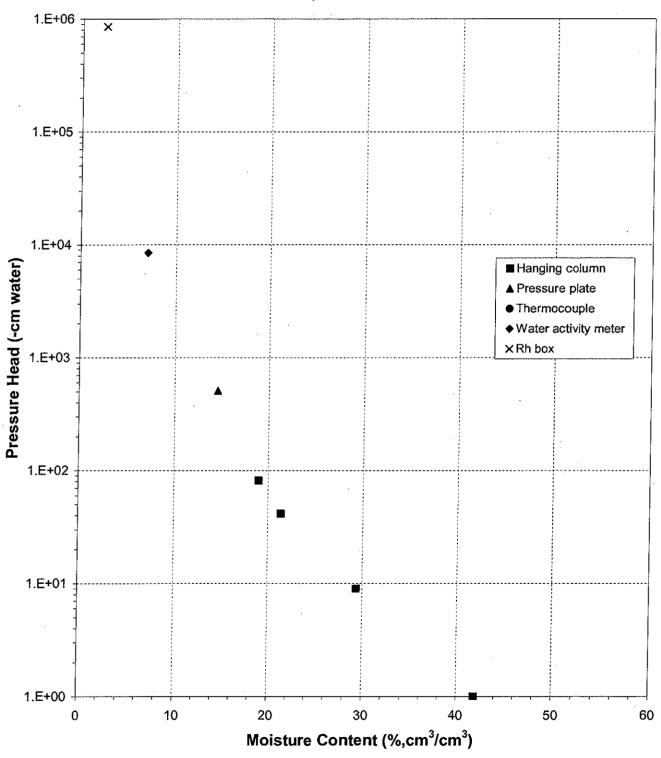
- * Weight including tares
- [†] Assumed density of water is 1.0 g/cm³

Laboratory analysis by: M. Carrillo/D. O'Dowd

Data entered by: T. Bowekaty Checked by: J. Hines

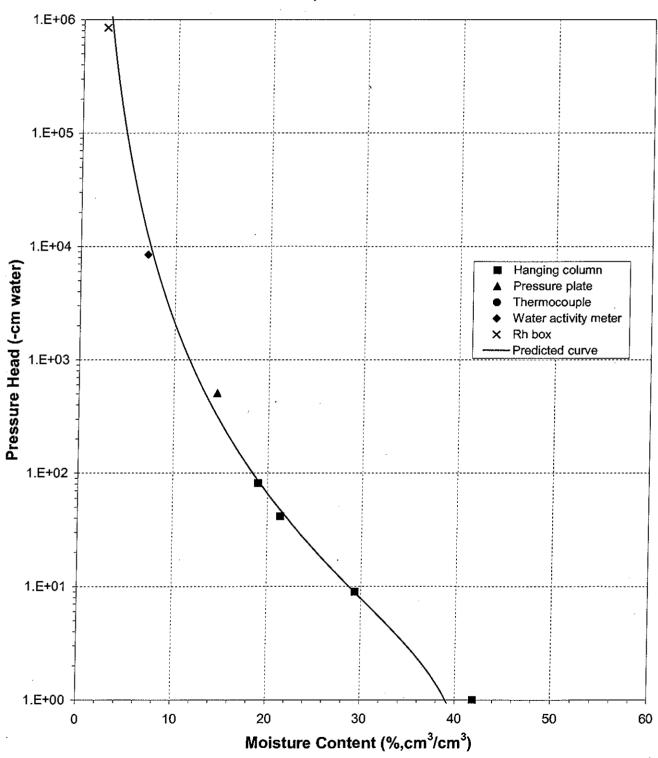


Water Retention Data Points



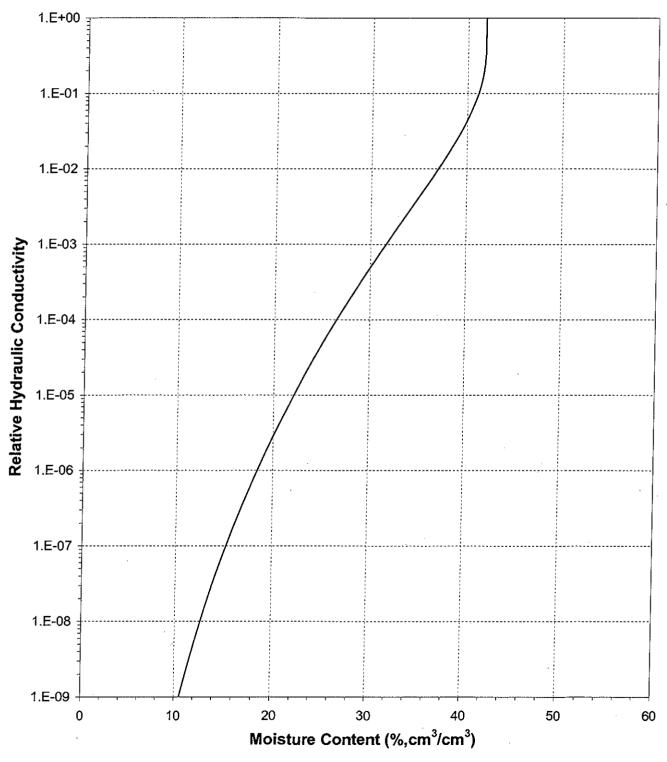


Predicted Water Retention Curve and Data Points



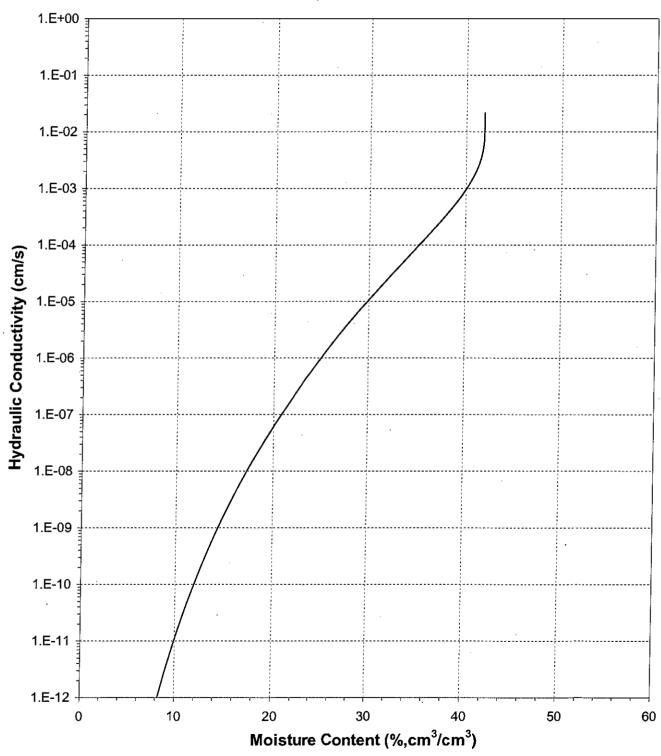


Plot of Relative Hydraulic Conductivity vs Moisture Content



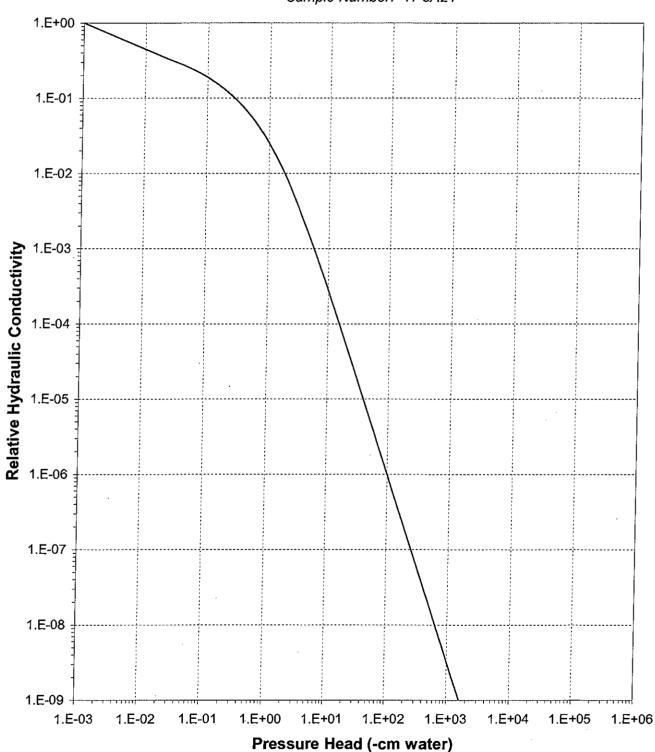


Plot of Hydraulic Conductivity vs Moisture Content



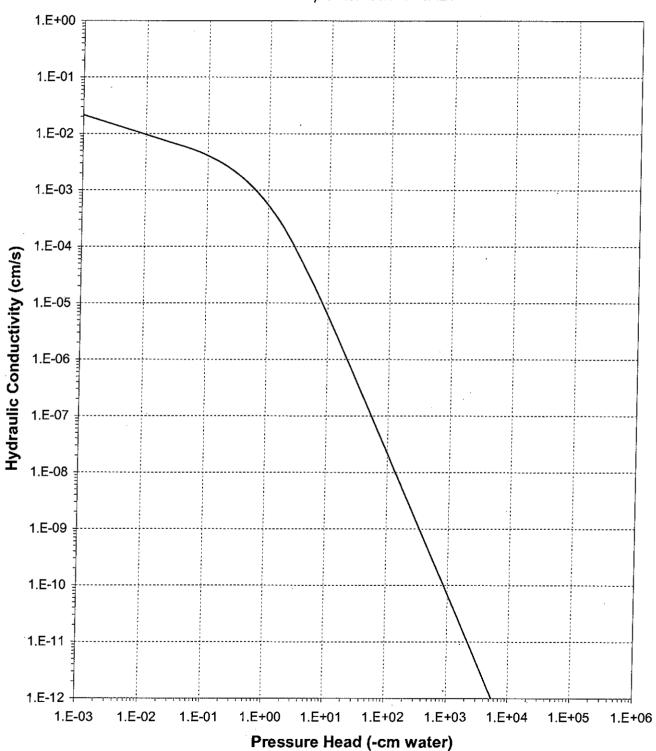


Plot of Relative Hydraulic Conductivity vs Pressure Head





Plot of Hydraulic Conductivity vs Pressure Head





Gravel Correction Data Sheet

Job Name: Golder Associates, Inc.

Job Number: LB05.0243.00

Sample Number: TP5A21 (Gravel Corrected)

Ring Number: NA Depth: NA

Split: #10 (2.00 mm)

Uncorrected input values

Corrected Values

Mass (coarse)(g): 4253

Mass (fines)(g): 1802

Dry bulk density (fines)(g/cm3): 1.4

[†]Density (coarse)(g/cm³): 2.65

Ksat value (fines)(cm/sec): 2.2E-02

Theta initial (fines): 0.1440

Theta saturated (fines): 0.4190

Theta residual (fines): 0.0000

*Theta initial (coarse): 0

*Theta saturated (coarse): 0

*Theta residual (coarse): 0

*Volume (coarse voids)(cm3): 0

Density (composite)(g/cm³): 2.09

Ksat composite(cm/sec): 9.8E-03

Theta initial composite: 0.0641

Theta saturated composite: 0.1865

Theta residual composite: 0.0000

Volumetric fraction of fines in composite: 0.445

Volumetric fraction of coarse in composite: 0.555

Volumetric fraction of voids in composite: 0.000

Volume (fines)(cm³): 1287.14

Volume (coarse)(cm³): 1604.91

Volume (composite)(cm³): 2892.05

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Comments:

[†]Assumed to be 2.65, unless measured.

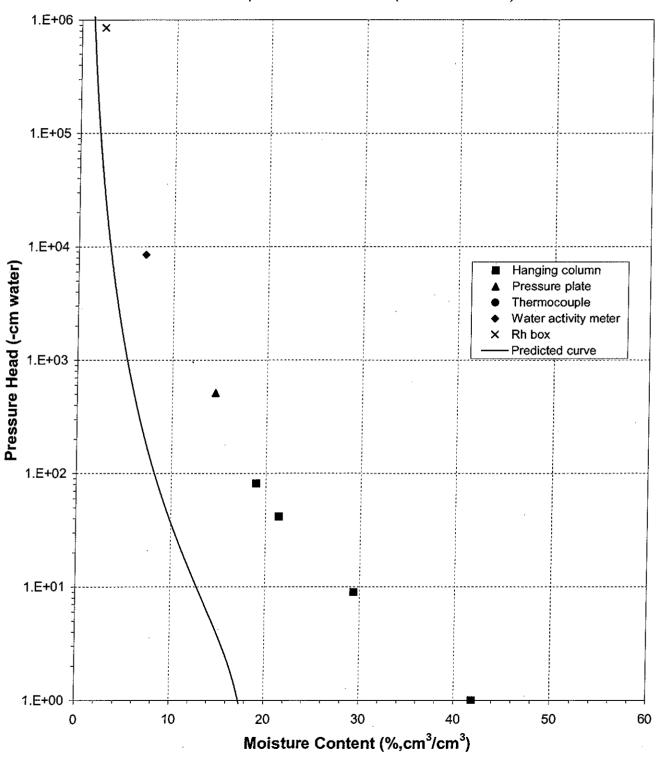
*Values will be zero if the coarse fraction is assumed to hold no water in pores.

Date: 30-Dec-05
Data entered by: D. O'Dowd



Predicted Water Retention Curve and Data Points

Sample Number: TP5A21 (Gravel Corrected)



Laboratory Tests and Methods



Tests and Methods

Dry Bulk Density:

ASTM D4531; ASTM D6836

Moisture Content:

ASTM D2216; ASTM D6836

Calculated Porosity:

Klute, A. 1986. Porosity. Chp.18-2.1, pp. 444-445, in A. Klute (ed.), Methods of Soil

Analysis, American Society of Agronomy, Madison, WI

Saturated K:

Constant Head:

ASTM D 2434 (modified apparatus)

Hanging Column Method:

ASTM D6836; Klute, A. 1986. Porosity. Chp.26, in A. Klute (ed.), Methods of Soil

Analysis, American Society of Agronomy, Madison, WI

Pressure Plate Method:

ASTM D6836; ASTM D2325

Water Potential Method:

ASTM D6836; Rawlins, S.L. and G.S. Campbell, 1986. Water Potential: Thermocouple Psychrometry. Chp. 24, pp. 597-619, in A. Klute (ed.), Methods of Soil Analysis, Part 1.

American Society of Agronomy, Madison, WI.

Relative Humidity Box:

Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil

Clays.SSA Journal 46:1321-1325

Calc. Kunsat:

ASTM D6836; Soil Sci. Soc. Am. J. 1980 44:892-898

Course Fraction (Gravel)

Correction (calc):

ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose.

Zones. Groundwater Vol. 22, No. 6