5.1.2 End plates are constructed of stainless steel. They are attached by means of eight, 6-mm (¼-in.) threaded rods or any other means which ensures a leakproof seal.

5.1.3 Gaskets, one at each end of the column, are constructed of chemically inert materials, and are as thin as possible while still providing a good seal. The gasket diameter should overlap the inside column diameter by 3 mm (⅛ in.) to prevent the gasket from being forced out while under pressure. Techniques other than gaskets for providing a seal between the column and end plates are allowed provided the technique used is specified in the report.

5.1.4 Flow distribution disks must be constructed of sintered stainless steel, with a nominal pore diameter of 70 µm. The disk thickness shall be 6 mm (¼ in.), with a diameter equal to the inside diameter of the column, approximately 100 mm (4 in.). The disk shall have eight evenly spaced grooves; each of which is 3 mm (⅛ in.) wide, 3 mm deep and 50 mm (2 in.) long. These grooves shall be positioned in a ray originating from the center of the disk.

5.1.5 Tubing used in the apparatus shall be of inert materials, for example, glass, stainless steel, polytetrafluoroethylene lined. The outer diameter shall be 6 mm (¼ in.).

5.1.6 Substitution of materials of construction of the column or any of its parts is acceptable, as long as it is demonstrated that levels of contamination for analyte(s) of interest are equal to or less than those specified. Any modification of the apparatus as described in this test method must be justified, documented, and delineated in the report.

5.2 *Pressurized Reservoir Vessel*, which is used to contain the leaching fluid, is constructed with requirements similar to those of the leaching column with the following exceptions: (*1*) no diffusion disks are used, and (*2*) it is equipped with a top port for refilling the fluid.

5.3 *Balance*, 10-kg capacity, with a 1-g sensitivity.

5.4 *Compressed Gas Source*, prepurified nitrogen or argon with a two-stage delivery regulator (0 to 350 kPa) (0 to 50 psig), and a pressure gage capable of measuring the pressure in the head space of the liquid reservoir to within ±7 kPa (1 psig).

6. Reagents and Materials

6.1 American Chemical Society (ACS) Reagent grade chemicals or equivalent are preferred.[10]

6.2 Other grades of chemicals may be used, provided that the reagent is of sufficiently high purity to permit its use without compromising the objectives of the testing.

6.3 Demonstration of acceptability through reagent blank data at or below the quantitation limits for all analytes of interest is required.

6.4 Unless otherwise indicated, references to reagent water mean water as defined in SW-846, Method 1311, 5.2. See reagent water under the terminology section of this test method (3.1.1).

[10] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

NOTE 1—Reagent water is defined in SW-846 as water in which an interferant is not observed at or above the method's detection limit of the analyte(s) of interest.

7. Safety Precaution

7.1 General operating pressure should not exceed 275.8 kPa (40 psig) with materials as defined herein. Other inert materials are available that can be used to manufacture the column which will withstand pressures above 275.8 kPa (40 psig).

8. Sampling

8.1 Sampling must be performed so as to obtain a representative sample of the material.

8.2 Where no specific sampling methods are available, sampling methods for materials of physical form similar to the material shall be used.

8.3 A minimum sample of 5000 g, or three column volumes, whichever is larger, shall be sent to the laboratory for each column.

8.4 Samples must be kept in closed containers appropriate to the sample type and otherwise protected if necessary prior to testing to prevent sample contamination or constituent change or loss. Where it is desired to test biologically or chemically active samples in their existing state, any sample storage required should be at 4°C (Practice D 3370) and the leaching should be started within 8 h of sample collection. Where appropriate, the tester may modify a test portion before leaching to simulate the results of biological or chemical activity in the field. Record the storage conditions, sampling procedures, handling practices, and any abnormal sampling conditions in the report.

9. Preparation of Apparatus

9.1 The assembled apparatus is shown in Fig. 1.

9.2 *Column Preparation*:

9.2.1 Before use, clean all parts of the test apparatus that will contact the waste material, leaching fluid, or product leachate.

9.2.1.1 Clean the sintered disks by boiling them for 15 min in reagent water, followed by a backflush with reagent water. Then saturate the disks with concentrated sulfuric acid and soak until all residues are removed. Then vacuum or pressure remove the excess acid with reagent water. Next, pump or draw either acetone or methanol through the disks, followed by either hexane or methylene chloride. Permit disks to air dry.

9.2.1.2 Clean the column apparatus by washing it with a nonionic surfactant soap and water. Rinse with tap water and follow with a reagent water rinse. Then rinse it with either acetone or methanol, followed by a rinse with either hexane or methylene chloride. Permit the apparatus to air dry.

9.3 Assemble the apparatus as depicted in Figs. 1 and 2. Weigh the dried, clean empty column, including end caps and other fittings necessary to contain the waste, and record the mass. This is the tare of the apparatus. Record the inside diameter and height of that part of the column to be filled with waste (that is, the column cylinder). If, following column saturation, the tester wishes to check the degree of saturation,

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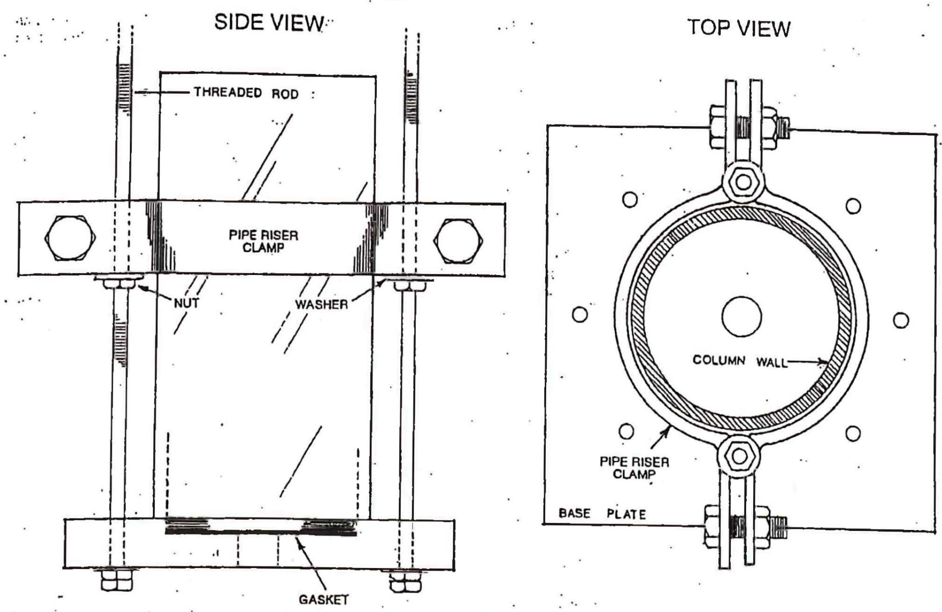

FIG. 2 Packing Configuration

it will first be necessary to determine the mass of water that can be contained in the porous flow distribution disks, end plates, and fittings.

10. Procedure

10.1 *Preconditioning*:

10.1.1 Prepare a test portion of waste in a manner that simulates the state the waste is in or will be in as it undergoes leaching in the field. Preparation of the test portion may include such factors as curing, and adjustment of moisture content and density. For such adjustments, the following procedures can be used where appropriate.

10.1.2 *Moisture Content*— Adjust the moisture content to that defined in the disposal scenario by dewatering or adding reagent water to the material. Increase moisture content to that defined in the disposal scenario by addition of reagent water. Note and record the volume of reagent water added. If the concentration of any trace analyte of concern found in the reagent water exceeds the reporting (quantitation) limit for the volume added, note this on the report form. Decrease moisture content by determining scenario temperature (normally less than 60°C) and drying the material at the temperature for a specified time interval. Determine actual moisture content of the waste as it is placed in the column using Test Method D 2216 and an appropriate drying temperature. Note and record the drying temperature used. Record the moisture content.

10.1.3 *Density*—Density is to be adjusted by vibration (see Test Method D 4253) or compaction (see Test Method D 698) to the anticipated field density. Pack the waste material in the column so that uniform density is achieved. This can be checked by visual observation of the waste in the transparent column.

10.1.4 *Curing*—Aging may be necessary for those materials that undergo physical or chemical changes with time in order to obtain a specimen (test portion) representative of the desired conditions. Curing may be accomplished in the field before testing in the column to produce a physical and chemical state representative of the waste as it undergoes leaching in the field. Note and record field conditions of temperature, humidity, and atmospheric pressure. Record the duration of the curing process and report with the test data.

10.1.5 *Particle Size*— Ensure that the particle size distribution of the waste as placed in the column is representative of that expected in field placement. Interpretation of results is based in part on a knowledge of the particle size distribution and surface area of the material. Maximum particle diameter must not exceed 1/10 of the inside diameter of the column. Particle size reduction is not recommended. An evaluation of the particle characteristics of size distribution and surface area may be useful. Test Methods D 422 and C 819 should be used to evaluate these properties of the waste.

10.2 *Column Filling*:

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10.2.1 Fill the column by compacting or vibrating the waste in five approximately equal layers. Approximate the expected field density. Scarify the top surface of each layer before adding the next increment. Do not scarify the top layer after final compaction. Fill the column to its final height, ensuring that the final height of the compacted material is equal to the height of the leaching column.

10.2.2 After filling the column, determine the mass, including the same fittings as in the determination of the tare. Record the total mass.

10.3 *Leaching*:

10.3.1 The leaching process is conducted in a continuous up-flow mode.

10.3.2 *Saturation*—After assembling the column as shown in Fig. 1, saturate the column with reagent water by the method outlined in Test Method D 2434 for determining permeability coefficients using a constant head permeameter. In this case, the column assembly replaces the constant head permeameter of that procedure. If it is determined that it is not possible to saturate the waste using Test Method D 2434, it may be necessary to increase the vacuum used in the procedure or attempt to saturate the column under pressure, or both, to promote the dissolution of gasses.

10.3.3 Water used to saturate the waste should be of the same quality as that to be used to leach the waste in the column. Collect a sample of this water at the time of saturation and analyze for the same properties and constituents as will be measured in the column effluent. An appropriate sample container, similar to that used for sample collection should be chosen and cleaned. Sample container guidance is given in 10.6.1. The test portion will be collected using the procedures for leachate collection.

10.3.4 *Determination of the Void Volume*—Void volume is estimated from the measurement of specific gravity of the solids in accordance with Test Method D 854, the mass of the wet solids placed into the column, the moisture content of the material in accordance with Test Method D 2216, and the volume of the column. Although the drying temperatures used in Test Methods D 854 and D 2216 can be selected on the basis of the specific characteristics of the material being dried, the drying temperatures used in the two procedures must be the same for the data to be used for porosity and void volume calculations.

10.3.4.1 Measure the mass of the sample material which fills the column apparatus. Note and record the moisture content of the material, as well as the specific gravity and any other specific information relevant to the material.

10.3.4.2 Calculate the void volume using the following equation:

$$V_p = V_c\{M/[(1 + w) \times S \times D]\} \quad (1)$$

where:

V_p = void volume in the column, cm^3,
V_c = volume of the column, cm^3,
M = as-packed mass of the material, including moisture, contained in the column,
w = moisture content of the material contained in the column as a mass ratio from Test Method D 2216, g water/g solids
S = specific gravity of the material as determined in Test Methods D 854, unitless, and
D = density of water, g/cm^3.

10.3.5 Estimate the degree of saturation by calculating the porosity n of the material using the following equation:

$$n = V_p/V_c \quad (2)$$

Calculate the mass gain in the saturated material. Add the value of the mass gain to the mass of the water in the packed column. Compare the value to the calculated void volume. The ratio is the degree of saturation. The degree of saturation can be estimated by determining the mass gain due to the water added to the waste during the saturation process, adding this mass gain to the mass of water in the packed column before saturation, and comparing this to the void volume just calculated. The mass gain can be determined by subtracting the mass of the packed, unsaturated column plus the mass of the packed, unsaturated column plus the mass of the water retained in the end plates, flow distribution disks, and fittings, from the mass of the saturated column.

10.4 *Effluent Flow*:

10.4.1 Once the column is saturated, begin the testing period. Adjust the pressure or hydraulic head, or both, so that one complete void volume exchange rate is accomplished in 24 ± 3 h. Maximum operating column pressure, for apparatus specified, should not exceed 275 kPa (40 psig). Read and record operating pressure, and effluent start time. If some test period other than 24 ± 3 h (an alternate void volume period) is warranted, record justification, time interval required, operating conditions, and effluent start time. Collect all column effluents as discrete void volume increments.

10.4.2 *Operating Requirements*—The column must be operated continuously. Note and record stop and restart times for all cessations. Determine total stoppage time for each occurrence per day and total daily stoppage. Cease test if, on any one day, total stoppage exceeds 1 h.

10.4.3 No type of channeling is permitted. When channeling is noted, note the time and cease the test. Determine if samples generated previously are usable. Document rationale for acceptance/rejection of previous sample effluent. Columns shall be protected from extraneous light except during column checks and sample collection intervals. Note and record all exposure periods.

10.4.4 Columns are to be run at ambient temperature, under normal test conditions. Sufficient pressure is required to maintain flow at the specified rate which will yield a void volume during the specified time interval. Temperature and pressures must be read and recorded periodically. For safety reasons, do not operate this equipment above 275 kPa (40 psig).

10.5 *Leachate Collection*:

10.5.1 The column must be inspected periodically and adjustments made if necessary to maintain the desired operating conditions.

10.5.2 Sufficient leachate from void volume periods shall be collected to establish a basis for judgment on completeness of

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the test. Minimally, it is recommended that Void Volumes 1, 2, 4, and 8 be collected and analyzed. Additional void volumes may provide additional useful data. The minimum number and sequence numbers of void volumes that will be collected and analyzed must be identified in advance of any collection activity.

10.5.3 Void volumes are sampled by collecting all column effluent generated over a 24 ± 3 h or other period corresponding to the void volume of interest.

10.5.4 Minimize contact of the leachate with the atmosphere. Fill effluent collection vessel head space with prepurified nitrogen or argon. Protect vessel head space with a water trap.

10.5.5 Collect effluent in appropriate containers. Containers shall be cleaned in an appropriate manner. Containers must be free from contamination for those parameters of interest in the leachate. Follow the procedures outlined in Practice D 3694 or Ref (4), or both.

10.6 *Leachate Sample Preparation*:

10.6.1 Sample containers must be constructed of materials that do not alter the sample quality. Follow the procedures outlined in Practice D 3694 or Ref (4), or both.

10.6.2 Sample containers must be cleaned according to Practice D 3694, methods contained in Ref (4), or as appropriate for the constituents of interest.

10.6.3 If collected leachates from void volume periods are stirred or agitated before filtration or analysis, this must be noted in the report. Minimize contact between the liquid and air during this mixing. If there are solids visible in the collected leachate before or after mixing, this must be noted in the report.

10.6.4 If filtration of the leachate is desired prior to chemical analyses, then such filtration steps must be noted. Analyze the filtered material separately to ensure that the suspended solids did not contain constituents that are of environmental significance. If suspended solids are found to contain analytes of significance, then redo the column leach test, and analyze the leachate without filtration.

10.6.5 If samples are filtered before analysis, the method of filtration must be noted in the report. Filtration must be completed within 1 h of sample collection. Contact with air must be minimized.

10.6.6 Samples must be stored under refrigeration at 4°C. Sample container head space must be minimized. A tight seal between the cap and the container is expected. Guidance on preservation techniques can be found in Practices D 3694 and D 3370 as well as in Ref (4).

10.7 *Sample Labeling*— At a minimum, the information regarding column source, collection date, collection time, void volume number, sampler's name, sampler's signature, and preservatives used must be recorded.

10.8 *Characterization of the Leachate*—The minimum test portion for characterization is equal to the volume of leachate produced during the void volume period. Suggested analyses for characterization of leachate include: pH, Test Methods D 1293; Conductivity, Test Methods D 1125; Redox Potential, Practice D 1498; Total Solids, Test Method D 1888; and any other analyses that will further characterize the material and provide interpretive guidance.

11. Report

11.1 The report must include at least the following information:

11.1.1 Project identification and description,

11.1.2 Description of waste as sampled,

11.1.3 Sampling procedures, waste sample handling, and storage procedures including the date and time of sampling,

11.1.4 All procedures used to condition the waste for placement in the column including curing and moisture adjustment procedures,

11.1.5 Permeability, particle size, and surface area information where available, including disposal scenario specifications; and a complete description of material as sampled,

11.1.6 Temperature used for drying in moisture determination and specific gravity procedures if different than 110 ± 5°C,

11.1.7 Materials used to construct the column apparatus if different than those specified in the test method,

11.1.8 Column washing procedures,

11.1.9 Waste moisture content as sampled and as packed in the column,

11.1.10 Characteristics of the waste as placed in the column including specific gravity of the solids, porosity, and void volume,

11.1.11 Mass of the waste placed in the column,

11.1.12 Saturation procedures used if different than Test Method D 2434, and date and time that column saturation began and ended,

11.1.13 Date and time that leaching began,

11.1.14 Temperature and pressure of column operation at the beginning of the test, and at each time samples are collected or flow rates are adjusted,

11.1.15 Means used to prevent exposure of column contents to light,

11.1.16 Total time for collection of each void volume, the measured volume of the leachate collected during the period, the date and time when measured, any corrections made to flow rates, and quantities of effluent collected between flow rate determinations,

11.1.17 Date, time, and duration of all flow stoppages,

11.1.18 Observations of unusual conditions in the column, such as density variations, cracks, gas-filled spaces, or evidence of fluid channeling along column walls,

11.1.19 Date and time that the tester began and finished collecting each void volume and the number of void volumes collected,

11.1.20 Type and material of construction of sampling containers and methods used to clean sample containers,

11.1.21 Steps taken to avoid sample contact with air where such steps are called for in the test method,

11.1.22 Results of measurements of index properties and any other analyses performed on unfiltered samples within 1 h of collecting the void volume from the column. The results of the analyses of that water used to saturate and leach the waste must also be included, and

11.1.23 All analytical data requested in disposal scenario with complete documentation and traceability through laboratory records.

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TABLE 1 Test Method Precision (Percent Relative Standard Deviations)

NOTE 1—The top number in each set is the pooled within-laboratory relative standard deviation while the bottom number is the overall interlaboratory variability for a single test result in terms of relative standard deviation.

NOTE 2—Because all chemical analyses were performed by a single laboratory, the total variance does not contain an interlaboratory analytical component.

Element	Number of Void Volumes of Liquid Having Passed Through the Column at the Time of Sample Collection						Average[A]
	1	2	4	8	16	32	
Aluminum	61/130	22/62[B]	44/54	30/40	29/85	10/50	35/72
Calcium	9/20	5/16	6/28	7/14	14/75	13/42	9/33
Cobalt	25/64[B]	...	...	...	...	...	...
Chromium	13/51	12/15	16/33	8/8	17/33[B]	...	12/17
Copper	25/33	8/10	12/22	18/26	33/43[B]	...	16/23
Iron	88/140	16/18	20/26	16/18	27/40[B]	...	35/51
Lithium	34/50	75/130	63/120	...	...	...	57/100
Magnesium	130/170[B]	...	...	...	...	...	...
Molybdenum	5/10	13/60	59/79	17/69	51/77[B]	...	24/55
Nickel	...	...	...	50/86[B]	36/41	21/34	61/38
Phosphorus	...	...	64/71	85/85[B]	67/73[B]	...	64/71
Potassium	24/82	28/110	63/120	93/100[B]	48/80	...	38/104
Silicon	...	...	...	...	34/48	22/29	28/39
Sodium	24/87	56/100	50/86	28/39	46/59	...	41/74
Strontium	19/42	18/18	28/52	4/22	36/75[B]	...	17/34
Vanadium	49/53[B]	10/27	30/60	16/18	24/33[B]	14/24	18/32
Zinc	99/100[B]	...	...	...	...	...	...
						Average	33/54

[A] Average values are based only on data without asterisks.

[B] Based on data sets that contain one to three values below detection limits (out of nine values). Those values below detection limits are assigned the detection limit in the calculations. If more than three values are below the detection limit, the data were not analyzed.

12. Precision and Bias

12.1 *Precision*—The precision of this test method has been studied for inorganic materials in a three-laboratory study involving triplicate columns at each laboratory. Fly ash was used as a waste material. Because the fly ash was of very low permeability, end caps without radial grooves were used. The column effluents were analyzed by a single laboratory for metals by emission spectroscopy using an inductively coupled plasma source. Those metals that were measured at concentrations above the method detection limits were used to determine the precision of the column extraction method according to Practice E 691. The precision identified in the study was a measure of the ability of the column method to generate effluents of similar quality from a single waste material in tests conducted at different laboratories, or in tests using multiple columns at a single laboratory. A summary of the precision data is contained in Table 1. The complete interlaboratory study is described in Ref (5). The pooled within-interlaboratory relative standard deviation for metals data averaged 33 %. The overall interlaboratory single test reproducibility in terms of standard deviation was 54 %. This excludes interlaboratory analytical effects because all analyses were performed by a central laboratory. The analytical precision reported by the central laboratory, at concentrations most frequently measured, was seldom greater than 5 % relative standard deviation.

12.2 Precision data for organic constituents are not available.

12.3 *Bias*—It is not possible to determine the bias of this test method because there are no accepted reference effluents generated.

13. Keywords

13.1 column leach; leachate; waste leaching technique

REFERENCES

(1) Grove, D. B., and Stollenwerk, K. G., "Modeling the Rate-Controlled Sorption of Hexavalent Chromium," *Water Resources Research*, Vol 21, No. 11, 1985, pp. 1703–1709.

(2) Parker, J. C., and Van Genuchten, M. T., "Determining Transport Parameters from Laboratory and Field Tracer Experiments," *Bulletin No. 84-3*, Virginia Agricultural Experiment Station, Virginia Polytechnical Institute and State University, Blacksburg, VA, 1984.

(3) Rao, P. S. C., Davidson, J. M., Jessup, R. E., and Selim, H. M., "Evaluation of Conceptual Models for Describing Non-Equilibrium Adsorption-Desorption of Pesticides During Steady-Flow in Soils," *Soil Science Society of America Journal*, Vol 43, 1979, pp. 22–28.

(4) *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA 600/4-82-029, September 1982.

(5) Miner, R. A., Van Maltby, C., Dell, L. R., "The Results of an Interlaboratory Study of a Column Method for Leaching Solid Waste," *Symposium on Hazardous and Industrial Solid Waste Testing and Disposal*, 6th ed., *ASTM STP 933*, ASTM, 1986.

DM 2/8/06

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

CF- 1893 QAQC-003 REV. 4

SHIP TO:

Company Name: HAZEN RESEARCH INC
ADDRESS: 4601 INDIANA STREET
CITY,STATE, ZIP: GOLDEN, CO 80403

CONTACT PERSON: DENNIS JOHNSON
PHONE: 303-279-4501

SHIP FROM:

CIMARRON CORPORATION
1/2 MILE NORTH OF HWY JCT 33 & 74
P.O. BOX 315
CRESCENT, OK 73028
PHONE: (405) 282-5680
FAX: (405) 282-0534

Contact Person: Karen Morgan

I ATTEST THAT THE PROPER FIELD SAMPLING PROCEDURES WERE USED DURING THE COLLECTION OF THESE SAMPLES.

SAMPLER SIGNATURE: Erik Tial

SAMPLE LOCATION

ANALYSIS REQUESTED

SAMPLE NAME	DATE	TIME	CONTAINER NO.	TYPE	SIZE	SOLID: SOIL	SOLID: OTHER	WATER	PRESERV. Y/N	FILTERED .45µ Y/N	BULK DENSITY		ELUTION
SC-04-BD_01262006_12.5-15'		1010	1	PB	4"	X	N/A				X		
SC-04_01262006_16-17'		1025	1	P	2Gal	X							X
SC-05_01262006_0-0.5'		1520	1	P	2Gal	X							X
SC-03-BD_01252006_14-14.5'		854	1	PB	4"	X					X		
SC-03_01252006_17-19.5'		1100	1	P	2Gal	X							X
SC-01-BD_01252006_12-12.5'		1305	1	PB	1"	X					X		
SC-02A_01252006_15-18'		1552	1	P	2Gal	X							X
SC-01_01252006_10-15'		1305	1	P	2Gal	X							X

Potential Hazardous Characteristics

☐ Non-Haz ☐ RCRA D001,2&3, or 4 ☐ RCRA Listed ☐ Radioactive X Unknown

Sample Disposal

X Disposal Lab ☐ Return to Client ☐ Holding pending further instructions

THIS SAMPLE MEETS ALL APPROPRIATE RADIOLOGICAL REQUIREMENTS: HP INITIAL: JM Approval By:

CUSTODY RECORDS	RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
Sign and RETURN Original Chain of Custody with Data Results.	Erik Tial	1/27/06	1100	DJohnson	1/30/06	1000

NOTE:
PB = Plastic bag
P = Plastic 2gal bucket

RETENTION TIME: T+20

DM Johnson 2/8/06

PAGE 1 OF 1

DOCUMENT CONTROL: [signature] QA Coordinator DATE: 01-27-06

SAMPLE RECEIVED

This form must be filled out completely!

From: Ron McGee (ENSR)

Via: FedEx

HRI No.: 51177

Project No.: 10364

Date Rec'd: 1/30/06

Total No. of Samples: 5 2 gallon buckets

Approx Wt. of Sample: ☐ <1 lb ☐ 1-5 lb ☐ 5-20 lb ☒ 20-100 lb ☐ >100 lb

How Shipped: ☐ Paper Envelopes ☐ Canvas Bags ☒ Poly Bags ☐ Barrels ☐ Poly Bottles ☐ Other

Treatability Study: ☐ Yes ☐ No Anticipated commencement date:

Description: Soil Samples

Sample Size: ☐ <10 mesh ☐ ~8-10 mesh ☐ ~4-6 mesh ☐ ~¼-½ in ☐ ~½-1 in ☐ ~1-2 in ☐ ~2-5 in ☐ >5 in ☐ Other

HRI No.	Sample ID	Net Wt lb or kg or g
-1	SC-01 10-15' Type P 2 gal	
-2	SC-01-BD 12-12.5' Type PB 1"	
-3	SC-02A 15-18' Type P 2 gal	
-4	SC-03 17-19.5' Type P 2 gal	
-5	SC-03-BD 14-14.5' Type PB 4"	
-6	SC-04 16-17' Type P 2 gal	
-7	SC-04-BD 12.5-15' Type PB 4"	
-8	SC-05 0-0.5' Type P 2 gal	

PB = Plastic bag
P = Plastic

Project Manager: [signature]

BLANK.XLW/sample recd

[signature] 2/8/06

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Dennis M. Johnson

From: Ferguson, Du'Bois [dferguson@ensr.aecom.com]
Sent: Wednesday, February 01, 2006 1:40 PM
To: Dennis M. Johnson; Charles W Kenney
Cc: Cao, Xiaoyun; Trail, Erin; Meenan, Michael
Subject: Kickoff Meeting Teleconference Summary
Importance: High

Thanks for taking time out of you schedules to map out the logistics for the Cimarron Project treatability testing.

A summary of the items discussed and agreed to are :

- February 20, 2006 will be the target start-up date for both the adsorption isotherms and soil elution (dynamic column) studies.
- James Cao from ENSR will visit the Hazen facilities on February 20, 2006 to observe both the startup of the column study and adsorption isotherm testing.
- Erin Trail will provide Dennis Johnson with a spreadsheet containing the measured field parameters so that Hazen can compare this with the groundwater quality they receive for the testing.
- Dennis Johnson will develop a flowchart outlining the specific steps to be followed during the study execution, as well as a schematic of the proposed column set-up for review and approval by James Cao prior to the commencement of the studies.
- E-mails will be the primary reporting mechanism that Hazen will use to keep the primary point of contact (POC) Joe Ferguson apprised of project milestones, problems, observations, decision points, etc. This will not preclude the two technical teams from having direct communications (i.e. Trail to Johnson, Johnson to Cao), as long a s I am copied on the communications.
- The minimum sample volume requirements for analysis is being evaluated by GEL and ENSR. This information will be communicated to Hazen within the next few days.
- ENSR will coordinate the shipment of sample containers from GEL as well as develop sample IDs. ENSR will check into the ability to provide pre-printed labels. Hazen stated that they do have the capability to do this if required.
- Hazen will provide a write-up to ENSR on how it will handle sample receipt and shipping tracking.
- The signed Chain of Custody (COC) for the first sampling event has been provided by Hazen under separate cover.
- Groundwater samples for the treability testing will be collected on February 15, 2006 and be delivered to Hazen on February 17, 2006.
- The treatability testing will be conducted at ambient temperature at the Hazen facility in Colorado.

I believe this covers all the items we discussed. If I have missed something or if clarifications are required, please don not hesitate to drop me a line with your feedback.

Regards

2/1/2006

DMJ 2/8/06

D. J. (Joe) Ferguson
Integrated Site Closure Dept. Manager
Direct Dial Tel 713-807-6517

ENSR
4888 Loop Central Drive, Suite 600
Houston Texas 77081
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2/1/2006

2/8/06

Dennis M. Johnson

From: Cao, Xiaoyun [xcao@ensr.aecom.com]
Sent: Thursday, February 02, 2006 1:57 PM
To: Dennis M. Johnson
Cc: Ferguson, Du'Bois (Joe); Meenan, Michael; Trail, Erin
Subject: Bench Scale Testing

Dennis,

As we are in full swing preparing for the bench scale tests, there are several items that need immediate action or attention since some involve deviation from or addition to the original test specs:

1. Along with the soil samples you received this week, there are three samples labeled SC-01BD, SC-03BD, and SC-04BD that are for bulk density determination. These tests need to be done ASAP because we don't want to lose moisture content from these samples and we need the data to pack the soil columns.

2. The sandstone column (#5, SC-04) was originally designed for rock core. Since no competent core was obtained, this column needs to be packed corresponding to its bulk density. Consequently, the sandstone sample (very soft!) will be prepared and the column packed using the same procedures as for columns #1 thru. #4. The size of the column shall also be changed to be in line with the soil columns.

3. With the addition of DOWEX 21K XLT, there are now three sorbents, instead of two, to be evaluated during the isotherm tests. As communicated previously, the specs for isotherm tests were developed for in field, on-site testing. The procedures may change slightly if the tests are carried out in a off-site laboratory. As such, the batch test bottles will be placed on a mechanic shaker and shake for 30 minutes.

4. Prior to starting the soil elution tests, make sure CO2 tank(s) and accessory tubings/pressure gage are available and ready for use. CO2 will be used to maintain the feed pH throughout the test to its field conditions.

5. Obtain one 40-gallon clean container for blending groundwater as the water will be delivered in one-gallon cubits.

Looking forward to working together and making this project a success.

Regards,

James Cao

DMJ 2/8/06

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Letter of Transmittal

Attention: Dennis Johnson
4601 Indiana Street
Golden, CO 80403

Date: January 3, 2006

Project Reference: Cimarron Treatability Studies

Project number: 04020044

We are sending you the following:

Adsorbent Material:	Quantity:	Description:
DOWEX 21K XLT	**1 KG**	Anion exchange resin, one bucket
AMBERJET ™4400 CL	**4 LBS**	Anion exchange resin, one bottle
HUMASORB-CS	**2 LBS**	Two bottles, soaked in DI water

Remarks

Each product is accompanied with manufacturer's MSDS or other pertinent info regarding the product. Please prepare the materials for isotherm and breakthrough tests per manufacturer's specifications.

James Cao James Cao
Signature

A Trusted Global Environmental, Health and Safety Partner

C:\Cimarron\Remediation\Hazen Shipping Letter.doc

DJohnson
2/8/06

Soil Sample Preparation

Soils Received
on 1/30/06

1. SC-01
2. SC-01-BD
3. SC-02A
4. SC-03
5. SC-03-BD
6. SC-04
7. SC-04-BD
8. SC-05

Note: Sample SC-04 was to be sealed in a column as Column Test 5. As of 2/2/06, the sample will be prepared and tested the same as the samples for Column Tests 1, 2, 3, and 4. The size of Column 5 will be the same as for the rest of the columns.

Determine Bulk Density
on Each of the
Following Samples

SC-01-BD
SC-03-BD
SC-04-BD

↓

Procedure:

1. Unseal each sample.
2. Measure its weight.
3. Measure its dimensions.
4. Dry at 110°C.
5. Reweigh and determine BD.

Prepare Each of the
Following Samples
for Column Testing

SC-01
SC-02
SC-03
SC-04
SC-05

↓

Procedure:

1. Unseal each sample.
2. Measure its weight.
3. Drying at 60°C may be necessary (Do under an N_2 cover, record before and after weights, minimize exposure to air).
4. Thoroughly homogenize the sample.
5. Take an aliquot for residual moisture determination.
6. Take an aliquot for Uranium analysis.
7. Seal dried solids under N_2 until used.
8. SC-01 will be used for Column Test No. 1.
9. SC-02 will be equally split and used for Column Tests No. 2 and 3.
10. SC-03 will be used for Column Test No. 4.
11. SC-04 will be used for Column Test No. 5.
12. SC-05 will be used for Column Test No. 6.

2/8/06

Elution Column Operating Parameters

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Solids: SC-01 Fine/ Silty Sand	Solids: SC-02 Coarse Sand	Solids: SC-02 Coarse Sand	Solids: SC-03 Clay	Solids: SC-04 Sand-stone B Core	Solids: Mix of 01 or 02 or 03 and SC-05 Top Soil
Solution: TMW-02 Sandstone B Water	Solution: TMW-02 Sandstone B Water	Solution: 02W33 Sandstone C Water	Solution: TMW-02 Sandstone B Water	Solution: TMW-02 Sandstone B Water	Solution: Synthetic Rain Water
Feed: Upflow @ 2 Pore Volume per Day 16 Days Minimum	Feed: Upflow @ 2 Pore Volume per Day 16 Days Minimum	Feed: Upflow @ 2 Pore Volume per Day 16 Days Minimum	Feed: Upflow @ 1 Pore Volume per Day 16 Days Minimum	Feed: Upflow @ 1 Pore Volume per Day 16 Days Minimum	Feed: Downflow @ 1 Pore Volume per Day 16 Days Minimum
Est. Soln. Required 22 L	Est. Soln. Required 22 L	Est. Soln. Required 22 L	Est. Soln. Required 11 L	Est. Soln. Required 11 L	Est. Soln. Required 11 L

DM 7/18/06

2/16/06

Tim Cobb and Chris Statile have been working on putting the column together, making a support stand, and piping the feed vessels. 100 micron porous plate circles were cut (3" dia) at Omnicut. These circles were prepared according to ASTM D4874-95 9.2.1.1 Procedures. Lynn Dolven determined the bulk density of the 3 samples, labled AB (SC-01, SC-03, & SC-04). We also dried and prepped soil samples. The samples were dried overnight @ 60°C in a N_2 purged oven. The dried samples were jaw crushed and screened at 6 mesh, blended, sampled for residual moisture & analysis, then bagged and purged with N_2 awaiting packing in the columns.

Head Samples (Dried)

2988-38-1	SC-01	5177-1&2	Feed for	CT1
2988-38-2	SC-02	5177-3	" "	CT2
2988-38-3	SC-02	5177-3	" "	CT3
2988-38-4	SC-03	5177-4&5	" "	CT4
2988-38-5	SC-04	5177-6&7	" "	CT5
2988-38-6	SC-05	5177-8	" "	CT6

Dennis M. Johnson

From: Ferguson, Du'Bois [dferguson@ensr.aecom.com]
Sent: Wednesday, February 01, 2006 1:40 PM
To: Dennis M. Johnson; Charles W Kenney
Cc: Cao, Xiaoyun; Trail, Erin; Meenan, Michael
Subject: Kickoff Meeting Teleconference Summary
Importance: High

Thanks for taking time out of you schedules to map out the logistics for the Cimarron Project treatability testing.

A summary of the items discussed and agreed to are :

- February 20, 2006 will be the target start-up date for both the adsorption isotherms and soil elution (dynamic column) studies.
- James Cao from ENSR will visit the Hazen facilities on February 20, 2006 to observe both the startup of the column study and adsorption isotherm testing.
- Erin Trail will provide Dennis Johnson with a spreadsheet containing the measured field parameters so that Hazen can compare this with the groundwater quality they receive for the testing.
- Dennis Johnson will develop a flowchart outlining the specific steps to be followed during the study execution, as well as a schematic of the proposed column set-up for review and approval by James Cao prior to the commencement of the studies.
- E-mails will be the primary reporting mechanism that Hazen will use to keep the primary point of contact (POC) Joe Ferguson apprised of project milestones, problems, observations, decision points, etc. This will not preclude the two technical teams from having direct communications (i.e. Trail to Johnson, Johnson to Cao), as long a s I am copied on the communications.
- The minimum sample volume requirements for analysis is being evaluated by GEL and ENSR. This information will be communicated to Hazen within the next few days.
- ENSR will coordinate the shipment of sample containers from GEL as well as develop sample IDs. ENSR will check into the ability to provide pre-printed labels. Hazen stated that they do have the capability to do this if required.
- Hazen will provide a write-up to ENSR on how it will handle sample receipt and shipping tracking.
- The signed Chain of Custody (COC) for the first sampling event has been provided by Hazen under separate cover.
- Groundwater samples for the treability testing will be collected on February 15, 2006 and be delivered to Hazen on February 17, 2006.
- The treatability testing will be conducted at ambient temperature at the Hazen facility in Colorado.

I believe this covers all the items we discussed. If I have missed something or if clarifications are required, please don not hesitate to drop me a line with your feedback.

Regards

2/16/2006

D. J. (Joe) Ferguson
Integrated Site Closure Dept. Manager
Direct Dial Tel 713-807-6517

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Dennis M. Johnson

From: Ferguson, Du'Bois [dferguson@ensr.aecom.com]
Sent: Wednesday, February 15, 2006 3:02 PM
To: Dennis M. Johnson; Cao, Xiaoyun; Trail, Erin
Cc: Meenan, Michael; McGrath, Debbie
Subject: Status of Cimarron Treatability Study Work
Importance: High

Here are the summary highlights from our call today.

- The columns for the elution column testing are currently being assembled. They should be completed by the close of business Thursday, if not, Friday 2-17-06.
- The solids were dried in a nitrogen purged oven.
- The soil samples are being stored under nitrogen environment & the samples for analysis are ready for submittal. The blended samples have been placed in bags and are awaiting total uranium analysis.
- James Cao will check with the lab to determine the amount of sample required for the total uranium analyses. He will get a back with Dennis Johnson on this ASAP.
- Joe Ferguson to confirm shipment dates of the groundwater samples to Hazen this week.
- James and Dennis are still working on an approach to control the breakthrough column studies.
- Dennis has compiled data on the bulk density and moisture content for the soil samples, and this information will be provided shortly.
- James Cao is scheduled to visit the Hazen facility on 2/20/06 or 2/21/06.

If there are any clarifications required or questions regarding this summary, please do not hesitate to contact me.

Regards

D. J. (Joe) Ferguson
Integrated Site Closure Dept. Manager
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and

10-15 gallons for Column 6

NOTE: Solutions are unbuffered and exact pH may not be attained.

5.4.2 Extraction fluid #2: This fluid is made by adding the 60/40 weight percent mixture of sulfuric and nitric acids (or a suitable dilution) to reagent water (Step 5.2) until the pH is 5.00 ± 0.05. The fluid is used to determine the leachability of soil from a site that is west of the Mississippi River.

2/20/06 Project # 10364

(1) [illegible] piping & valving

(2) Rinse all system with D.I

(3) Leak test Column #1 → 6

(4) Tare weight of receiver buckets:

Bucket #	Bucket wt	Lid wt	Total Tare
1	231 g	89 g	320 g
2	233.5 g	87.5 g	321 g
3	231 g	87 g	318.5 g
4	233 g	87 g	320 g
5	229.5 g	88.5 g	318.5 g
6	233.5 g	87.5 g	321 g

(5) Make up 10 gallons of West of [illegible] Rain H_2O synthetic rain H_2O

10 gal of D.I. H_2O
pH with 60% H_2SO_4 & 40% Nitric Acid to pH 5.01

2/21/06 Packing Column #1 Empty column wt = 3067.0
No filter no top & no tip bottle

started with 2006 g of SC-01 —
added 1/2 of dry load + 100 g H_2O D.I Tamp

added 1/2 of dry load + 100 H_2O D.I Tamp

added 200 g more dry solid
added 100 g more dry solids
added 50 g more dry solids.
" 25 g " " "
added 30 g D.I H_2O to [illegible] [illegible]
added 100 g more of dry solids.

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

CF- 1897

QAQC-063 REV. 4

SHIP TO:

Company Name: HAZEN RESEARCH INC.
ADDRESS: 4601 INDIANA STREET
CITY,STATE, ZIP: GOLDEN, CO 80403

CONTACT PERSON: DENNIS JOHNSON
PHONE: 303-279-4501

SHIP FROM:

CIMARRON CORPORATION
1/2 MILE NORTH OF HWY JCT 33 & 74
P.O. BOX 315
CRESCENT, OK 73028
PHONE: (405) 282-5680
FAX: (405) 282-0534

Contact Person: Karen Morgan

I ATTEST THAT THE PROPER FIELD SAMPLING PROCEDURES WERE USED DURING THE COLLECTION OF THESE SAMPLES.

SAMPLER SIGNATURE: [signature]

SAMPLE LOCATION: BA-1

SAMPLE Sample Location	Date	TIME	CONTAINER NO.	TYPE	SIZE	SAMPLE TYPE SOLID SOIL	OTHER	WATER	PRESERV. Y/N	FILTERED .45µ Y/N	ANALYSIS REQUESTED Soil Elution	Groundwater Treatability
02W33_021523006		1315	2	PL	5gal				N	N	X	
TMW-02_02152006		1544	6	PL	5gal				N	N	X	
TMW-09_02152006		1040	11	PL	5gal				N	N		X
02W04_02152006		1440	11	PL	5gal				N	N		X

Potential Hazardous Characteristics

☐ Non-Haz ☐ RCRA D001,2&3, or 4 ☐ RCRA Listed ☐ Radioactive X Unknown

Sample Disposal

X Disposal Lab ☐ Return to Client ☐ Holding pending further instructions

THIS SAMPLE MEETS ALL APPROPRIATE RADIOLOGICAL REQUIREMENTS: HP INITIAL [initials] Approval By: [signature]

NOTE:

CUSTODY RECORDS	RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME
Sign and RETURN Original Chain of Custody with Data Results.	RELINQUISHED BY SAMPLER: [signature]	2/16/06	1100	[signature]	2/17/06	1100
	RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME
	RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME
	RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME

RETENTION TIME: T+20

PAGE 1 OF 1

DOCUMENT CONTROL: [signature] DATE: 2/16/06
QA Coordinator

SAMPLE RECEIVED

This form must be filled out completely!

From: ENSR
Kerr-McGee

Via: FedEx

HRI No.: 51187
Project No.: 10364
Date Rec'd: 2/17/06
Total No. of Samples: 4
Approx Wt. of Sample: ☐ <1 lb ☐ 1-5 lb ☐ 5-20 lb ☐ 20-100 lb ☒ >100 lb

How Shipped: ☐ Paper Envelopes ☐ Canvas Bags ☐ Poly Bags ☐ Barrels ☐ Poly Bottles ☐ Other Coolers

Treatability Study: ☐ Yes ☐ No Anticipated commencement date:

Description: Water

Sample Size: ☐ <10 mesh ☐ ~8-10 mesh ☐ ~4-6 mesh ☐ ~¼-½ in ☐ ~½-1 in ☐ ~1-2 in ☐ ~2-5 in ☐ >5 in ☐ Other

HRI No.	Sample ID	Net Wt lb or kg or g
-1	TMW-09-06	5
-1	TMW-09-10	5
-1	TMW-09-08	5
-1	TMW-09-01	5
-1	TMW-09-04	5
-1	TMW-09-07	5
-2	TMW-02-01	5
-2	TMW-02-02	5
-3	02-W04-08	5
-3	02-W04-09	5
-1	TMW-09-02	5
-1	TMW-09-03	5
-3	02-W04-02	5
-4	02-W33-02	5
-3	02-W04-05	5
-3	02-W04-06	5
-1	TMW-09-09	5
-1	TMW-09-11	5
-3	02-W04-11	5
-3	02-W04-10	5
-3	02-W04-04	5
-3	02-W04-03	5
		5

Project Manager: [signature]

BLANK.XLW/sample recd

Continued on Next Page

Continued from Previous Page

-2* TMW-02-05 (leaking container)	5 gal.	
-3 02-W04-01	5 gal.	
-2 TMW-02-06	5 gal.	
-2 TMW-02-04	5 gal.	
-4 02W-33-01	5 gal.	
-2 TMW-02-03	5 gal	
-1 TMW-09-05	5 gal.	
-3 02W-04-07	5 gal.	

2/20/06

Cooler # 6	56.5°F	
# 8	55.0°F	
# 12	55.1°F	
BID#16	54.2°F	

09:10	#1	57.1°F
	#2	57.6°F
	#3	56.9°F
	#4	54.6°F
09:23	#5	54.2°F
	#6	56.5°F
	#7	56.5°F
	#8	55.0°F
	#9	56.7°F
	#10	54.8°F
	#11	54.2°F
	#12	55.1°F
	#13	55.5°F
09:35	#14	55.0°F

2/21/06 continued from pg. 41

TMW-02 Barrel check

Temp 16.1° C
conductivity = 0.59 mS
pH = 7.46
orp = 378 mv

02W04 Barrel Check:

Temp. 11.7°C
Cond. = 1.4 ms
pH = 7.08
orp = 430

2/21/06 – Sparged 55 gal. drum of 02W04 for 4 min. with CO_2. PH dropped from 7.08 to 6.76

TMW-09 Barrel Check

Temp. 11.8°C
Cond. = 1.0 ms
pH = 7.06
orp = 381

2/21/06 – Sparged 55 gal drum of TMW-09 for 10 min with CO_2. pH dropped from 7.06 to 6.7

02W33 Barrel Check

Temp. 12.1°C
Cond. = 2.0 ms
pH = 7.25
orp = 380

2/21/06 – Sparged 10 gal. container of 02W33 for 5 min. with CO_2. pH dropped from 7.25 to 6.7

West of Mississippi Rain H_2O

Temp. 12.8°C
Cond. = 0.0 ms
pH = 5.01
orp = 405

Column #1:

2

Packed column with SC-01 fine/silty sand solids (2,481g).

Filled pressure container with TMW-02 sample water (4,000g).

Added 230 g of DI H_2O to facilitate column packing.

Pressurized to 25 psi at 1330 on 2/21/2006. Initial saturation of column.

2/22/06 Top Filter change out.
from S.S./paper to sand/Polypropylene
used 84.0 g of Colorado Silica Sand.

Boat Tare = 7.09 g

Removed 225.41g from column to insert new filter.

Total volume of SC-01 in column is 2255.59g.

2/23/2006 Added 4001g of TMW-02 to column 1 pressure tank.
Total volume in tank is 8001g.

Started to collect leachate and flow determination at 10:30.

Lowered pressure to 10 psi to control flow.

Lowered pressure to 5 psi to control flow.

Column #2:

2/21/2006 Started packing column 2.
Empty column weight = 2951 g
no top filter, nuts or bolts

Packing column with SC-02 dry solids.
Added 2000g to column.
Added 450g more to column.

Filled pressure tank with TMW-02 sample water (4002.5g).

Added 250 ml of TMW-02 to column to facilitate packing.

Pressurized to 25 psi @ 1420 on 2/21/2006 Initial saturation of column.

2/22/06 Top Filter change-out from S.S/paper → sand/PVC
used 74.6 g

Boat Tare = 7.11 g

Removed 23.4 g from column to insert new filter.

Total volume of SC-02 in column is 2426.6 g.

2/23/2006 Added 4000.5g of TMW-02 to column 2 pressure tank.
Total volume in tank is 8003g

Started to collect leachate and flow determination at 1030.

Lowered pressure to 10psi to control flow.

Lowered pressure to 5 psi to control flow.