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Final

Meeting Minutes Transmittal/Approval
Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
740 Stevens Center, Room 1200, Richland, Washington
November 17, 1993

FROM/APPROVAL: Eric D. Goller Date 2/23/94
Eric D. Goller, 100 Area Unit Manager, RL (A5-19)

APPROVAL: Jack W. Donnelly Date 2/23/94
Jack W. Donnelly, 100 Aggregate Area Unit Manager, WA Department of Ecology

APPROVAL: Dennis Faulk Date 2-23-94
Dennis Faulk, 100 Aggregate Area Unit Manager, EPA (B5-01)

Meeting Minutes are attached. Minutes are comprised of the following:

Attachment #1	-	Meeting Summary
Attachment #2	-	Attendance Sheet
Attachment #3	-	Agenda
Attachment #4	-	Action Item Status List
Attachment #5	-	November Unit Manager's Meeting 100 Area Status Package
Attachment #6	-	100 Area Hanford Soil Washing Treatability Tests
Attachment #7	-	Soil Washing Continues to be a Viable Volume Reduction Treatment Technology
Attachment #8	-	100 Area Soil Washing Bench Scale Test Data
Attachment #9	-	100-BC-5 OU LFI Groundwater Investigation Validated Data Memorandum
Attachment #10	-	100-FR-3 OU LFI Groundwater Investigation Validated Data Memorandum
Attachment #11	-	100-KR-4 OU LFI Groundwater Investigation Validated Data Memorandum

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Prepared by: Kay Kimmel Date: 2/23/94
Suzanne Clarke, Kay Kimmel, GSSC (B1-42)

Concurrence by: Bob Henckel Date: 2/23/94
Bob Henckel, WHC Coordinator (H6-02)

Attachment #1
Meeting and Summary of Commitments and Agreements

Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
November 17, 1993

1. **SIGNING OF THE SEPTEMBER 100 AREA UNIT MANAGER'S MEETING MINUTES** - Minutes were reviewed and approved with no changes. Unit Managers agreed to cancel the October 1993 meeting due to a schedule conflict with the ER '93 Conference.

2. **ACTION ITEM UPDATE: (See Attachment 4 for complete status, items listed below indicate the update to Action Items made during the meeting):**

1AAMS.15	No additional information.
1AAMS.16	No additional information.
1AAMS.18	Closed 11/17/93

3. **NEW ACTION ITEMS:**
No new action items.

4. **100 AREA ACTIVITIES:**
   - Soil Washing Treatability Study: Jim Field provided the Soil Washing update (see attachment #6). He indicated that meeting Performance Level A for Cs-137 was not achievable, but Level B was achievable. ~~The Performance Level for Chromium at 1600 ppm is based on MTCA.~~ EDA 2/23/94 Attrition scrubbing was run at 83% solids. It appeared that Cs-137 was in the grains themselves - tied in the mica of the rock. Chemical extractions provided reproducible results. The two most efficient chemical extractants are currently being considered for patents. The extraction efficiency was improved by utilizing a combination of chemical extraction with attrition scrubbing. Note: attrition scrubbing is used for sandy soils; autogenous grinding is used on soils with higher cobble content.

     Bob Scheck discussed examples of beneficial applications of soil washing to remediation strategies (see attachment #7).

     100 Area Soil Washing Bench Scale Test Data (Draft) is provided as attachment #8. A meeting was scheduled for December 7 at 1:00 pm at 740 Stevens to discuss soil washing data and the objectives for pilot scale testing.

   - 100-HR-3 Groundwater Treatability Study: Jim Duncan presented an update of the status of the groundwater treatability study. Comments from RL are currently being incorporated. The scheduled date of January 31, 1994 for transmittal of the document to the regulators will be met.

     In order for this project to advance to the pilot scale stage, issues involving nitrate treatment require resolution. Specifically, chromium and nitrate are above maximum permissible drinking water standards; however, of these two contaminants, only chromium is an ecological contaminant of potential concern. Thus, the necessity for nitrate treatment before reinjection requires resolution. A meeting to discuss these and other issues was tentatively set for November 18 at 7:00 am. In addition, 100-HR-3 data for the past year will be provided to the Regulators at the

November 18 meeting.

- 100 Area Excavation Treatability Study: Jim Field discussed excavation of the Pluto Crib, 116-F-4, at 100-FR-1. Data will be provided at the next unit manager's meeting. No additional contamination was found to 15 feet; however, additional contamination was found at a depth of 27 feet. Verification samples were taken (3 at 14', 3 at 18', 1 at 26') and analyzed for gross alpha and gross beta. A clear plastic sheet was laid to mark the depth of excavation. Contamination was not as wide spread as expected. One very hot spot was found in an open 55-gallon drum. Since the contamination was less dispersed than expected, cleanup progressed more quickly than anticipated. A question remains concerning the inlet piping to the drum.

- Operable Unit Status: Attachment #5 was provided for general information on the 100 Areas Operable Units.

- Unit Manager: Wayne Soper is Ecology's new 100 Area groundwater operable unit manager.

- 100-HR-1, 100-BC-1, 100-DR-1: Since these three documents are similar, the common comments and programmatic issues will be resolved prior to resolution of the specific comments. RL anticipates providing the comment responses back to the Regulators within the next three weeks.

5. INFORMATION:

- LFI Data: 100-HR-3 LFI data will be provided to the regulators at the November 18 meeting. 100-FR-1 vadose zone LFI reports were provided to those who did not receive a copy in September.

- Scheduling of CERCLA UMMs: RL management has indicated that a set time each month, occupying one to two days, is no longer necessary as the concerned parties are already meeting at other times during the month. One of these meetings would need to be documented each month for the public record, in accordance with the guidelines in the Tri-Party Agreement. The three parties agreed that a single day for all CERCLA UMMs was a benefit. This day should be scheduled in advance to avoid scheduling conflicts.

- Points of Contact: Ecology will provide a revised list in the near future.

- Year End Review: HQ and RL counterparts met to discuss budget issues and work progress. HQ personnel provided positive reactions on the accomplishments in the 100 Areas based on the number of Milestones met. However, reevaluation of long-range goals and the strategies for accelerating the pace of meeting these goals required discussion. The necessity for identification of site-wide critical path issues, such as ERDF, which is on the critical path for 100 Area remediation, were discussed.

- Memoranda: Attachments #9, 10 and 11 are provided to document transmittal of data validation reports to the regulators.

6. NEXT MEETING: January 27, 1994.

Attachment #2

100 Aggregate Area Unit Manager's Meeting
Official Attendance Record
November ~~19,~~ 1993
17

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PRINTED NAME	ORGANIZATION	O.U. ROLE	TELEPHONE
Brian Drost	USGS	EPA Support	206-593-6510
Audree DeAngeles	PRC	EPA Support	206-624-2692
Jeff Ross	PRC	EPA Support	206-624-2692
Phil Staats	Ecology	OUM	736-3029
Wayne N. Soper	Ecology	OUM	735-7581
William E. Lum II	USGS	EPA Support	206 5936510
CHUCK CLINE	ECOLOGY	HYDROGEO. SUPPORT	206 407-7135
JACK Donnelly	Ecology	100 Area Supervisor	736-3013
Larry Gadbois	EPA	RPM	376-9884
Gary Freedman	Ecology	OUM	376-3026
KAY KIMMEL	DAMES & MOORE	RL SUPPORT	946-3692
Jim Field	WHC	Treatability	376-3753
Diana Sickle	WHC	ER-Program Support	(509) 372-3141
~~[illegible]~~ BOB SCHECK	Dames + Moore	GSSC	946-3688
Eric Goller	DOE-RL	100 Area UM	376-7326
Ted Wooley	Ecology	OUM	736-3012
Dave Holland	Ecology	OUM	736-3027
Paul Beaver	EPA	OUM	376-8665
Mat Johansen	USACE for DOE	DOE Support	" 9725
Shas Mattigod	PNL	100 Area Soil Washing	376-4311
Ron Belden	WHC	100 Area Soil Wash	372-1226
Angel Joy	USACE	DOE Support	376-7142
TED KARR	WHC	100 AREA SUPPORT	376-1702
BOB HENCKEL	WHC	100 AREA	376-2091
Alan D. Krug	WHC	100 Area	366-5634

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Attachment #2

100 Aggregate Area Unit Manager's Meeting
Official Attendance Record
November ~~19~~ 17, 1993

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PRINTED NAME	ORGANIZATION	O.U. ROLE	TELEPHONE
J.K. PATTERSON	WHC	ER Program Office	376-0902
R.L. BIGGERSTAFF	WHC	ER 100 Area	3765634
J.B. DUNCAN	WHC	ER 100 Area	372-0896
Diana Sickle	WHC	ER Program Support	509-372-3141

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Attachment #3
Agenda

Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
November 17, 1993

100 Area General Discussions

- **100 Area Excavation Treatability Studies**
  - **100-HR-1 Excavation Treatability Study** - Jil Frain
  - **Soil Washing Treatability Study** - Jim Field
  - **100-HR-3 Treatability Study** - Jim Duncan

Additions to the agenda:

- UMM Schedule
- Year End Review Recap

Operable Unit Status - Questions - Naiknimbalkar/Ayres/Krug/Steve Vukelich/Jim Roberts/Kytola

Action Item Status

Attachment #4

Unit Manager's Meeting: 100 Aggregate Area/100 Area Operable Units
November 17, 1993

Action Item Status List

ITEM NO.	ACTION	STATUS
1AAMS.15	Provide response to April 2 EPA letter concerning river seeps. Action: Eric Goller (RL) 7/29/92.	Open (7/29/92). In DOE for transmittal (8/26/92). Letter is pending (09/29/93).
1AAMS.16	DOE should transmit Revision 1 of M-30-01.	Open (7/29/92). In DOE for transmittal (8/26/92). Letter is pending (09/29/93).
1AAMS.18	Provide to EPA and Ecology all available shoreline site maps at a scale of 1:2000 by the October UMM. Action: Eric Goller, Bob Henckel	Open 09/29/93. Closed 11/17/93

NOVEMBER UNIT MANAGERS' MEETING

100 AREA STATUS PACKAGE

100 AREA TREATABILITY TEST STATUS
November 1993, Unit Managers Meeting

SOIL WASHING TREATABILITY TEST

100 Area soil washing tests for 100-B/C and 100-D samples are completed except for extract water analyses and final combination tests. All soil washing data obtained to date in weeklies from PNL will be presented at the November UMM meeting. A report of the 100-B/C and 100-D tests is being prepared and scheduled to be delivered to EPA and Ecology by January 31, 1993. Evaluations are in progress to assess cost/benefit of soil washing processes based on 100-D and 100-C laboratory results.

100-F soils sieving and characterization started this month. Borehole data and 100-F pluto crib excavation data show that these soils contain higher concentrations of strontium and plutonium than samples 100-D or 100-B/C samples. Testing of 100-F soils is scheduled to continue through February.

100-HR-1 EXCAVATION TREATABILITY TEST

As of 11/8/92, excavation has reached a depth of 18 feet below ground surface (corresponds to lift number 9). Contamination levels dropped off significantly around the 14 foot level. Only a small area around the borehole drilled in the crib exhibits levels of contamination greater than background. Approximately 50 cubic yards of space remains in the Terra-Stor.

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It has been agreed by RL/EPA/Ecology to stop excavation in lifts at the current depth of 18 feet. The five verification samples will be taken to ensure that contamination is not present at this depth. The area surrounding the borehole will be excavated down to a depth of approximately 26 feet. The sixth verification sample will be taken from the bottom of the pit dug to excavate the remaining borehole material. Up to three additional pits will be dug in the bottom of the excavation to examine the soil for migrating contamination. However, contamination is not expected beyond the 18 foot level.

Water was used for dust control during the first portion of the test. In addition, crusting agents were used to stabilize the excavation over night, and were tested on the spoil piles, Terra-Stor, and high traffic areas. Dust control testing activities have progressed from water to testing with surfactants. However, because the wind levels have been so moderate, and very little water has been needed to control dust, there is little data to make a comparison between water and surfactants.

Activities will be completed on schedule to meet the November 30, 1993 TPA milestone.

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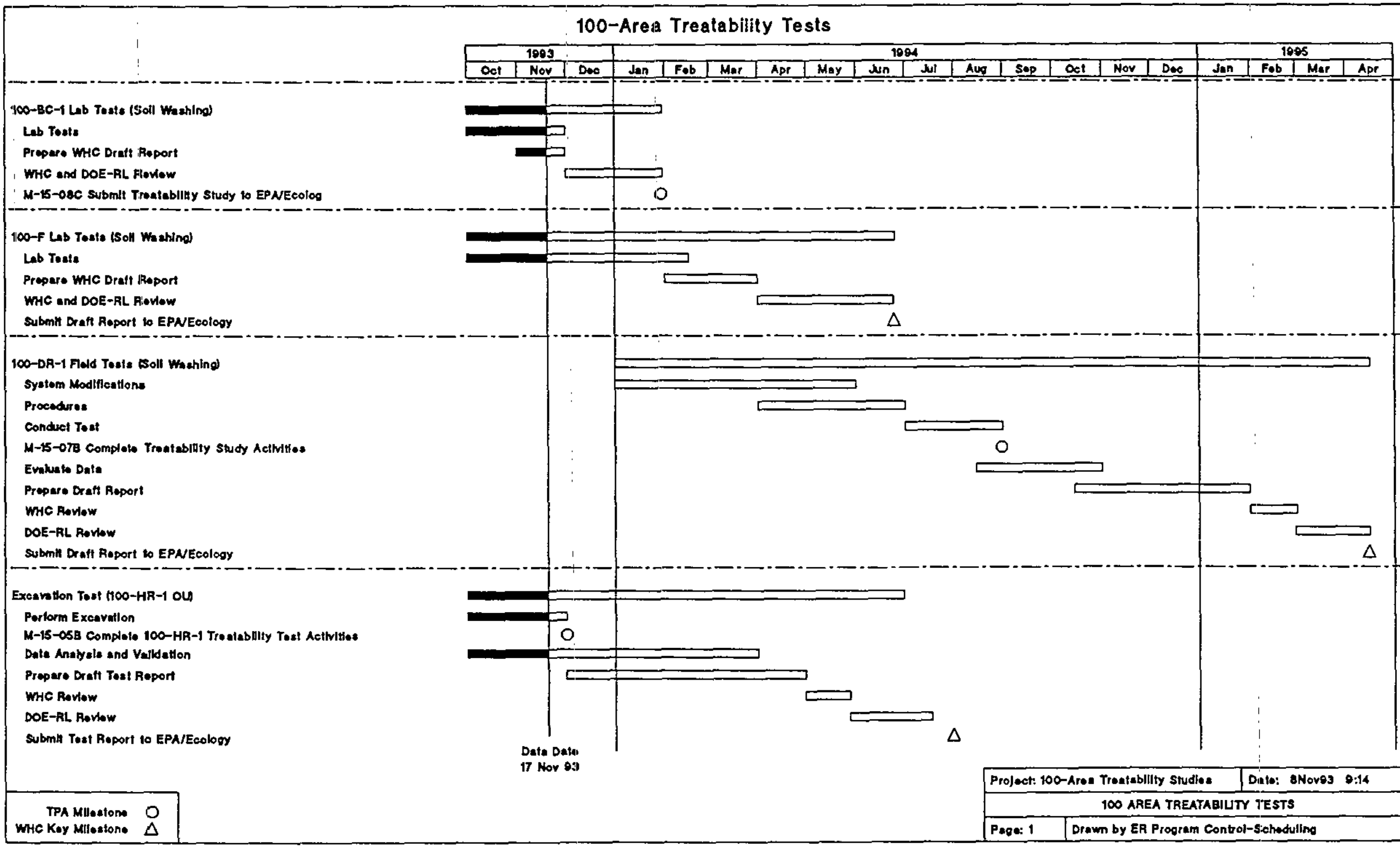

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100-HR-3 Groundwater Treatability

STATUS:

Both laboratory activities (biodenitrification (PNL) and chromate, nitrate and uranium removal by reduction/precipitation and/or ion exchange (WHC)) have completed the laboratory phase.

Comments from DOE-RL are being recieved and incorporated into the Biodenitrification Final Report from PNL.

The WHC comments on the final draft report for chromium reduction/precipitation and/or ion exchange are being incorporated into the report. The samples are approximately 98% complete at PUREX lab.

The milestone M-15-06B has been completed and a letter will be issued to DOE on or before November 24.

100-BC-1 SOURCE OPERABLE UNIT WORK SUMMARY
November 15, 1993

Task 11 - Qualitative Risk Assessment:

The final document was delivered to EPA and Ecology on July 31, 1993. Comments were received from EPA and are currently being dispositioned.

Task 13 - Limited Field Investigation (LFI) Report:

The final document was delivered to EPA and Ecology on July 31, 1993. Comments were received from EPA and are currently being dispositioned.

100-BC-2 SOURCE OPERABLE UNIT WORK SUMMARY

RI/FS Work Plan:

Regulator comments have been incorporated.

Field Activites:

Vadose drilling at the 116-C-2A pluto crib is complete. Sample data are being validated.

100-BC-5 STATUS

- 1ST QUARTER (JULY), 2ND QUARTER (OCTOBER), 3RD QUARTER (JANUARY), 4TH QUARTER (APRIL), 5TH QUARTER GROUNDWATER SAMPLING COMPLETE. SAMPLING WILL BE ON A SEMI-ANNUAL BASIS STARTING IN OCTOBER 1993.
- SAMPLE VALIDATION REPORTS FOR DRILLING SAMPLE DATA AND 1ST QUARTER GW SUBMITTED DECEMBER 31, 1992
- SAMPLE VALIDATION REPORT FOR 2ND QUARTER GW SUBMITTED APRIL 14, 1993
- SAMPLE VALIDATION REPORT FOR 3RD QUARTER GW SUBMITTED JUNE 1, 1993
- SAMPLE VALIDATION REPORT FOR 4TH QUARTER GW SUBMITTED AUGUST 27, 1993
- LFI AND QRA REPORT SUBMITTED AUGUST 30, 1993
  - COMMENTS WERE RECEIVED FROM EPA AND ARE CURRENTLY BEING DISPOSITIONED

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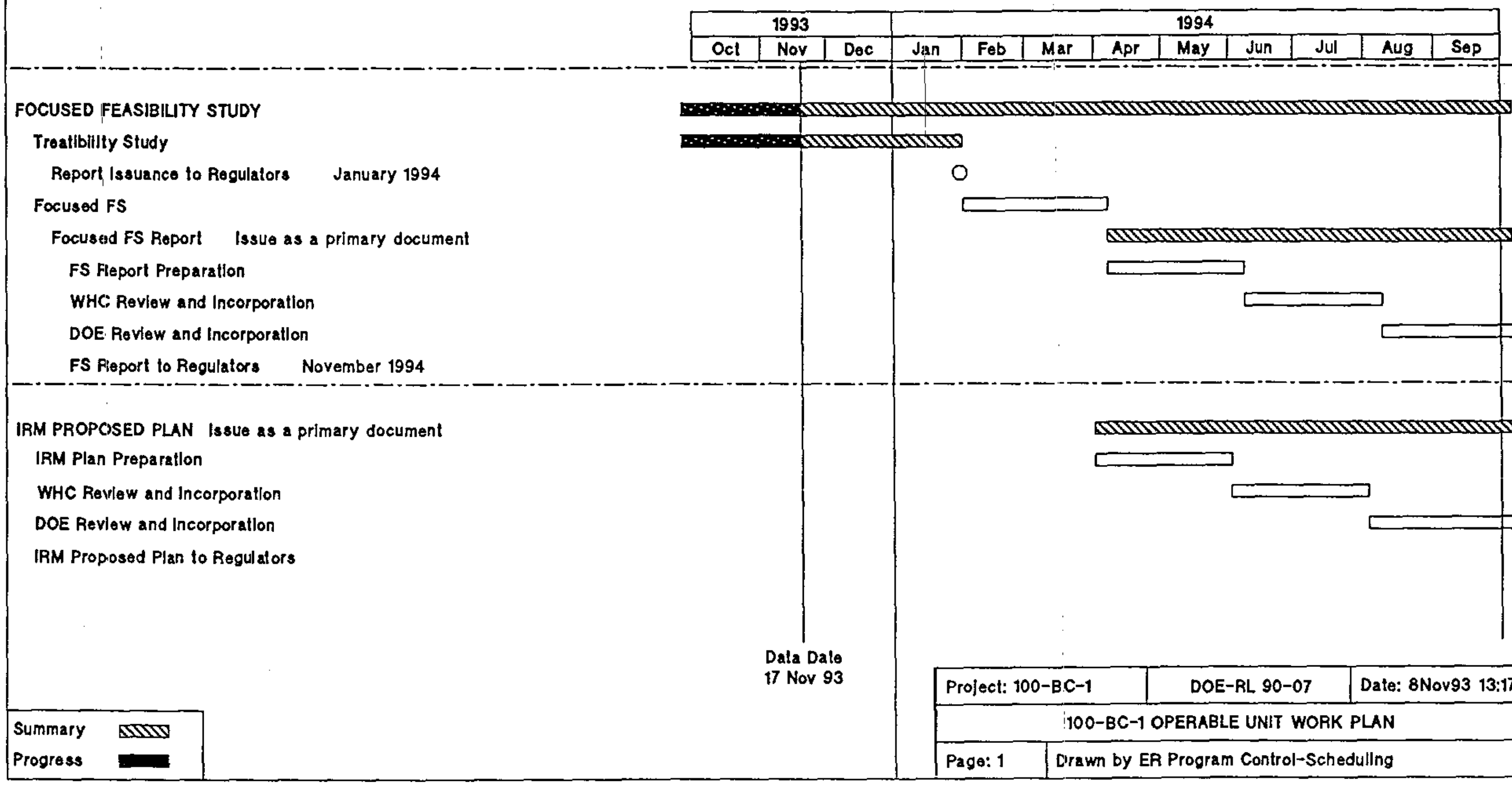
100-BC-1 OPERABLE UNIT



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100-BC-1 OPERABLE UNIT WORK PLAN		
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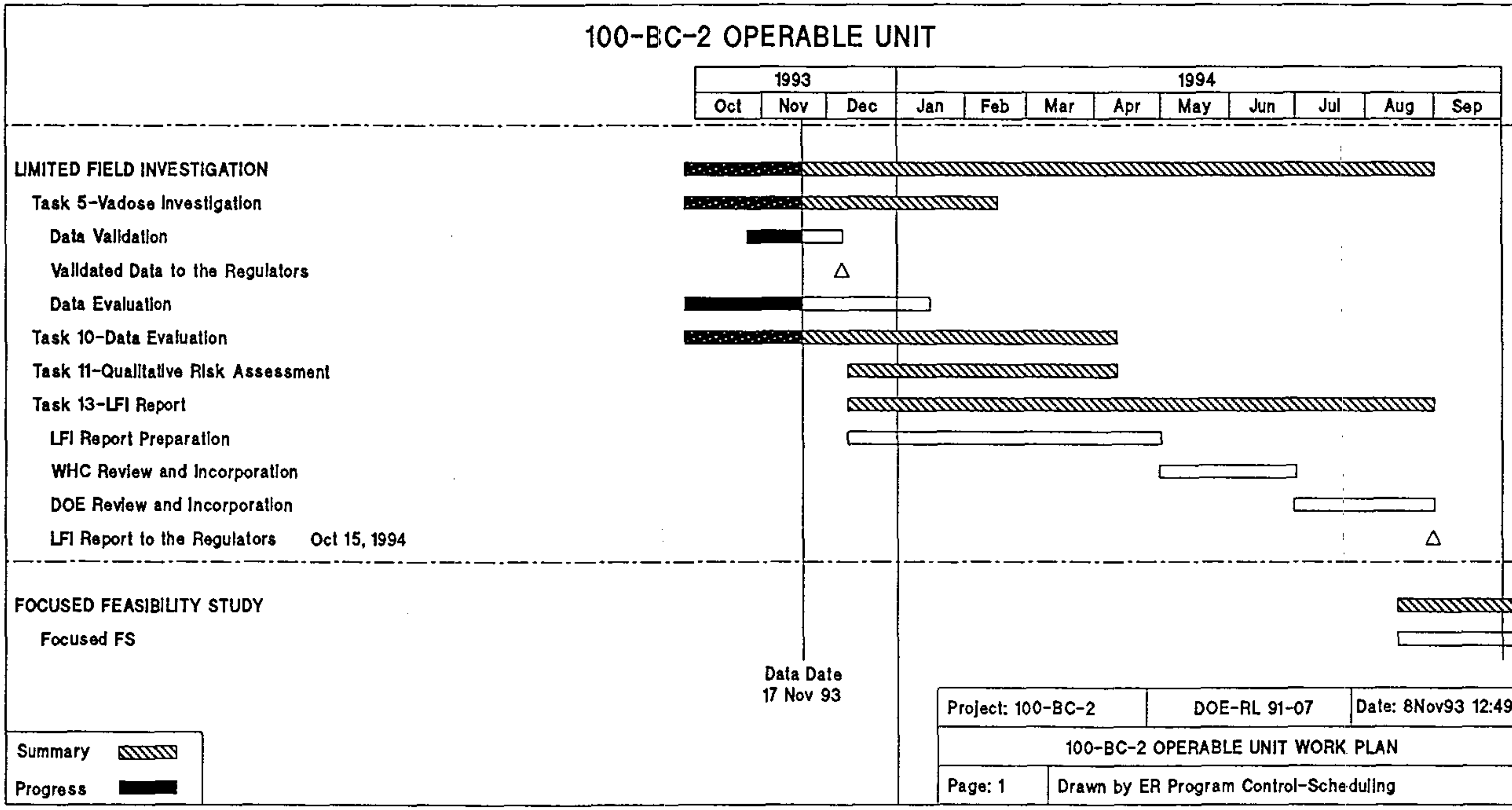

100-BC-2 OPERABLE UNIT
1993
1994
Oct
Nov
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Sep
LIMITED FIELD INVESTIGATION
Task 5-Vadose Investigation
Data Validation
Validated Data to the Regulators
Data Evaluation
Task 10-Data Evaluation
Task 11-Qualitative Risk Assessment
Task 13-LFI Report
LFI Report Preparation
WHC Review and Incorporation
DOE Review and Incorporation
LFI Report to the Regulators
Oct 15, 1994
FOCUSED FEASIBILITY STUDY
Focused FS
Data Date
17 Nov 93
Summary
Progress
Project: 100-BC-2
DOE-RL 91-07
Date: 8Nov93 12:49
100-BC-2 OPERABLE UNIT WORK PLAN
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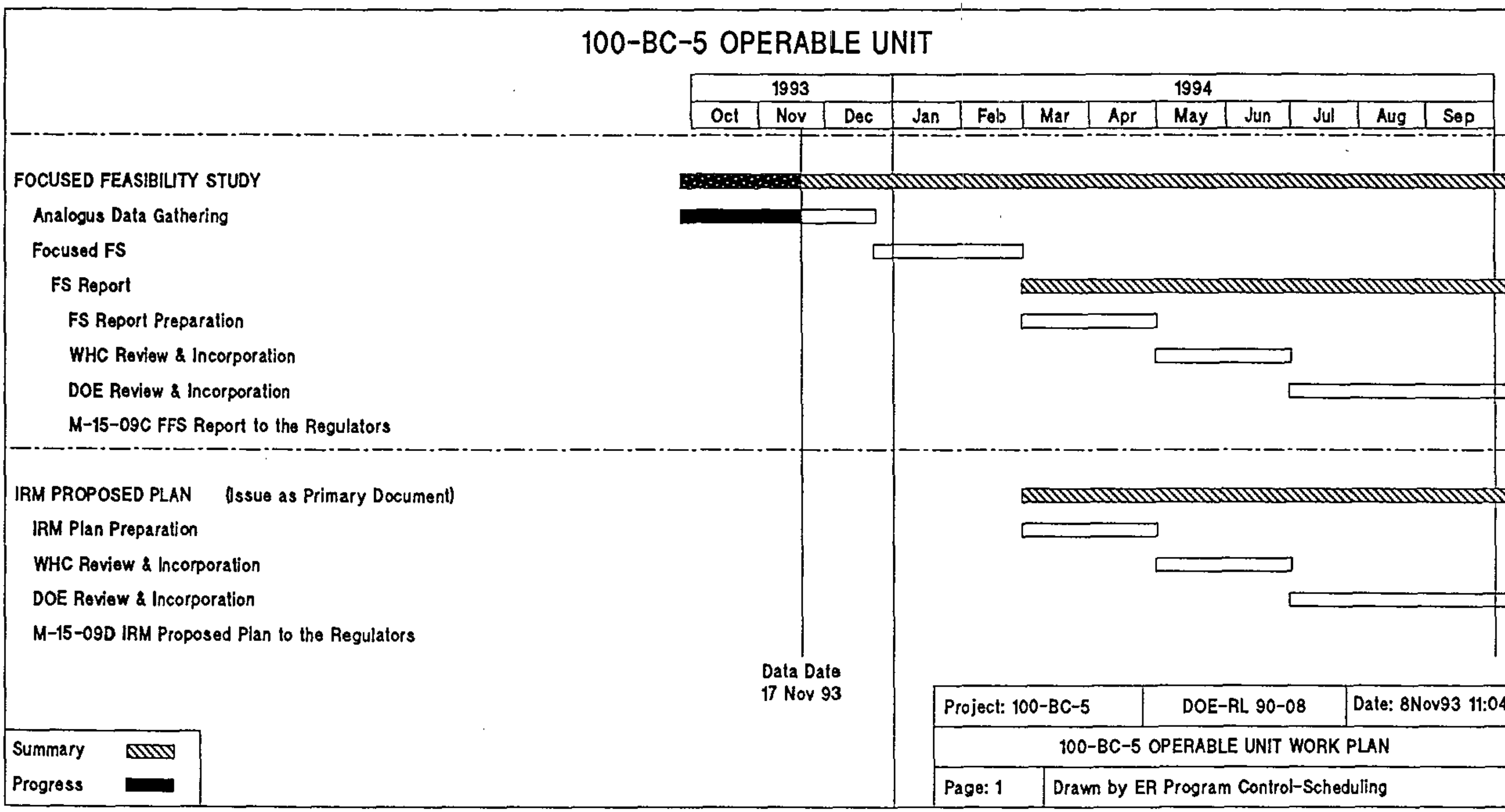
100-BC-5 OPERABLE UNIT
1993
1994
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Sep
FOCUSED FEASIBILITY STUDY
Analogus Data Gathering
Focused FS
FS Report
FS Report Preparation
WHC Review & Incorporation
DOE Review & Incorporation
M-15-09C FFS Report to the Regulators
IRM PROPOSED PLAN (Issue as Primary Document)
IRM Plan Preparation
WHC Review & Incorporation
DOE Review & Incorporation
M-15-09D IRM Proposed Plan to the Regulators
Data Date
17 Nov 93
Summary
Progress
Project: 100-BC-5
DOE-RL 90-08
Date: 8Nov93 11:04
100-BC-5 OPERABLE UNIT WORK PLAN
Page: 1
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FY 1993 ACTIVITIES FOR 100-KR-1

NOVEMBER 1993 STATUS REPORT
N.M. Naiknimbalkar

- 100-KR-1 QRA and LFI Reports

  TASK 11: 100-KR-1 QRA (WHC-SD-EN-RA-009, Rev. 0) is in WHC review process.

  TASK 13: 100-KR-1 LFI (DOE/RL 93-78 WHC Internal) draft is in Westinghouse Hanford Company (WHC) review process.

100-KR-4 STATUS

- **The Limited Field Investigation Report was submitted November 12th to DOE for review and comment.**
- **A reduced analyte list is currently being prepared for DOE and regulatory review, comment and approval.**
- **The Groundwater Validation Report for the 4th Round sampling event was submitted to DOE on November 12, 1993.**

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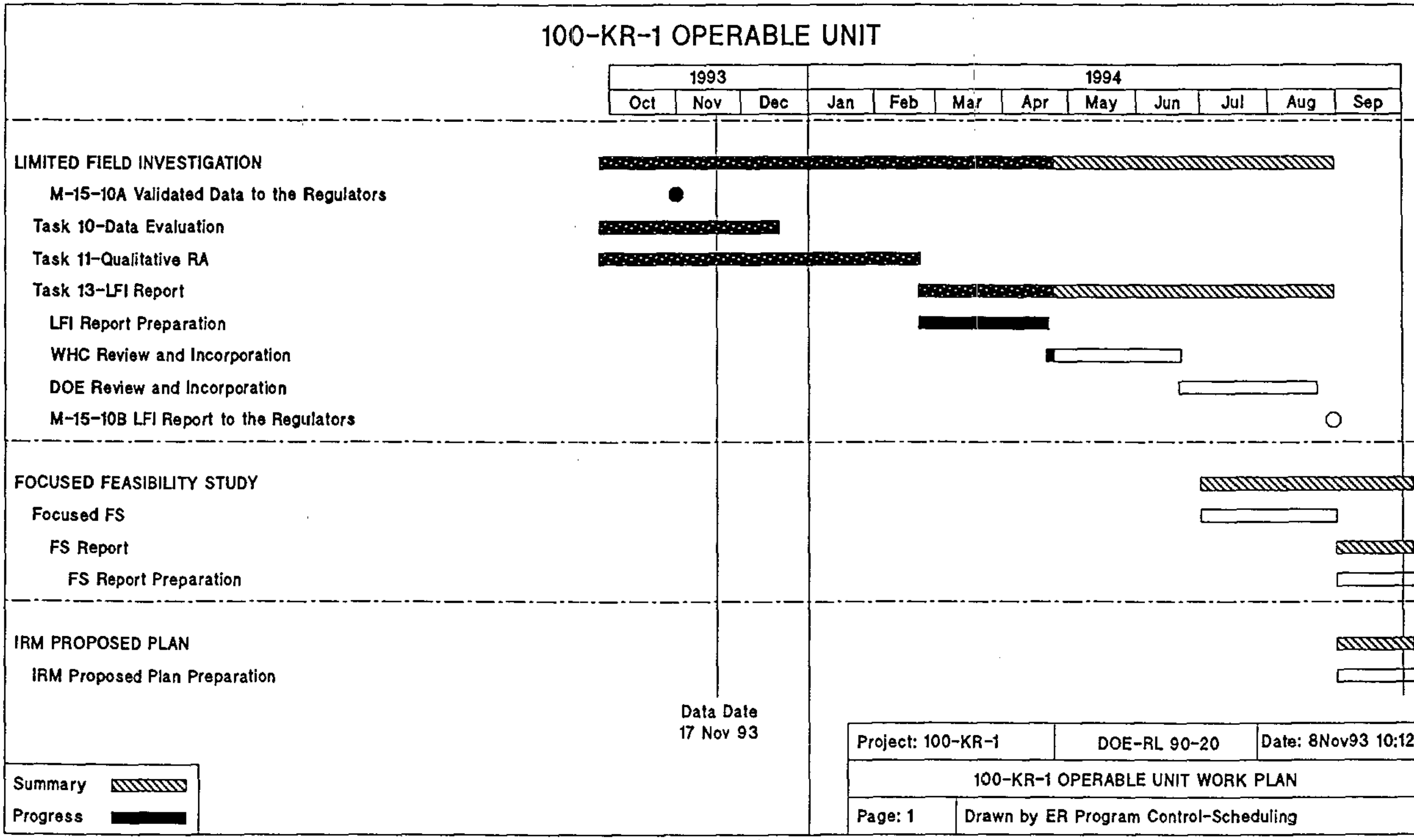

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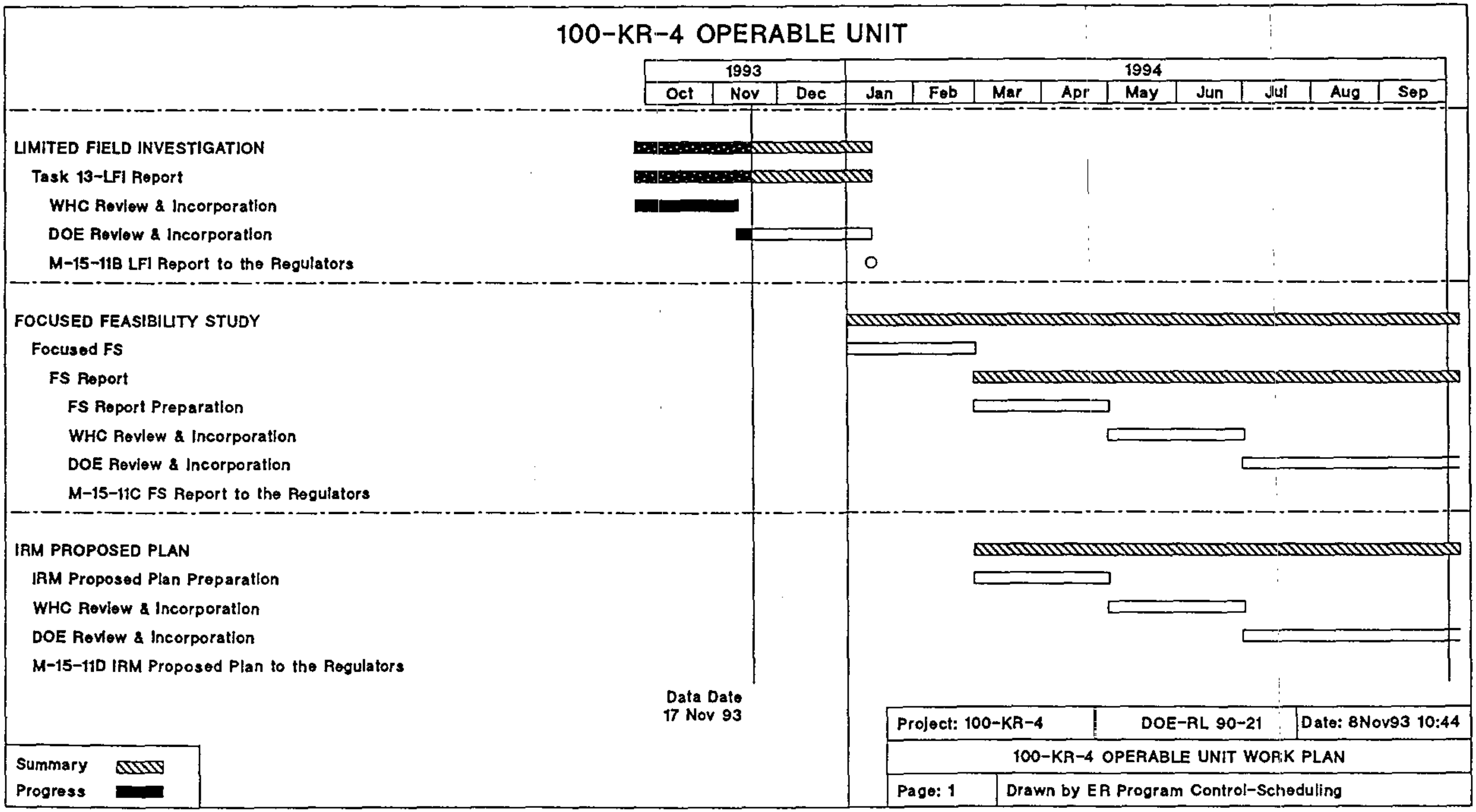

<u>100-NR-1 Operable Unit Work Plan</u>

- No activity.
- DOE/RL is proposing to modify the boundaries of the 100-NR-1 and 100-NR-2 Operable Unit boundaries to include land which was formerly leased by the Washington Public Power Supply System. This land, which housed the Hanford Generating Plant (HGP), was not previously included in the operable units because leased land was excluded from the TPA. A Federal Facility Agreement and Consent Order Change Control Form has been prepared for signature.

<u>100-NR-1 Qualitative Risk Assessment</u>

Work on preparation of the QRA Report is continuing.

<u>100-NR-1 Limited Field Investigation Report</u>

Work on preparation of the LFI Report is continuing.

100 NR-2 GROUNDWATER OPERABLE UNIT WORK SUMMARY 11/17/93

<u>WORK PLAN</u>

The 100 NR-2 Work Plan is on hold until 100-NR1 comments are resolved.

<u>TASK 6 - GROUNDWATER INVESTIGATION</u>

Quarterly Monitoring - Four rounds of groundwater samples have been taken.

Data Validation - The soil data has been validated.

LFI Report - WHC has initiated work on the LFI even though a schedule has not been approved.

QRA Report - WHC has initiated work on the QRA even though a schedule has not been approved.

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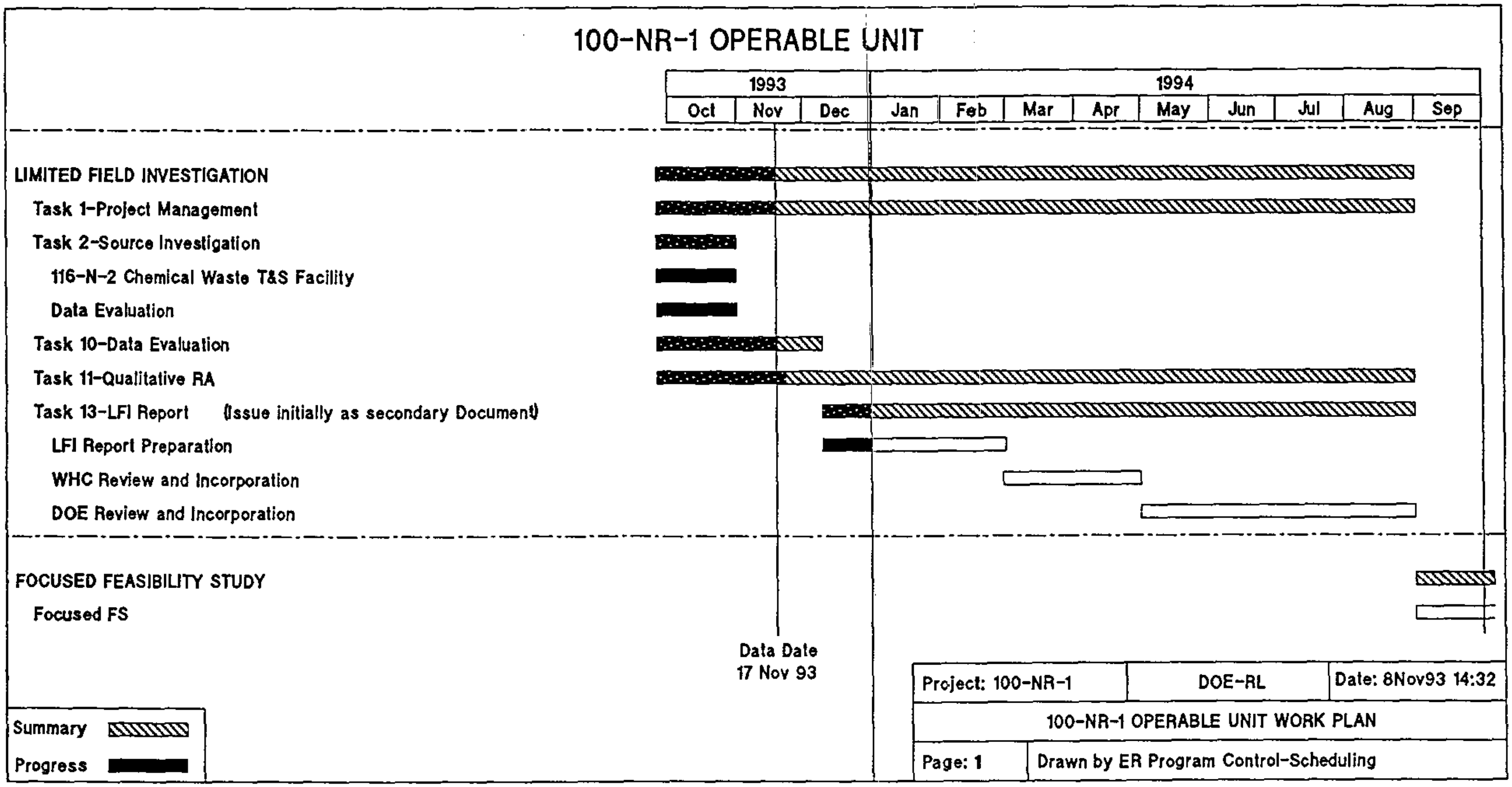

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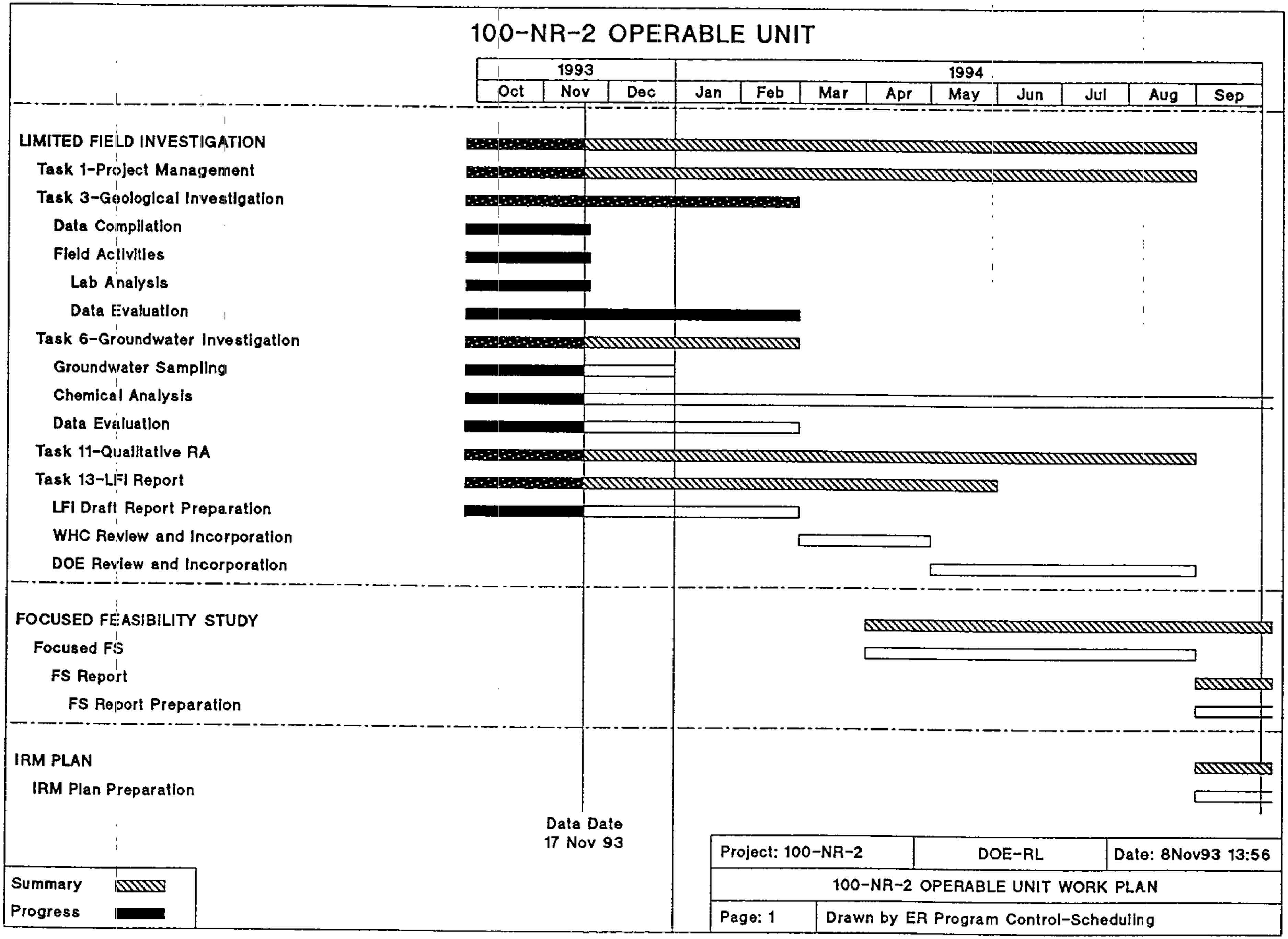

FY 1993 Activities for 100-DR-1/DR-2
N.M. Naiknimbalkar

NOVEMBER 1993 Status Report

100-DR-1 QUALITATIVE RISK ASSESSMENT/LFI STATUS

Qualitative Risk Assessment
Document Preparation:

- Qualitative Risk Assessment report Regulatory comments have been received and at present the resolutions are being prepared.

LFI Report

- Limited Field Investigation (LFI) report Regulatory comments have been received and at present the resolutions are being prepared.

100-DR-2 Work Plan Status

100-DR-2 Work Plan

- 100 DR-2 Work Plan was reviewed by DOE/DOE-HQ. The comment resolutions meeting was conducted to resolve comments. The document has been revised and is in Regulatory review.

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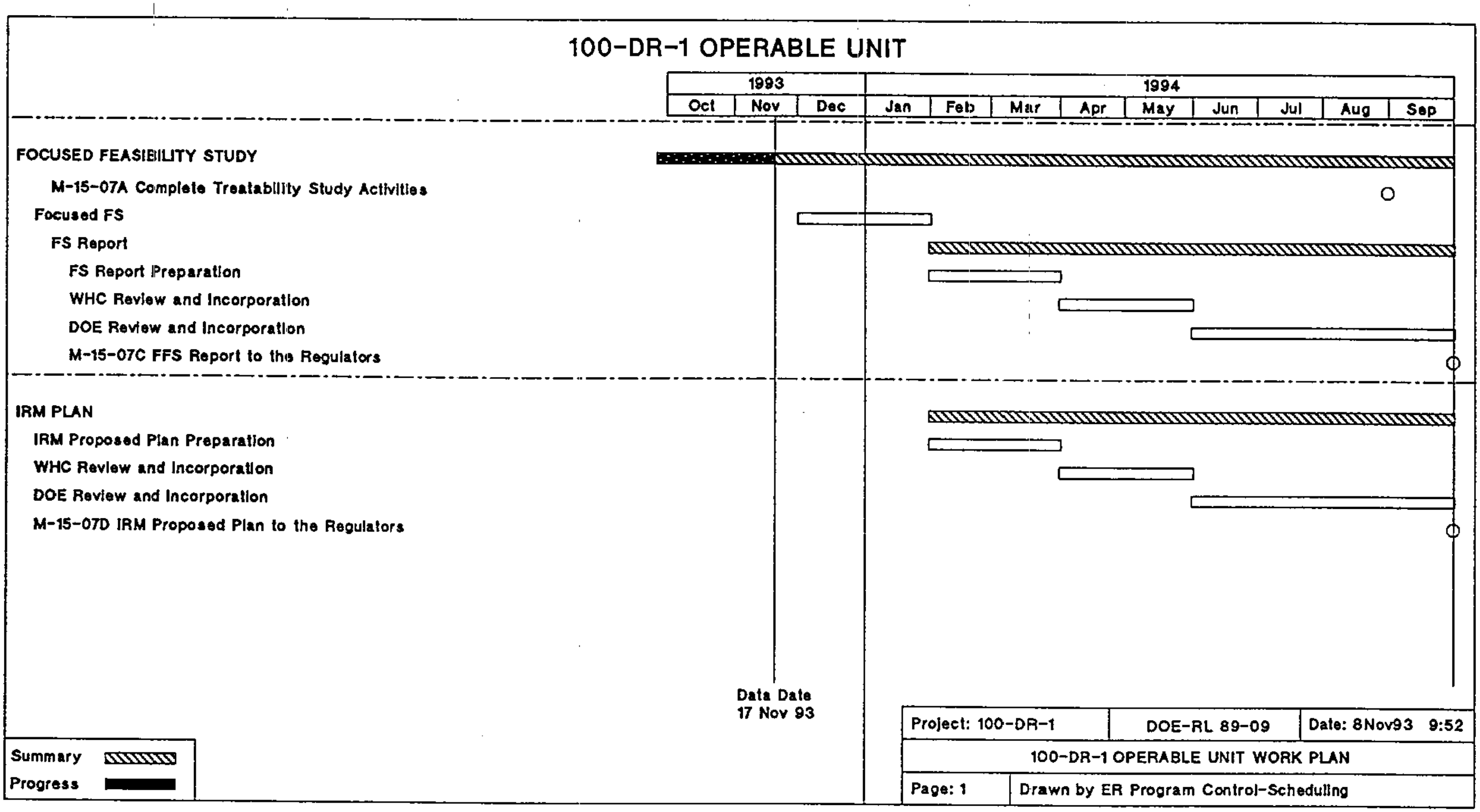

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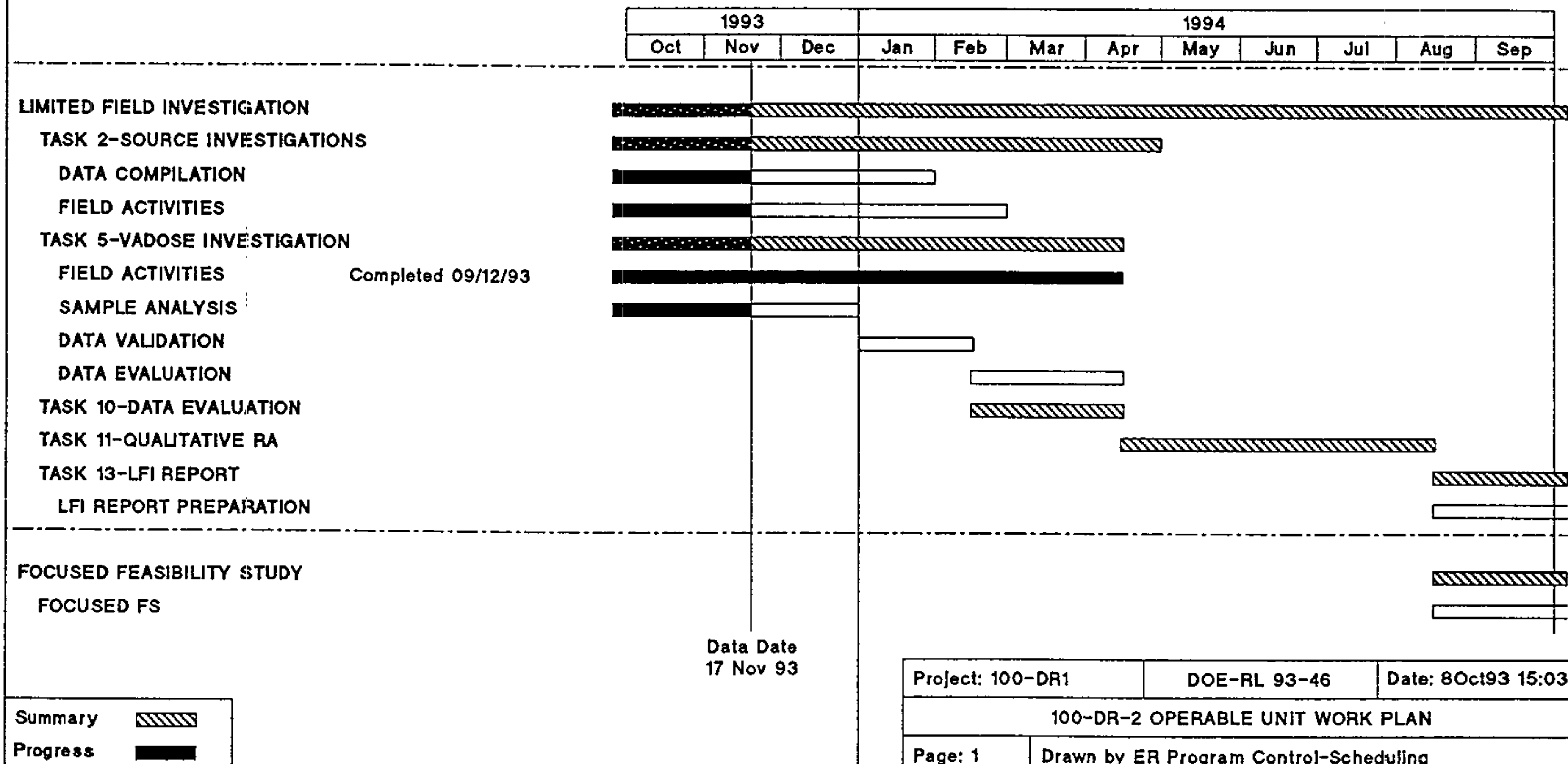
100-DR-2 OPERABLE UNIT



Project: 100-DR1	DOE-RL 93-46	Date: 8Oct93 15:03
100-DR-2 OPERABLE UNIT WORK PLAN		
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100-HR-1

- Comments from Ecology and EPA on the LFI and QRA have been received and are being resolved. Resolutions to be completed by 11/15/93.

100-HR-2 SOURCE OPERABLE UNIT

PLANNING DOCUMENT

Regulator comments have been incorporated and the public review draft will be transmitted to DOE-RL November 8, 1993.

SURFACE GEOPHYSICS

Data interpretations are on going for burial grounds 118-H-1, 118-H-2, 118-H-3 and the Buried Thimble Site.

SOIL GAS SURVEY

Prep-work for a soil gas survey at the 128-H-1 Burn Pit has begun. GPR and/or EMI surveys will be conducted on November 5 to help in locating the best positions for the soil gas probes. Soil gas samples will be collected during November, weather permitting.

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TASK 10 - DATA EVALUATION

The Historical Data Baseline Report for 100 H-Area is 90% complete and is expected to be issued in November. The compilation of other data needed in support of the QRA preparation has also been initiated.

TASK 11 - QUALITATIVE RISK ASSESSMENT (QRA)

The QRA for the 100-HR-2 Operable Unit has been initiated and will be prepared by WHC.

100 HR-3 GROUNDWATER OPERABLE UNIT WORK SUMMARY 11/17/93

TASK 6 - GROUNDWATER INVESTIGATION

Quarterly Monitoring - Five rounds of groundwater samples have been taken.

Data Validation - First, second, third and fourth round groundwater data has been validated. The fifth round is being validated.

LFI Report - WHC submitted the LFI to DOE for regulator review.

QRA Report - WHC submitted the QRA to DOE for regulator review.

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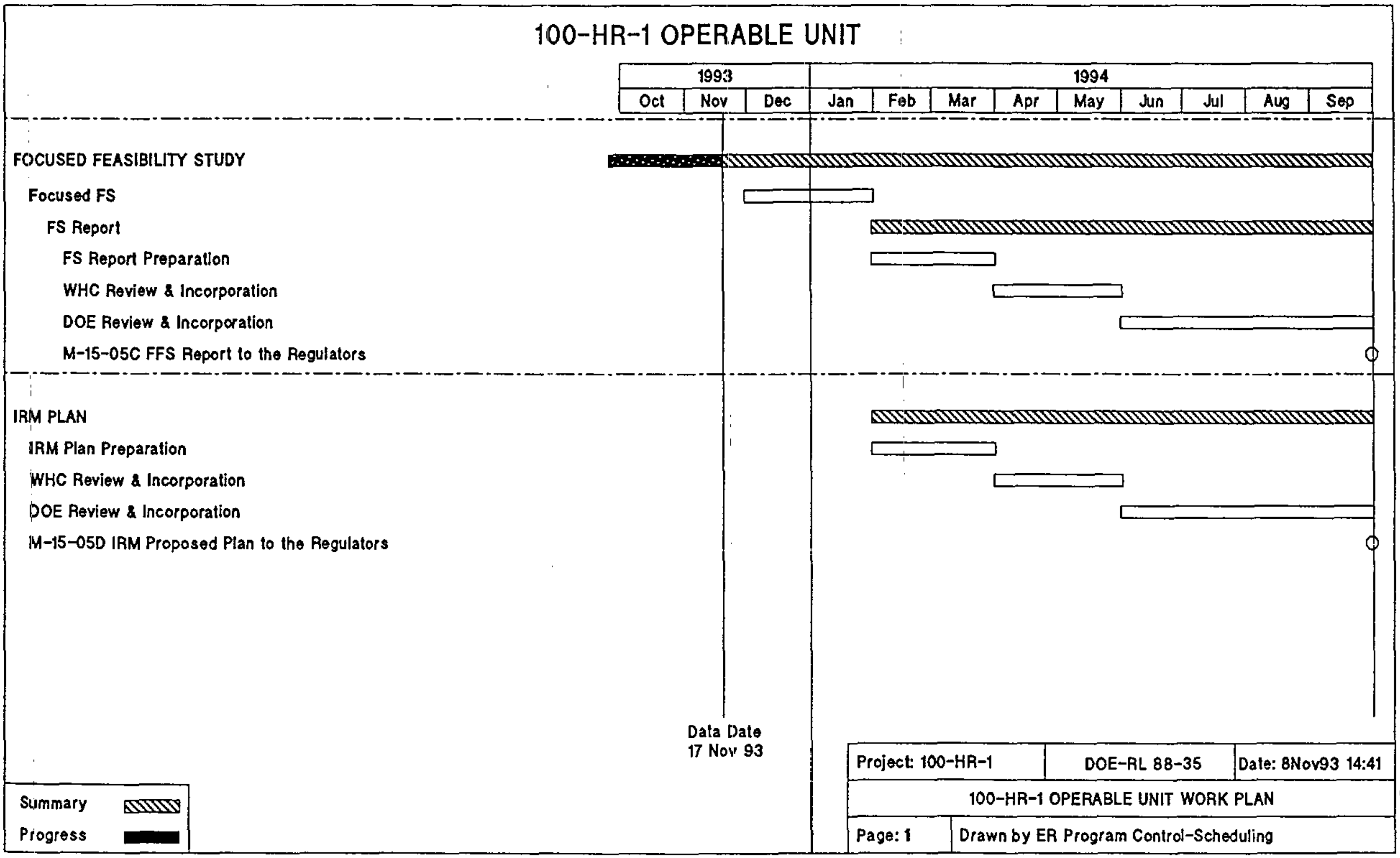

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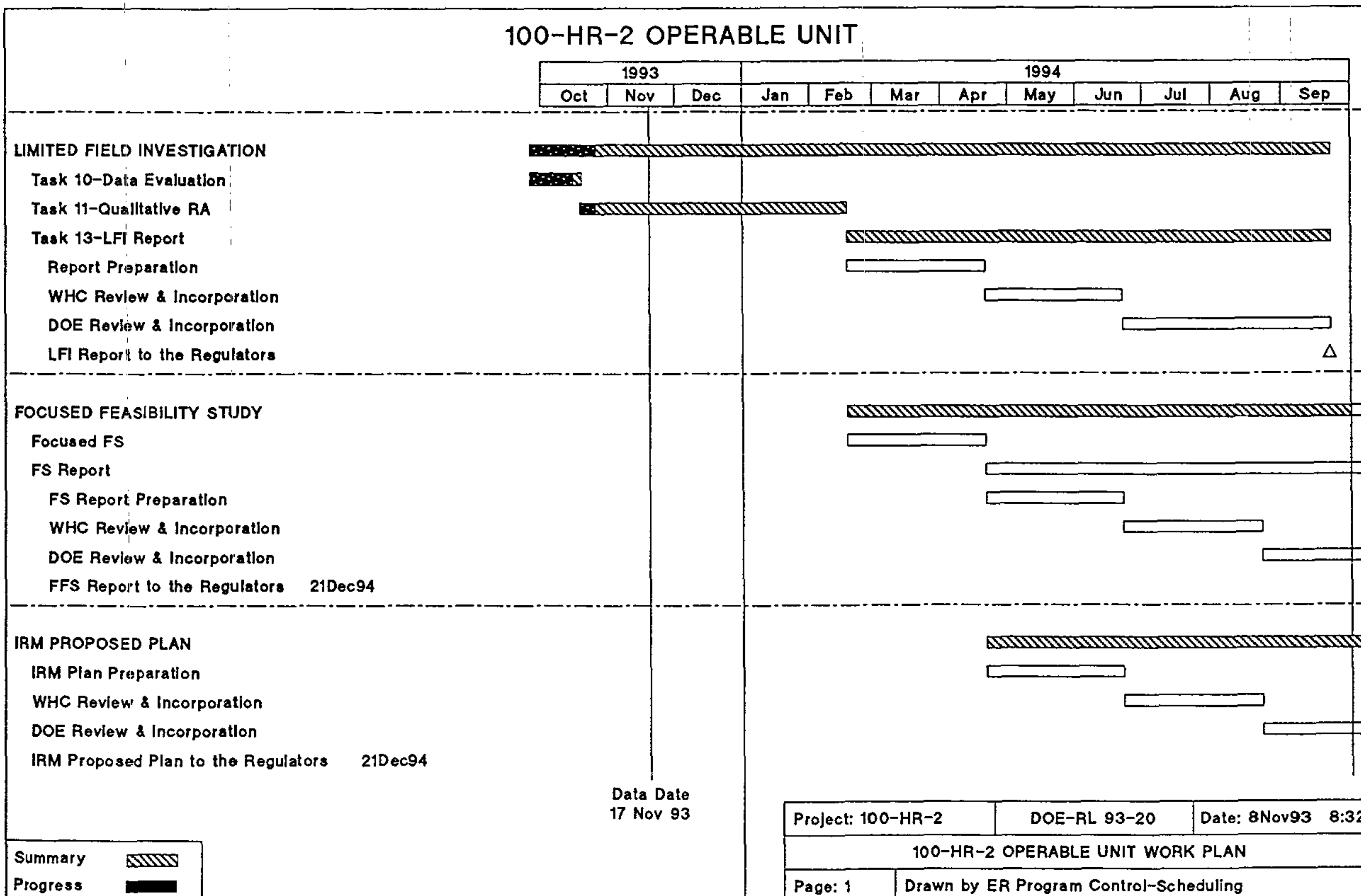
100-HR-2 OPERABLE UNIT



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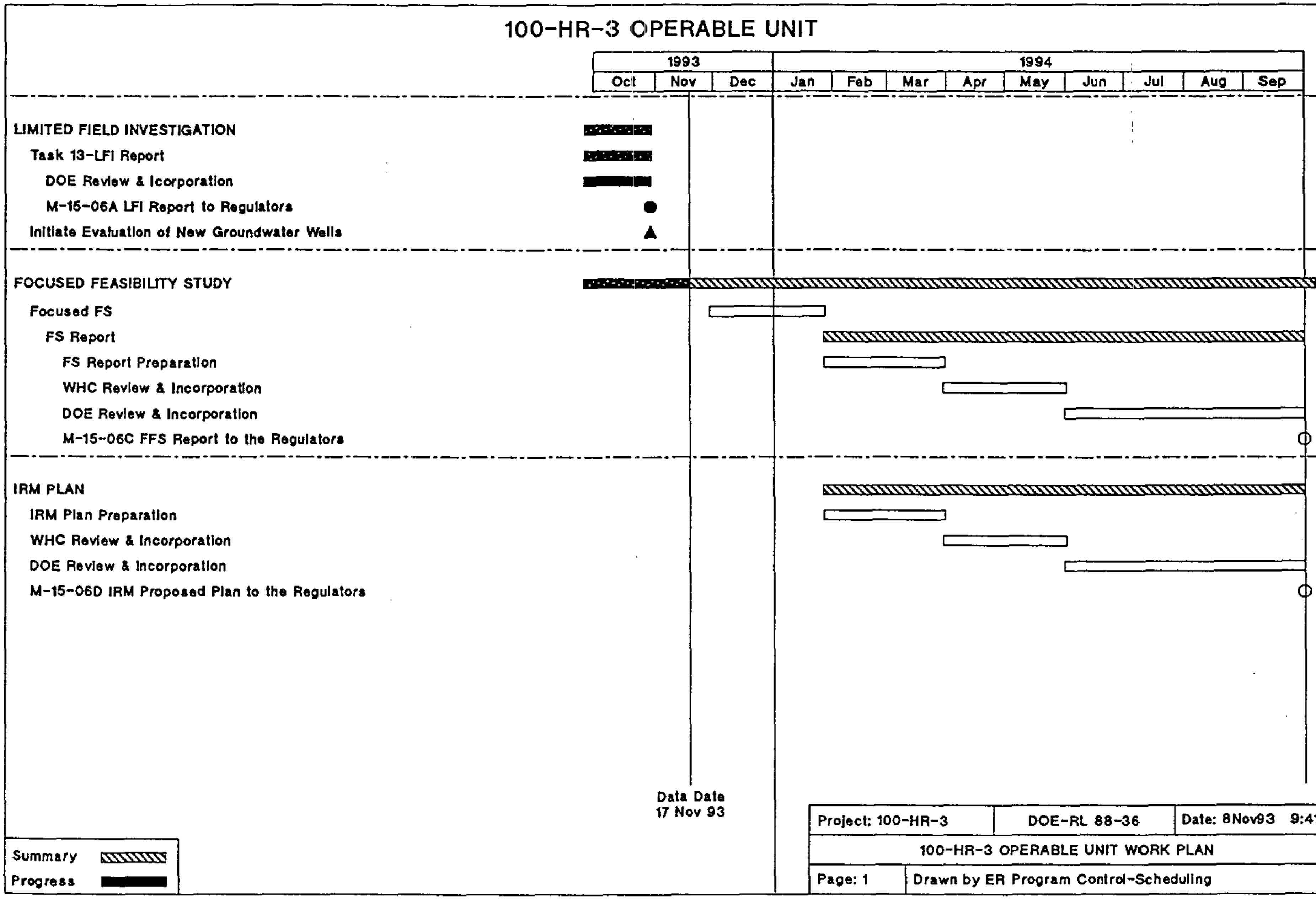

OU MANAGERS MEETING - NOVEMBER 93

100-FR-1

- The LFI and QRA reports are in process. The reports are scheduled to be ready for regulator review on 6/15/94.

100 FR-3 GROUNDWATER OPERABLE UNIT WORK SUMMARY 11/17/93

TASK 6 - GROUNDWATER INVESTIGATION

Quarterly Monitoring - Four rounds of groundwater samples have been taken.

Data Validation - Two rounds of groundwater data have been validated. The third round is being validated.

LFI Report - The LFI is on schedule to be submitted to the regulators on April 14, 1994.

QRA Report - The QRA is on schedule to be submitted to the regulators on April 14, 1994.

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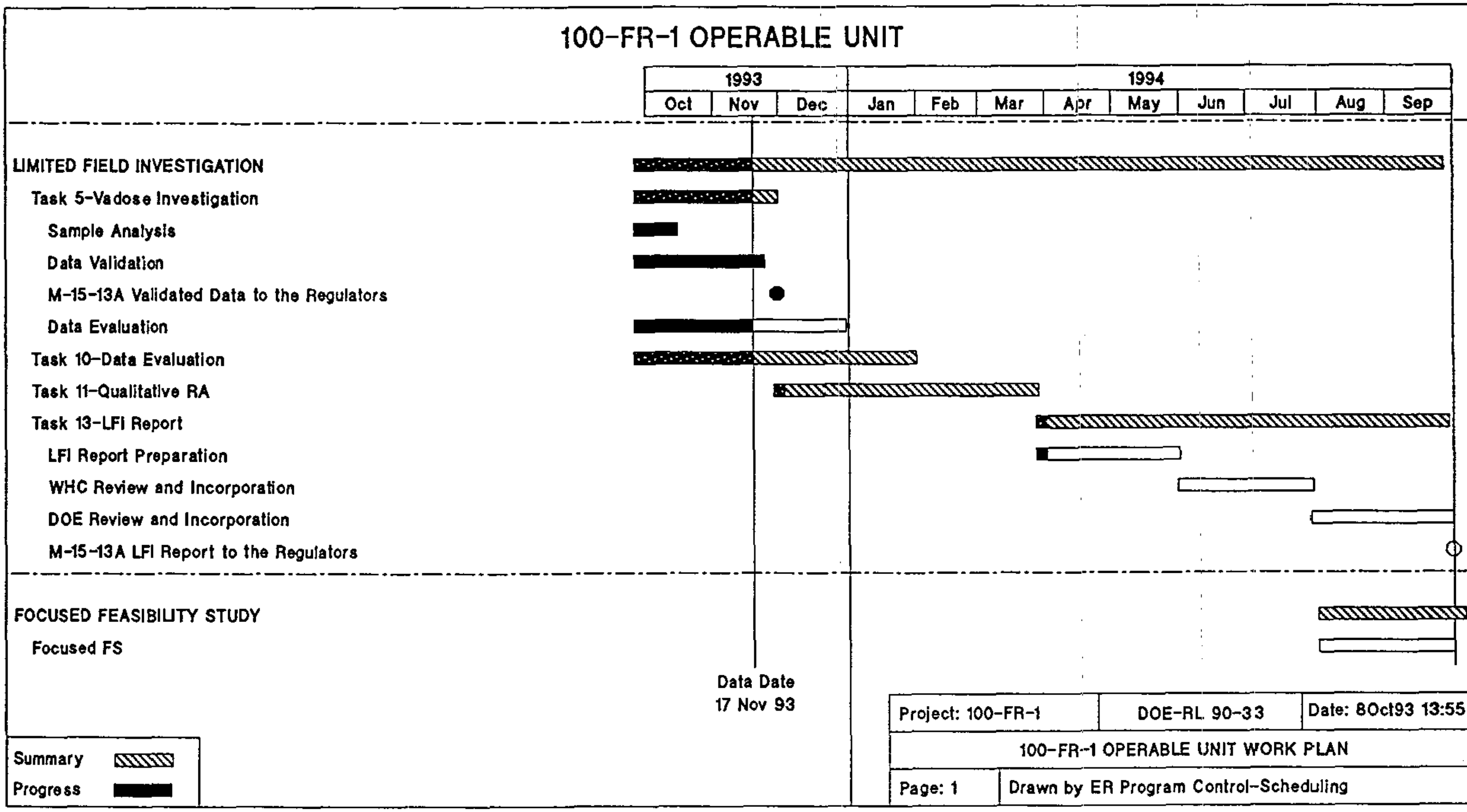

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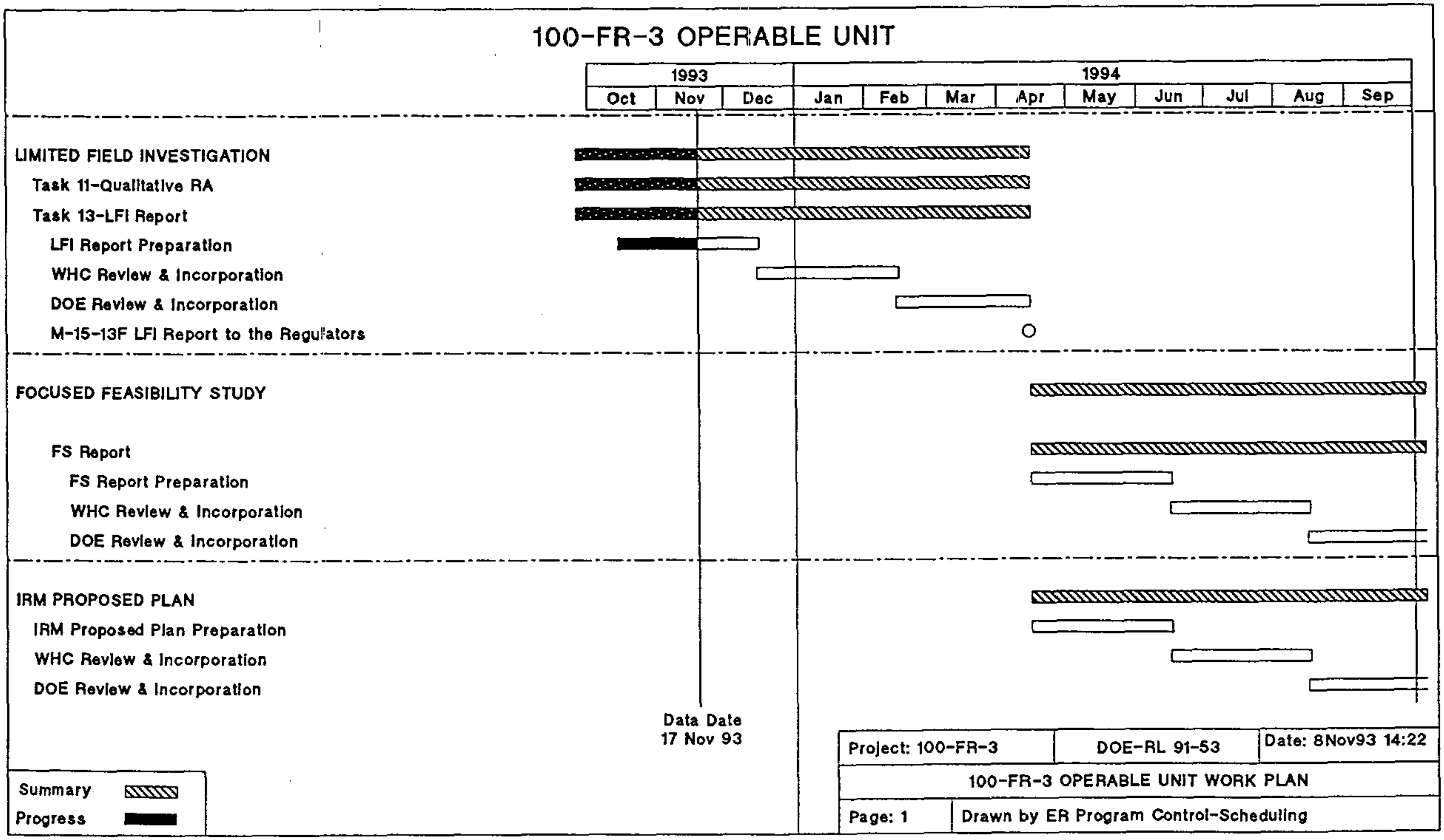


DRAFT

100 Area Hanford Soil Washing Treatability Tests

J. G. Field, R. D. Belden
Westinghouse Hanford Company

R. J. Serne, S. V. Mattigod, H.D. Freeman
Battelle Pacific Northwest Laboratories

R. W. Scheck
Mactec/Dames & Moore

E. D. Goller
U. S. Department of Energy, Richland Operations Office

Attachment #6Page 1 of 14

REMEDY SCREENING TEST OBJECTIVES

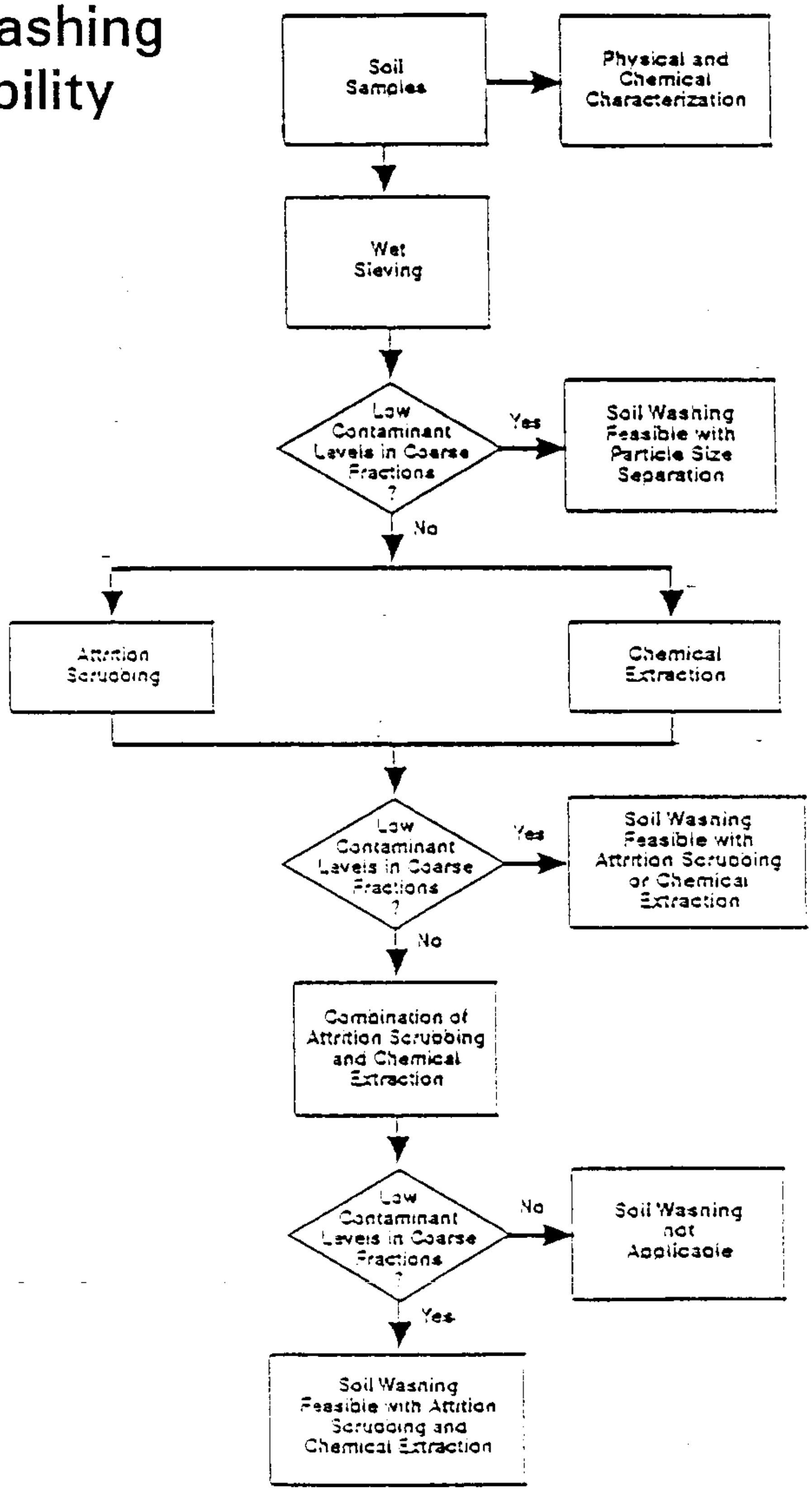
- Characterize 100-D and 100-C soils by size fraction.
- Determine the effectiveness of wet sieving, attrition, chemical extraction, and heap leaching
- Assess Water treatment needs
- Obtain data to conduct benefit/cost analyses and develop flow sheets for remedy selection (field) tests.

PERFORMANCE LEVELS FOR CONTAMINANTS OF CONCERN		
Contaminant	Performance Level A	Performance Level B
RADIONUCLIDES	Test Plan[1] (pCi/g)	WHC-CM-7-5[2] (pCi/g)
^{60}Co	1	7.1
^{90}Sr	13	2,800
^{134}Cs	2	10
^{137}Cs	3	30
^{152}Eu	3	15
^{154}Eu	3	15
^{155}Eu	100	630
^{235}U	15	170
^{238}U	50	370
$^{239/240}Pu$	75	190
CHEMICALS	Test Plan (ppm)	Test Plan (ppm)
Chromium (total)	1,600	1,600

1. WHC Environmental Compliance Manual, Table K-1, prior to June, 1993)

2. WHC Environmental Compliance Manual, Effective June, 1993).

Scheme for Soil Washing Treatability Tests



Particle-Size Distribution of Soils 116-C-1, and 116-D-1B

Particle Size (mm)	116-C-1 (Batch I)	116-C-1 (Batch II)	116-D-1B (Batch III)
	Wt %		
>2 (Cobbles, Gravel)	90.0	97.2	46.9
2 - 0.25 (Sand)	3.6	1.3	42.3
0.25 - 0.074 (Fines)	3.4	0.5	3.7
<0.074 (Fines)	3.0	1.0	7.1

Particle size data for <2mm fractions were obtained through wet sieving.

TOC, pH, and TCLP Measurements for 100 Area Soil Samples

Measurement	116-C-1, I	116-C-1, II	116-D-1B
TOC (mg/kg)	1130.0	1640.0	600.0
pH	6.5	7.4	7.7
TCLP	mg/l		
Ag	*	0.03	<0.01
As	*	0.20	0.20
Ba	*	0.35	0.29
Cd	*	0.01	0.02
Cr	*	<0.02	<0.02
Pb	*	<0.06	<0.06
Se	*	<0.20	<0.20

* Not determined

Radionuclide Data for 100 Area Soil Samples (pCi/g)

Sample	^{40}K	^{60}Co	^{134}Cs	^{137}Cs	^{152}Eu	^{154}Eu	^{155}Eu
116-C-1 (Batch I)	16	7	<0.8	0.74	28	4.4	0.54
116-C-1 (Batch II)	<7	525	<10	5495	2320	337	70
116-D-1B	7	15	<2	205	177	17	1.4

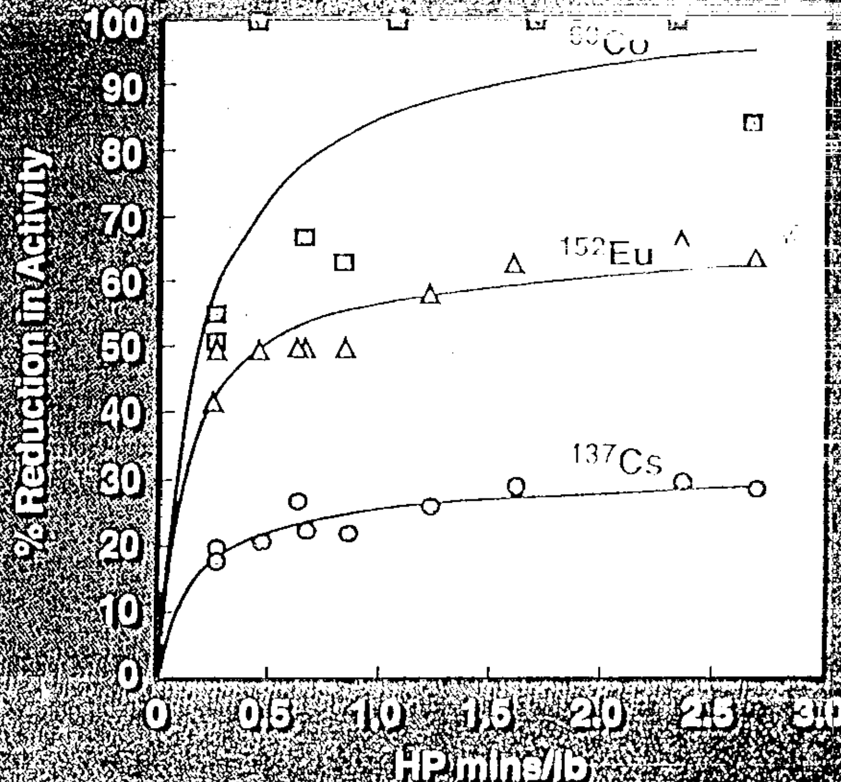
Reported values are averages of duplicate values.
All measurements conducted on <2 mm material.

Radionuclide Data for Size-Fractioned Soils (pCi/g)

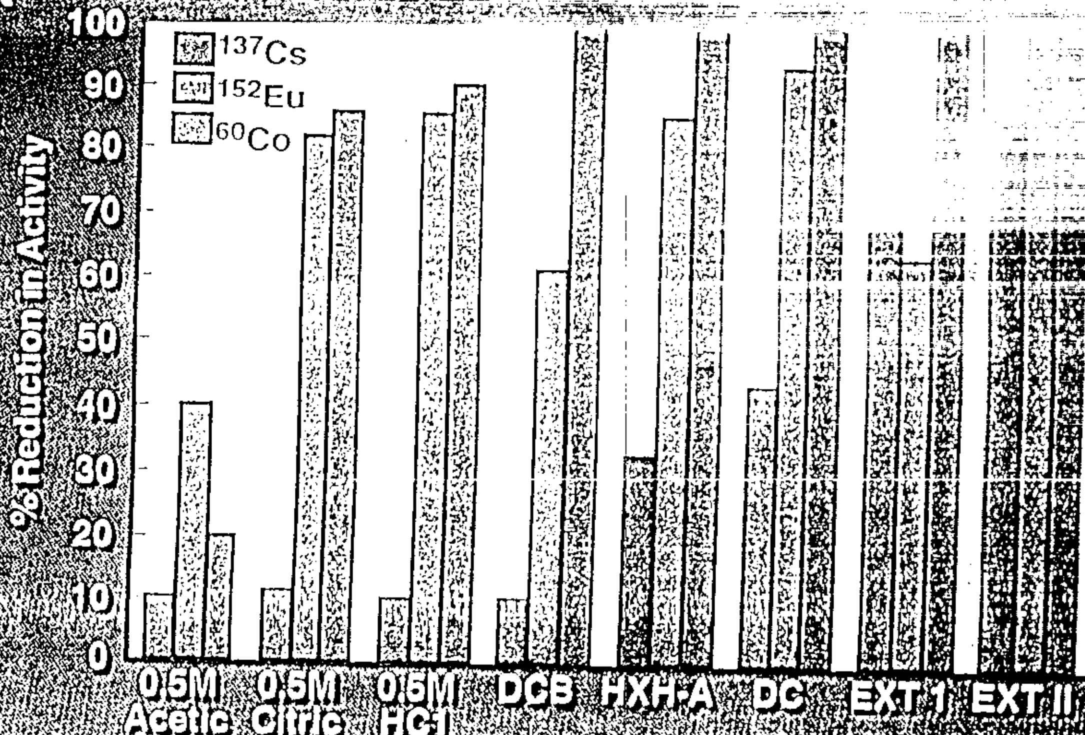
Size Fraction	^{60}Co	^{137}Cs	^{152}Eu	Weig[illegible]
116-C-1 Sample				
>2 mm	<3	675	21	97.2
<2 mm	1621	28300	4856	2.8
116-D-1B Sample*				
13.5 - 9.51 mm	<3	13	<5	7.9
9.5 - 2 mm	<3	41	<5	5.3
2 - 0.25 mm	<3	56	17	40.7
0.25 - 0.074 mm	5	213	47	4.8
0.074 - 0.028 mm	30	380	277	7.4
<0.028 mm	252	1110	2350	0.2

* 33.7% of particles > 13.5 mm

Attrition Scrubbing
116-D-1B Sample



Chemical Extraction: 116-D-1B S
(2–0.25 mm fracti



DCB: Na-dithionite/citrate/bicarbonate, HXH-A: NH_2OH HCℓ + acetic
DC: sodium dithionite + citric acid

S9309111.11C

Attrition Scrubbing Combination Tests

Treatment	^{137}Cs (pCi/g)	^{152}Eu (pCi/g)	^{60}Co (pCi/g)	Cs % Reduction	Eu % Reduction	Co % Reduction
(116-D-1B)						
Two-stage in DI water	94	52	4.8	33	71	>90
One-stage in electrolyte	94	52	4.8	39	83	>90
Two-stage in electrolyte	94	52	4.8	49	97	>90

The electrolyte solution consisted of 0.5 M ammonium citrate with pH adjusted to 3 with citric acid.

Autogenous Grinding of 116-C-1 (Batch II) Samples

Treatment	^{137}Cs (pCi/g)	% Red Cs Act.	^{152}Eu (pCi/g)	% Red Eu Act.	^{60}Co (pCi/g)	% Red Co Act.
16% DI water	822	14	69	97	16	85
17% electrolyte	883	25	88	94	26	88
Dry (25% sand[a])	868	17	90	89	23	74
17% DI water + 16.6% sand[b]	693	21	29	90	28	93
With EXTII	751	55	19.3	53	97	93

Sand fraction (2-0.25 mm) from 116-D-1B soil was used as a grinding medium

[a]Approximately, 2% fines (<0.25 mm) were generated from the rocks, and 11% from sand.
[b]Approximately, 4% fines (<0.25 mm) were generated from the rocks, and 15% from sand.

Preliminary Data: Radionuclide Activity in Waste Water from treating 116-D-1B (2- 0.25 mm) Soil

Treatment	Activity in Waste Water (pCi/g of solution)		
Att. scrubbing with DI water I stage	<1	<1	<1
Att. scrubbing with DI water II stage	2	<1	<1
Att. scrubbing with electrolyte I stage	6	10	1
Att. scrubbing with electrolyte II stage	2	6	6
Chem. extraction with Extractant I	10	<1	5
Chem. extraction with Extractant I	8	<1	5
Chem. extraction with Extractant II	9	5	4
Chem. extraction with Extractant II	4	<1	6

All waste solutions were filtered through Whatman (2.5 micron) filters before counting.

SUMMARY OF SOIL WASHING TEST RESULTS

116-D-1B (Batch III)		
Radionuclide	Previous Performance Levels	Revised Performance Levels
^{137}Cs	O	■ (W/2A, W/C)
^{152}Eu	■ (W/2A, W/C)	■ (W/2A, W/C)
^{60}Co	■ (W/2A, W/C)	■ (W/2A, W/C)
116-C-1 (Batch II, sampled near the trench inlet)		
^{137}Cs	O	O
^{152}Eu	■ (W/CS, W/GE)	■ (W/CS, W/GE)
^{60}Co	O	■ (W/CS, W/GE)
116-C-1 (Batch I, sampled near the middle of the trench)		
^{137}Cs	■ (W)	■ (W)
^{152}Eu	O*	■ (W)
^{60}Co	O*	■ (W)

Note: Autogeneous grinding and chemical extraction <u>were not conducted</u> on 116-C-1 (Batch I) material.

■: Performance level achieved.
O: Performance level unattained.
*: Based on only wet-sieving.
W/2A: Two-stage attr. with electrolyte.
W/C: Chemical extraction with Ext. II.
W/CS: Static chemical extraction with Ext.II.
W/GE: Autogenous surface grinding with Ext. II.
W: Wet-sieving.

- **Cost/Benefit Evaluations are in Progress**

SOIL WASHING CONTINUES TO BE A VIABLE VOLUME REDUCTION TREATMENT TECHNOLOGY

- Reduces localized regions of high activity; risk reduction
- Real potential to reduce volume of material sent to ERDF
- Degree of volume reduction is controllable; flexible
- Potential for removal of majority of Curie content from 100 Area
- Residual contamination is covered with soil backfill of known thickness; certainty of barrier, shield, risk
- A 100 Area remediation system design could address decay of remaining Cs-137 during institutional control of reasonable duration
- Remaining contamination is tightly bound; (reduction in risk to groundwater)
- Reason to believe metals and other hazardous materials can be handled similarily to radionuclides.

100 Area Soil Washing Bench Scale Test Data

DRAFT

Sample Set I. Near middle of 116-C-1 trench

Sample Set II. Near inlet of 116-C-1 trench

Sample Set III. Near inlet of 116-D-1B trench

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ATTACHMENT: ER '93 REPORT "100 Area Hanford Soil Washing Treatability Tests"

TEST PERFORMANCE LEVELS FOR CONTAMINANTS OF CONCERN		
Contaminant	Performance Level A	Performance Level B
RADIONUCLIDES	Test Plan[1] (pCi/g)	WHC-CM-7-5[2] (pCi/g)
^{60}Co	1	7.1
^{90}Sr	13	2,800
^{134}Cs	2	10
^{137}Cs	3	30
^{152}Eu	3	15
^{154}Eu	3	15
^{155}Eu	100	630
^{235}U	15	170
^{238}U	50	370
$^{239/240}$Pu	75	190
CHEMICALS	Test Plan (ppm)	Test Plan (ppm)
Chromium (total)	1,600	1,600

1. Accepted upper limit of radioactive material concentrations for soils (WHC Environmental Compliance Manual, Table K-1, prior to June, 1993)

2. Accessible Soil Concentration limits for 100-BDKN Areas. Values reflect a 10 mrem/yr operational EDE limit (WHC Environmental Compliance Manual, Effective June, 1993).

1.0 SYNOPSIS OF DATA

A bench-scale feasibility study was conducted to evaluate the use of physical separation systems and chemical extraction methods as a means of separating chemically and radioactively contaminated soil fractions from uncontaminated soil fractions. The soil washing feasibility studies were conducted on soil samples from two trenches, 116-C-1 and 116-D-1B. Two samples of soil from trench 116-C-1, one from the middle of the trench (Batch I), and second close to the inlet (Batch II) were obtained. A single sample (Batch III) was obtained from the 116-D-1B trench.

Particle-size distribution data indicated that <2mm fractions in Batch I, II, and III samples constituted approximately 10, 2.8, and 53.1% of the total mass of each sample respectively. Preliminary gamma counting data indicated that the coarse fraction (>2mm) of Batch II sample had significantly higher activities of ^{60}Co, ^{90}Sr, ^{137}Cs, ^{152}Eu, and ^{154}Eu as compared to the coarse fractions of Batch I sample.

The pH of these soils ranged from 6.5 to 7.66, and the total organic carbon contents were relatively low (0.06 - 0.164 %). The cation exchange capacities of these soils were typical of Hanford soils and ranged within the narrow limits of 8 -8.9 meq/100g. In all cases the dominant exchangeable cation was Ca. Trace element analyses of these soils (<2mm fractions) showed no anomalous values. Total chromium concentrations in these soils were relatively low (56-236 mg/kg). The TCLP extraction of these soils indicated that all the eight inorganic constituents were well below the regulatory levels.

The radionuclide data indicated that the soil washing tests should be focused on Batch II sample from the 116-C-1 trench, and the Batch III sample from the 116-D-1B trench. All soil washing tests on Batch II material were conducted on coarse fraction (>2 mm in size) because this fraction constituted a major fraction (97.2%) of this soil. In contrast, the radionuclide data for Batch III soil showed that it is appropriate to conduct additional soil washing tests on 2- 0.25 mm fraction (42.3% of the total soil mass). The radionuclide data for these soil fractions also indicated significant activities (above the performance levels) of only three of the radionuclides, ^{60}Co, ^{137}Cs, and ^{152}Eu. Therefore, the effectiveness of subsequent soil washing tests were evaluated on the level of activity attenuation of these radionuclides.

Two types of tests (physical and chemical) were conducted to reduce the activities of ^{60}Co, ^{137}Cs, and ^{152}Eu in these selected soil fractions. The physical tests consisted of attrition scrubbing (2 -0.25 mm fraction of Batch III sample), and autogenous grinding (>2mm fraction of Batch II sample). Chemical extractions were conducted on both these samples.

Preliminary attrition scrubbing tests indicated that for Batch II sample (2-0.25 mm fraction) the optimum pulp density for effective scrubbing was approximately 83% Based on these data, a number of attrition scrubbing tests were conducted to establish the relationship between energy input, reduction in radionuclide activity, and the amount of fines (<0.25 mm material) generated. The results indicated optimum performance was obtained at an average energy input 1.43 HP mins/lb (residence time 30 mins). The average reduction in ^{60}Co, ^{137}Cs, and ^{152}Eu activities were >99, 28, and 61% respectively. Scrubbing at this intensity generated about 9% fines. Doubling the energy input did not result in any noticeable increase in radionuclide removal efficiencies. Therefore, another scrubbing experiment was conducted with an electrolyte to enhance radionuclide removal.

The results show >79, 39, and 83% reduction in ^{60}Co, ^{137}Cs, and ^{152}Eu activities. Optical and electron microscopic observations of soil particles before attrition scrubbing indicated iron oxide and aluminosilicate coatings on the particle surfaces. Observations of the scrubbed particle surfaces indicated significant removal of these coatings indicating that a major fractions of ^{60}Co, ^{152}Eu and a minor fraction of ^{137}Cs were associated with these surface coatings.

Two-stage attrition scrubbing experiments were also conducted on Batch III soil (2 -0.25 mm fraction). The results show that two-stage scrubbing with deionized water removed additional amounts of radionuclides as compared to a single stage scrubbing with deionized water. Among all scrubbing experiments, the highest removal of radionuclides were observed when two-stage scrubbing was conducted with an electrolyte. Approximately 48, 94, and >79% of ^{137}Cs, ^{152}Eu, and ^{60}Co activity were removed, and about 14% fines were generated during this process. Autogenous grinding experiments conducted on gravel and cobble fraction of Batch II material showed that major fractions (84% and 94%) of ^{60}Co, and ^{152}Eu activities could be removed if the grinding was conducted with 17% electrolyte. As a result the residual activities of these two nuclides were below the proposed performance levels. In contrast, grinding resulted in only 25% reduction in ^{137}Cs activity. Approximately 5% fines were generated during this experiment. Additional dry and wet (with deionized water) grinding with 17 -25% sand as a grinding medium resulted in radionuclide removal in amounts comparable to the previous experiment however, these experiments generated excessive fines (13 -19% by weight).

Chemical extraction experiments were also conducted on Batch III sample (2-0.25 mm fractions), and Batch II sample (>2mm in size). Preliminary extraction studies were conducted with widely used extract compositions derived from published literature. Even though some of these extractants removed major fractions (>90 and 92%) of ^{60}Co and ^{152}Eu, they were not as effective in reducing ^{137}Cs activities (30 -40% removal). Therefore, based on the knowledge of contaminant-substrate association, two new extractants were formulated and tested on these soil fractions. These extractants removed major fractions of all three radionuclides from the coarse fractions of trench 116-D-1B (Batch-II) soil. These extractants consistently removed on average 85, >99, and >90% of ^{137}Cs, ^{152}Eu, and ^{60}Co respectively resulting in residual activities that were well below the proposed performance levels.

Chemical extraction of Batch II material (gravel and cobble fraction) with one of the new extractant was also conducted under static conditions. Significant reduction in ^{60}Co (82%), and ^{152}Eu (92%) activities that resulted in residual activities below the proposed performance levels were observed in these experiments. The reduction in ^{137}Cs activity did not exceed 40% and because of inherently higher activity of ^{137}Cs in Batch II coarse material, the residual activity was still significantly elevated. Increased removal of ^{137}Cs (57%) was achieved in another autogenous grinding experiment with Batch II material (in contact with one of the new extractant). The initial ^{137}Cs activity in Batch II material indicate that approximately 93- >97% reduction is necessary to achieve residual activities that approach the proposed performance levels.

The data obtained from tests conducted so far indicate that Batch I material from the middle of trench 116-C-1 can be soil-washed with only wet screening resulting in about 90% mass reduction. By contrast, the soil washing can significantly reduce the activities of ^{152}Eu and ^{60}Co in Batch I sample (obtained close to the inlet from trench 116-C-1), the ^{137}Cs activity cannot be reduced below the proposed performance level. Finally, the tests on Batch III sample show that the soil from trench 116-D-1B can also be soil-washed that combines wet sieving with either two-stage attrition scrubbing in electrolyte or a single chemical extraction step. The anticipated mass reduction for this soil is approximately 80-85%

2.0 WEEKLIES

April 12-16, Weekly

We are conducting several physical and chemical characterization tests such as moisture content, specific gravity, CEC, and TCLP. Homogenized representative samples of Batch I, II, and III are being used in all the tests. Early next week, we will be sending representative samples to the ACL for analyses of radionuclides, Cr, and TOC.

We have also obtained preliminary radionuclide data on Sr and the alpha emitters for all three samples (Table A). We had previously reported preliminary data on ^{60}Co, ^{137}Cs, and ^{152}Eu in these samples.

These preliminary data suggest that the contaminants of concern in these soils are mainly ^{60}Co, ^{137}Cs, ^{152}Eu, and ^{154}Eu. All other nuclides including alpha emitters appear to be below the proposed performance levels. These data will be verified when we obtain the results of detailed analyses of these samples.

We have also conducted some additional cursory tests on some of the "hot rock" samples (Table B). Three grab samples of pebbles (from sample container BO80L6) were first tumbled in DI water, and then tumbled with an equal mass of clean sand in 1N ammonium acetate solution. The DI water step reduces the activities of all measured radionuclides, but the residual activities are still greater than the specified performance levels. The ammonium acetate step further reduces the activities of all nuclides significantly. The residual activity of ^{60}Co after this step is below the proposed performance level of 7.1 pCi/g, and the activities of ^{152}Eu and ^{154}Eu are also below the proposed levels of 15 and 14 pCi/g respectively. These two washing steps appear to effectively reduce ^{137}Cs activities by 37 - 52% however, the residual activity is still way above the performance level for this nuclide.

Visual observations indicate that these pebbles have a tenacious coating of what seems to be iron oxides. Some of the pebbles contained residual coating even after a two step washing. Our initial guess from these data is that ^{137}Cs is associated with this iron oxide film. These cursory data suggest that for these "hot rock" samples ^{137}Cs is the principal "risk-driver." Perhaps autogenous grinding with a stronger extractant may be needed to remove the residual of the ^{137}Cs-containing iron oxide film.

Table A. Preliminary Radionuclide Data on 100 Area Soil Samples

Sample	^{60}Co pCi/g	^{90}Sr pCi/g	^{137}Cs pCi/g	^{152}Eu pCi/g	^{154}Eu pCi/g	Total α pCi/g
100-B/116-C-1 (Sample set I received 1/19/93). Mainly cobbles assessed to contain about 5% soil						
Small mud rocks (Container BO80K1) Counting time 15 hr	29	0.6	4	107	21	3.0
Rock (container BO80K6) Counting time 15 hr	3	*	0.3	8	2	*
100-B/116-C-1 (Sample set II received 1/27/93). Mainly cobbles assessed to contain about 1% soil						
Mud coated cobbles (Container BO80L7) Counting time: 5 min.	127	20	2856	548	142	20 -35
Same rocks washed in DI water. Counting time: 5 min	ND	*	675	21	ND	*
Filtered soil (oven-dried) from wash solution. Counting time: 5 min	1621	*	28300	4856	1088	*
Same rocks tumbled in the TCLP device for 7 days with 200 ml DI water. Counting time: 30 min	ND	*	150	ND	ND	*
116-D-1B (Sample set III received 2/12/93). Sandy soil assessed to contain about 5% cobbles						
1. Soil (Composite BO1957 & BO1960). Counting time: 1 hr	22	1	159	180	93	0.7
2. Soil (Composite BO1957 & BO1960). Counting time: 15 hr	17	*	170	181	24	*

ND: Not detected. * Not measured. Counting was conducted on all samples as received except the sample from 116-D-1B were oven-dried.

Table B. Preliminary Radionuclide data on washed and treated pebbles from 100-B/116-C-1 (Sample set II received 1/27/93).

	Sample	^{60}Co pCi/g	^{137}Cs pCi/g	^{152}Eu pCi/g	^{154}Eu pCi/g
1.	Pebbles from container BO80L6	102	6500	408	99
	Pebbles tumbled for 2 hours in DI water	24	4478	78	12
	Pebbles tumbled with sand (lot 2M867) in 1N ammonium acetate solution for 20 hours	5	3117	11	3
2.	Pebbles from container BO80L6	86	6104	259	26
	Pebbles tumbled for 2 hours in DI water	29	5160	48	15
	Pebbles tumbled with sand (lot 2M867) in 1N ammonium acetate solution for 20 hours	6	3830	12	6
3.	Pebbles from container BO80L6	122	5895	481	143
	Pebbles tumbled for 2 hours in DI water	19	4232	77	89
	Pebbles tumbled with sand (lot 2M867) in 1N ammonium acetate solution for 20 hours	4	2881	6	7

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100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (April 19 -23)

The extracts from EC (exchangeable cation) measurements have been submitted to ACL. Analyses of the TCLP extracts are currently being conducted at ACL. We are now conducting wet-sieving of 116-D-1B (Batch III Sample). We are expecting to finish wet sieving of other two samples before the end of next week. The sieved fractions will be gamma-counted after oven-drying.

We have received the results of one set of XRF analyses. The second set of the duplicate samples are currently being done. The major element concentrations (Table A) are typical of soils. Among trace elements (Table B), total Cr concentrations in all three soils are significantly below the required performance level. Other trace elements such as Sb, As, Ba, Cd, Hg, Ni and Ag appear to be present in concentrations that are less than the proposed RCRA Action Levels.

Table A. Major Element Concentrations (%) in 100 Area Soil Samples.

Element	Samples		
	116-C-1 (Batch I)	116-C-1 (Batch II)	116-D-1B (Batch III)
Aluminum	5.26	4.62	5.05
Calcium	2.57	2.65	4.08
Iron	4.41	5.67	6.80
Potassium	1.55	1.32	1.12
Silicon	22.2	20.0	20.2
Titanium	0.61	0.64	1.00

Note: Measurements of single samples conducted by X-Ray Fluorescence Spectrometry.

Table B. Trace Element Concentrations (mg/kg) in 100 Area Soil Samples.

Trace Element	Samples		
	116-C-1 (Batch I)	116-C-1 (Batch II)	116-D-1B (Batch III)
Antimony	<13	<15	<15
Arsenic	4.4	7.4	<1.9
Barium	738	762	644
Cadmium	<11	<12	<12
Chromium (Total)	56.5	224	56.4
Copper	42.2	50.7	58.7
Lead	12.6	102.7	14.1
Manganese	783	1097	1111
Mercury	<2.7	13.3	<3.7
Nickel	23.9	36.9	24.8
Rubidium	62.8	60.4	42.0
Selenium	<0.92	<1.1	<1.1
Silver	<9.5	<10	<11
Strontium	406.3	416.7	366.3
Uranium	<4.4	<4.8	5.8
Vanadium	167	173	313
Zinc	87.3	865	137.7
Zirconium	237	240	219

Note: Measurements of single samples conducted by X-Ray Fluorescence Spectrometry.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (May 3 - 7)

Preliminary gamma counting to the wet-sieved soil fractions of 116-D-1B (Batch III Sample) was completed (Table A). As expected, coarser size fractions have lower activity. The 2 - 0.25 mm size fraction which constitutes a significant mass of this soil material contains significantly less activity than all the finer size-fractions. The ^{60}Co activity in 2 - 0.25 mm size fraction is below the MDA, and the activity of ^{152}Eu is slightly above the proposed performance level of 15 pCi/g. The ^{137}Cs activity in this size fraction is about twice the proposed performance level.

Wet-sieving of 116-C-1 (Batch I) sample was completed, and wet-sieving of Batch II is in progress.

Wet Sieving and Gamma counting Data for 116-D-1B (Batch III) Sample

Size Fraction	^{60}Co pCi/g	^{137}Cs pCi/g	^{152}Eu pCi/g	Weight %
13.5 mm -9.5 mm	<2.7	12.5	<5.1	7.9
9.5 mm - 2 mm	<2.7	40.7	<5.1	12.6
2 mm - 0.25 mm	<2.7	55.8	16.6	60.9
0.25 mm - 0.075 mm	5.1	213	46.6	7.2
0.075 mm - 0.028 mm	30	380	277	11.1
<0.028 mm	252	1110	2350	0.3

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (May 10 - 14)

Wet-sieving of 116-C-1 (Batch I Sample) was completed (Table A). The fraction analyzed (<2 mm in size) constitutes about 10% of the whole soil. Wet-sieving of 116-C-1 (Batch II) is in progress. The coulometric analyses of the soils (Table B) indicate low TOC values (0.06% to 0.2% on oven-dry basis). The pH values of these soils (Table C) indicate slightly acidic reaction of Batch I soil and slightly alkaline reaction of Batch II and III material. These measurements were conducted with glass electrode. Preliminary measurements conducted with ISFET (Ion-Sensitive Field Effect Transistor) electrodes indicated alkaline conditions. Because of unreliability of the ISFET electrodes, all pH measurements were conducted with well-calibrated glass electrodes.

Measurements show that the <2mm fractions of all the soils contain levels of ^{90}Sr activity that are about one to three orders of magnitude less than the proposed performance level of 2800 pCi/g (Table D).

Duplicate XRF analyses of all the soil samples were completed (Table E and F). These analyses confirm that total Cr concentrations in these soils (Table E) are well below the required performance level of 1600 mg/kg. Concentrations of Ag, As, Ba, Cd, Hg, Ni, and Sb in these soils are all less than the proposed RCRA Action Levels.

Table A. Wet Sieving Data for 116-C-I (Batch I) Sample

Size Fraction	Weight %
9.5 mm - 2 mm	3.4
2 mm - 0.25 mm	35.0
0.25 mm - 0.075 mm	29.6
0.075 mm - 0.028 mm	30.7
<0.028 mm	1.3

<2 mm material constitutes about 10% of the total soil mass.

Table B. Coulometric Determination of Total Organic Carbon in 100 Area Soil Samples.

Sample	TOC (mg/kg)
116-C-1 (Batch I)	1130
116-C-I (Batch II)	1640
116-D-1B (Batch III)	600

Table C. pH Measurements on 100 Area Soil Samples.

Sample	pH
116-C-1 (Batch I)	6.50
116-C-1 (Batch II)	7.40
116-D-1B (Batch III)	7.66

Measurements were made with glass electrode on duplicate samples equilibrated with DI water.

Table D. Activity of ^{90}Sr in 100 Area Soil Samples.

Sample	^{90}Sr (pCi/g)
116-C-1 (Batch I)	<0.2
116-C-1 (Batch II)	115
116-D-1B (Batch III)	12.5

The activities were measured on <2 mm material.

Table E. Trace Element Concentrations (mg/kg) in 100 Area Soil Samples.

Trace Element	Samples		
	116-C-1 (Batch I)	116-C-1 (Batch II)	116-D-1B (Batch III)
Antimony	<16	<19	<19
Arsenic	4	7	<2
Barium	729	753	632
Cadmium	<12	<13	<14
Chromium (Total)	56	236	58
Copper	44	50	61
Lead	13	101	13
Manganese	847	1114	1154
Mercury	<3	12	<4
Nickel	26	37	24
Rubidium	63	61	43
Selenium	<1	<1	<1
Silver	<10	<12	<12
Strontium	401	415	377
Uranium	5	<5	9
Vanadium	165	161	295
Zinc	88	855	138
Zirconium	211	209	205

Note: Measurements of duplicate samples conducted by X-Ray Fluorescence Spectrometry using Ag, Gd, Fe, and Zr targets.
* Federal Register 40 CFR Part 264 Subpart S Appendix A [Section 264.521 (a) (2) (i-iv).
** Performance Level for 100 Area Soils.

Table F. Major Element Concentrations (%) in 100 Area Soil Samples.

Element	Samples		
	116-C-1 (Batch I)	116-C-1 (Batch II)	116-D-1B (Batch III)
Aluminum	5.70	5.11	5.67
Calcium	2.65	2.65	4.10
Iron	4.51	5.59	6.83
Potassium	1.60	1.36	1.15
Silicon	23.9	21.25	22.25
Titanium	0.64	0.65	1.02

Note: Measurements of duplicate samples conducted by X-Ray Fluorescence Spectrometry using Ag, Gd, Fe, and Zr targets.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (May 17 - 21)

Wet-sieving of 116-C-1 (Batch I Sample) was completed. Gamma counting of size fractions are in progress. Wet-sieving of 116-C-1 (Batch II) has been completed. The TCLP data for 116-C-1 (Batch II), and 116-D-1B (Batch III) indicate that analyzed constituents are well below the EPA regulatory levels (Table A). EC measurements showed that Ca is the dominant exchangeable cation in all the soils (Table B). Exchangeable Ca, and Mg account for almost all of CEC of these soils.

We are conducting set-up tests of attrition scrubbing using clean soils. Following these tests, we plan to begin attrition scrbbing tests on 116-D-1B (Batch III) soil.

Table A. Analyses of Extracts from Toxicity Characteristics Leaching Procedure

Element	Soil Sample		EPA Regulatory Level (mg/l)
	116-C-1 (Batch II) (mg/l)	116-D-1B (Batch III) (mg/l)	
Ag	0.03	BD	1.0
As	0.20	0.20	5.0
Ba	0.35	0.29	100.0
Cd	0.01	0.02	1.0
Cr	BD	BD	5.0
Hg	*	*	0.2
Pb	BD	BD	5.0
Se	BD	BD	1.0

Extractions conducted on <2 mm material.
* Will be measured by CVAA. BD: Below detection Limit.
The detection limits for Ag, Cr, Pb, and Se are 0.01, 0.02, 0.06, and 0.2 mg/l respectively.

Table B. Exchangeable Cations in the 100 Area Soil Samples.

Sample	Exchangeable Cations (meq/100 g)					CEC meq/100g
	Ba	Ca	Mg	Sr	Na	
116-C-1 (Batch I)	0.03	6.82	2.00	0.02	0.00	8.9
116-C-1 (Batch II)	0.02	6.65	1.65	0.02	0.09	8.4
116-D-1B (Batch III)	0.03	6.75	1.20	0.02	0.00	8.0

Measurements conducted on <2 mm material.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (June 1 - 4)

Uranium analyses of 116-C-1 (Batch I and II) and 116-D-1B (Batch III) bulk soils show very low activities that are significantly lower than the performance levels of 15 and 50 pCi/g for ^{235}U and ^{238}U respectively (Table A).

We started the attrition scrubbing tests on 116-D-1B soil (Batch III). We will continue these tests this week.

Table A. Uranium Activities in 116-C-1 and 116-D-1B Samples*

Soil Sample	^{235}U (pCi/g)	^{238}U (pCi/g)
116-C-1 (Batch I)	0.061	1.31
116-C-1 (Batch II)	0.057	1.23
116-D-1B (Batch III)	0.111	2.38

*All measurements conducted on <2mm material.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (June 14 - 18)

We completed the first set of attrition scrubbing tests on 116-D-1B soil (Batch III). The preliminary data (Table B) shows that about 15-16% reduction in Cs activity in >60 mesh fraction can be achieved at 80-83% solid wt% during 15 min scrubbing time. About 2 to 4% additional fines (<60 mesh) were generated during the scrubbing process. The reduction in Cs activities were based on data obtained from wet-sieving (Table A). We achieved additional 5-6% reduction in Cs activity by increasing the scrubbing time from 15 to 30 min. The preliminary counts of Cs activity were measured by a NaI detector. We will conduct the gamma counting of Cs, Eu, and Co in these fractions after we setup and calibrate the spectrometer with the GeLi detector.

100 Area Soil Washing Bench Scale Data, DRAFT

Table A. Cs Activity in Wet-sieved >60 Mesh Fraction from 116-D-1B (Batch III) Soil Sample

Replicates	Coarse fraction >60 mesh wt %	Fine fraction <60 mesh wt %	Cs activity in coarse fraction. Counts/g	Average Cs Activity in Coarse fraction
1	80	20	356	354
2	80	20	352	

Table B. Preliminary Results from Attrition Scrubbing Tests on 116-D-1B (Batch III) Soil Sample

Replicates	Solids wt %	Time (min)	Coarse fraction >60 mesh Wt %	Fine fraction <60 mesh wt %	Cs Activity in Coarse fraction Counts/g	Reduction in (%) Cs activity in Coarse fraction	Reduction Average %
1	75	15	80	20	323	9	10
2	75	15	79	21	318	10	
1	80	15	78	22	290	18	15
2	80	15	79	21	310	12	
1	83	15	76	24	307	13	16
2	83	15	76	24	289	18	
1	85	15	77	23	330	7	13
2	85	15	78	22	287	19	
1	83	30	76	24	281	21	21
2	83	30	75	25	282	20	

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (June 28 - July 2)

The isotopic analyses of 116-C-1 (Batch I and II) and 116-D-1B soils were completed. These analyses confirm that ^{60}Co, ^{137}Cs, ^{152}Eu, and ^{154}Eu are the contaminants of concern in these soils. The ACL analyses also reported the presence of ^{241}Am in one of the soil samples (116-C-1, Batch II). We plan to use more accurate alpha spectrometry to confirm the reported gamma measurements of ^{241}Am activity. The particle-size distribution measurements are in progress. We are also conducting additional attrition scrubbing tests on 116-D-1B (Batch III) soil.

Radionuclide Data for 100 Area Soil Samples

Sample	^{40}K	^{60}Co	^{134}Cs	^{137}Cs	^{152}Eu	^{154}Eu	^{155}Eu
116-C-1 (Batch I)	16	7	<0.8	0.74	28	4.4	0.54
116-C-1 (Batch II)	<7	525	<10	5495	2320	337	*
116-D-1B (Batch III)	7	15	<2	205	177	17	1.4

* Reported Interference. Data review requested.
Reported values are averages of duplicate values.
All measurments conducted on <2 mm material

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (July 7 - 9)

We completed another set of attrition scrubbing tests on 116-D-1B soil (Batch III). Previous set of data (June 23 report) showed that scrubbing on whole soil was most effective at 80-83 wt% solids. Therefore, these tests were conducted to examine the effect of different scrubbing times on contaminant reduction in 10 - 60 mesh material at the same weight % solid content. Attrition data show (Table A) that increasing scrubbing time results in increasing quantities of fine material (<60 mesh) with concomitant reduction in Cs activity in coarse fraction (10 - 60 mesh). Cesium activity reductions up to 25% were achieved after scrubbing for 30 minutes. Doubling the scrubbing time to 60 minutes results in only 2% additional activity reduction. All Cs counting data were obtained using a NaI detector. In the near future, we will gamma-count Cs, Eu, and Co in these soil fractions using a calibrated intrinsic Ge detector.

100 Area Soil Washing Bench Scale Data, DRAFT

Table A. Preliminary Results from Attrition Scrubbing Tests on 116-D-1B (Batch III) Soil Sample

Replicates	Time (min)	Wt % fines (<60 mesh) generated	Wt % fines (<60 mesh) generatedAverage	Reduction in (%) Cs activity in Coarse fraction (10-60 mesh)	Reduction Average %
1	5	6	5	13	14
2	5	4		15	
1	10	7	7	21	21
2	10	6		21	
1	15	7	7	19	19
2	15	7		19	
1	30	9	9	25	25
2	30	9		24	
1	60	12	12	32	27
2	60	11		27	

Attrition scrubbing conducted on 10 - 60 mesh material.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (July 12 - 16)

We are including the torque measurements and the related calculations that were obtained as part of the attrition scrubbing test data (reported last week) on 116-D-1B soil (Batch III). All tests were conducted at 83 wt% solids. The data we reported last week was preliminary because gamma counting data for Cs, Eu, and Co were not available for accurately assessing the reduction in activities. We expected to report on both gamma counting and torque measurements as soon as the data set was completed. We included preliminary data to facilitate data tranfer and will report detailed data as soon as all the measurements are completed.

100 Area Soil Washing Bench Scale Data, DRAFT

Preliminary Results from Attrition Scrubbing Tests on 116-D-1B (Batch III) Soil Sample

Replicates	Time (min)	Wt % fines (<60 mesh) generated	Wt % fines (<60 mesh) generatedAverage	Reduction in (%) Cs activity in Coarse fraction (10-60 mesh)	Average Reduction %	Initial Torque oz-in	Final Torque oz-in	Average Torque oz-in	HP	HP mins/lb Average	Watt hr/lb Average
1	5	6	5	13	14	63	62	63	0.0563	0.26	3.18
2	5	4		15		70	58	64	0.0571		
1	10	7	7	21	21	88	69	79	0.0706	0.56	6.97
2	10	6		21		66	51	59	0.0527		
1	15	7	7	19	19	80	57	69	0.0616	0.80	10.00
2	15	7		19		73	52	63	0.0563		
1	30	9	9	25	25	72	43	58	0.0519	1.38	17.12
2	30	9		24		69	41	55	0.0491		
1	60	12	12	32	27	74	45	60	0.0536	2.80	34.85
2	60	11		27		75	35	55	0.0491		

Attrition scrubbing conducted at 900 rpm on 10 - 60 mesh material.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (July 19 - 23)

We have complete data on the radionuclides of interest in bulk soils. As indicated by t preliminary data; ^{60}Co, ^{137}Cs, and ^{152}Eu are the contaminants of concern in 116-D-1B sampl The analyses of 116-C-1 (I and II) samples (conducted on <2mm fractions constituting abo 10 and 3 wt% of the total material respectively) show that the Batch II sample has highe activities than Batch I sample.

Mercury analyses on TCLP extracts were completed using the CVAA. Mercury concentrations in these extracts were below detection limits of 0.0004 mg/l. Therefore, all TCLP elements in these soils are well below the regulatory levels.

Beginning next week, we will be conducting the first set of chemical extractions and autogenous grinding (116-C-1 II). We also expect to begin gamma-counting on attrition-scrubbed material.

Radionuclide Data for 100 Area Soil Samples

Radionuclide (pCi/g)	116-C-1 (I)	116-C-1 (II)	116-D-1B	Accessible Soil Activity Limits*
^{60}Co	7	525	15	7.1
^{134}Cs	<0.8	<10	<2	10
^{137}Cs	0.74	5495	205	30
^{152}Eu	28	2320	177	15
^{154}Eu	4.4	337	17	14
^{155}Eu	0.54	70	1.4	630
^{90}Sr	<0.2	115	12.5	2800
^{235}U	0.06	0.06	0.11	170
^{238}U	1.31	1.23	2.38	370
$^{239/240}Pu$	0.08	414	2.74	190

Analyses conducted on <2mm material.
* Table 6-2, Environmental Compliance, WHC-CM-7-5

Table A. Analyses of Extracts from Toxicity Characteristics Leaching Procedure

Element	Soil Sample		EPA Regulatory Level (mg/l)
	116-C-1 (Batch II) (mg/l)	116-D-1B (Batch III) (mg/l)	
Ag	0.03	BD	1.0
As	0.20	0.20	5.0
Ba	0.35	0.29	100.0
Cd	0.01	0.02	1.0
Cr	BD	BD	5.0
Hg	BD	BD	0.2
Pb	BD	BD	5.0
Se	BD	BD	1.0

Extractions conducted on <2 mm material. BD: Below detection Limit. The detection limits for Ag, Cr, Hg, Pb, and Se are 0.01 0.02, 0.0004, 0.06, and 0.2 mg/l respectively.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (Aug 2 - 6)

We have completed gamma counting on attrition-scrubbed 116-D-1B sample. The data (Table A) show that we can remove significant fractions ^{152}Eu (42-66%) and ^{60}Co (>52%) activity using attrition scrubbing. However, only up to a third of ^{137}Cs activity in this size fraction can be removed through attrition. Also, the data show good correlation between scrubbing energy expended and the reduction in soil radionuclide activities. Weight percent fines generated during scrubbing also appears to correlate well with the input energy.

We have also obtained preliminary data from chemical extraction experiments (Table B). Three different acids of 0.5M concentration (acetic, citric, and hydrochloric) were used in these experiments. The data show that either citric or hydrochloric acid will remove >70% of ^{152}Eu and ^{60}Co activity from the soil fraction. Removal of ^{137}Cs in all experimen ranged from 8-11% We will conduct additional chemical extraction experiments next week. We are also setting up preliminary autogenous grinding experiments for coarse fractions of sample 116-C-1 (Batch II).

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100 Area Soil Washing Bench Scale Data, DRAFT

Table A. Results from Attrition Scrubbing Tests on 116-D-1B (Batch III) Soil Sample

Replicates	Time (min)	Wt % fines (<60 mesh) generated	HP	HP mins/lb	Watt hr/lb	^{137}Cs pCi/g	Cs % RReduction	^{152}Eu pCi/g	Eu % Reduction	^{60}Co pCi/g	Co % Reduction
0	0	0	0	0	0	90	0	38	0	3	0
1	5	4	0.0592	0.27	3.36	72	20	22	42	1.43	52
2	5	4	0.0603	0.27	3.36	74	18	19	50	1.33	56
1	10	7	0.0706	0.64	7.96	66	27	19	50	0.74	75
2	10	6	0.0527	0.48	5.97	71	21	19	50	0	100
1	15	7	0.0629	0.86	10.69	70	22	19	50	1.07	64
2	15	7	0.0500	0.68	8.45	69	23	19	50	0.97	68
1	30	9	0.0596	1.62	20.14	64	29	14	63	0	100
2	30	9	0.0454	1.24	15.42	67	26	16	58	0	100
1	60	11	0.0496	2.71	33.69	65	28	14	63	0.47	84
2	60	11	0.0434	2.37	29.46	64	29	13	66	0	100

Attrition scrubbing tests were conducted at 900 rpm on 10 - 60 mesh material.

Table B. Preliminary Chemical Extraction Data for 116-D-1B Soil

Replicate	Extractant	Activity in Extracted soil (pCi/g)			Activity Reduction %		
		^{137}Cs	^{152}Eu	^{60}Co	^{137}Cs	^{152}Eu	^{60}Co
1	0.5M Acetic	81	23	2.4	9	40	20
2	0.5M Acetic	79	23	2.4	11	40	20
1	0.5M Citric	79	7	0.5	11	82	83
2	0.5M Citric	79	7	0.8	11	82	73
1	0.5M HCl	82	6	0.6	8	84	80
2	0.5M HCl	79	5	0	11	87	100

All acid extractions were conducted on 2-0.25mm soil fractions (1:1 solid-solution ratio) for 4 hrs at room temperature.
Measured activities of ^{137}Cs, ^{152}Eu, and $^{6.0}Co$ in soil before extraction were 89, 38 and 3 pCi/g respectively.activities in

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (Aug 9 - 20)

We conducted additional chemical extraction experiments and the results indicate that the CBD extraction is only as effective as the 0.5M citric and 0.5M HCl extractions. The results of HAH extraction are the best so far in removi ^{137}Cs from the soil. About 30 % of ^{137}Cs, 84% of ^{152}Eu and >93% of ^{60}Co was removed by the HAH extractant. We will be testing a few more extractants before moving into the optimization phase for 116-D-1B sample.

Dry autogenous grinding experiment rocks from 116-C-1 (Batch II) sample has been completed and we are trying to resolve the problems associated with counting geometry for rocks. We will be conducting additional wet and dry grinding experiments on this material.

100 Area Soil Washing Bench Scale Data, DRAFT

Chemical Extraction Data for 116-D-1B Soil

Replicate	Extractant	Activity in Extracted soil (pCi/g)			Activity Reduction %		
		^{137}Cs	^{152}Eu	^{60}Co	^{137}Cs	^{152}Eu	^{60}Co
1	DCB	81	15	<0.2	9	61	>93
2	DCB	79	15	<0.2	11	61	>93
1	HAH	62	6	<0.2	30	84	>93
2	HAH	60	6	<0.2	33	84	>93

Measured activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in soil before extraction were 89, 38 and 3 pCi/g respectively.
All extractions were conducted on 2-0.25mm soil fractions (1:4 Solid-solution ratio).

DCB Extraction: 0.3M sodium citrate + 1M sodium bicarbonate (pH 7). Soil and extractant heated to 80 °C, solid sodium dithionite added to the mixture to bring the solution upto 0.4M in sodium dithionite. Extraction time 15 minutes.

HAH Extraction: 0.1M hydroxylamine hydrochloride in 25% (v/v) acetic acid. The soil/extractant mixture is heated to 96° C. Extraction time: 6 hrs.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (Aug 23 - 27)

We conducted an additional chemical extraction experiment and the results indicate that a combination of ammonium citrate, citric acid, and sodium dithionite is the most effective so far in mobilizing Cs. The data (Table) show that this extraction removes about 42% of ^{137} Cs, 92% of ^{152}Eu and >93% of ^{60}Co from the soil. We are also testing a few other extractants before moving into the optimization phase for 116-D-1B sample.

A preliminary dry autogenous grinding test on a sample of very low activity rocks from 116-C-1 (Batch II) was completed. The results show that the initial activities of 7, 9 and 6 pCi/g for ^{137}Cs, ^{152}Eu, and ^{60}Co were reduced to 4, 5, and 5.5 pCi/g respectively after 1 hr grinding. The dry grinding generated about 2% fines containing 146, 19 and 35 pCi/g of ^{137}Cs, ^{152}Eu, and ^{60}Co activity. We will be conducting additional dry and wet grinding experiments on hotter rocks from batch II material.

100 Area Soil Washing Bench Scale Data, DRAFT

Chemical Extraction Data for 116-D-1B Soil

Replicate	Extractant	Activity in Extracted soil (pCi/g)			Activity Reduction %		
		^{137}Cs	^{152}Eu	^{60}Co	^{137}Cs	^{152}Eu	^{60}Co
1	DCB	81	15	<0.2	9	61	>93
2	DCB	79	15	<0.2	11	61	>93
1	HAH	62	6	<0.2	30	84	>93
2	HAH	60	6	<0.2	30	84	>93
1	CD	53	3	<0.2	40	92	>93
2	CD	50	3	<0.2	44	92	>93

Measured activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in soil before extraction were 89, 38 and 3 pCi/g respectively.
All extractions were conducted on 2-0.25mm soil fractions (1:4 Solid-solution ratio).

DCB Extraction: 0.3M sodium citrate + 1M sodium bicarbonate (pH 7). Soil and extractant heated to 80 °C, solid sodium dithionite added to the mixture to bring the solution upto 0.4M in sodium dithionite. Extraction time 15 minutes.

HAH Extraction: 0.1M hydroxylamine hydrochloride in 25% (v/v) acetic acid. The soil/extractant mixture is heated to 96° C. Extraction time: 6 hrs.

CD Extraction: 0.3M ammonium citrate + 0.4M citric acid. Soil and extractant mixture heated to 80° C, solid sodium dithionite added to bring the solution upto 0.3M. Extraction time 3 hrs.

100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (Oct 4 - 8)

Autogenous grinding data on 116-C-1 (Batch II) cobbles and gravel show that all types of grinding treatment effectively reduce Eu, and Co activities below the performance levels. However, none of the treatments showed significant removal of Cs activity. Other differences between various treatments also emerge if we examine the quantity of fines generated. Adding grinding medium (in these experiments, 2-0.25 mm fraction from 116-D-1B soil) generated 13 to 19% fines because a major fraction of added sand ends up as fines. We may note that dry grinding also produces extremely fine particles in respirable range and because no significant improvement in performance is observed, dry grinding seems to be a nonviable approach.

Even though grinding in electrolyte removes about 25% of Cs activity in cobble and gravel fraction, the residual activity of Cs in this fraction is still significantly well above the suggested performance level. Therefore, we plan to conduct additional grinding and extraction experiments on this sample to try to improve upon the Cs removal efficiency observed in these experiments.

100 Area Soil Washing Bench Scale Data, DRAFT

Autogenous Grinding of 116-C-1 (Batch II) Samples

Autogenous Grinding Treatment	^{137}Cs (pCi/g)		% Red Cs Act.	^{152}Eu (pCi/g)		% Red Eu Act.	^{60}Co		% Red Co Act.	HP-mins/lb	%Fines by wt
	Initial	Final		Initial	Final		Initial	Final			
16% DI water	822	707	14	69	2	97	16	2	85	--	0.5
17% electrolyte	883	665	25	88	5	94	26	3	88	6.3	5.0
Dry (25% sand[a])	868	724	17	90	10	89	23	5	74	6.6	13.0[b]
17% DI water + 16.6% sand[c]	693	547	21	29	3	90	28	2	93	6.1	19.0[d]

Sand fraction (2-0.25 mm) from 116-D-1B soil was used as a grinding medium that had initial activities of ^{137}Cs, ^{152}Eu, and ^{60}Co measured at 95, 47, and 5 pCi/g respectively.

[a]Final activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in sand fraction were 99, 37, and 6 pCi/g respectively.
[b]Approximately, 2% fines (<0.25 mm) were generated from the rocks, and 11% resulted from ground-up sand.
[c]Final activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in sand fraction were 822, 374, and 99 pCi/g respectively.
[d]Approximately, 4% fines (<0.25 mm) were generated from the rocks, and 15% resulted from ground-up sand.

<u>100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (Oct 11 - 15)</u>

Combination test data show that one-stage attrition scrubbing with electrolyte is more effective than two-stage scrubbing with DI water. One-stage scrubbing with electrolyte removes 39%, 83%, and 94% of Cs, Eu and Co activities respectively. We may note that one-stage scrubbing with the electrolyte removes 5%, 12% and 8% more Cs, Eu, and Co activity than two-stage scrubbing with DI water. Also, one-stage scrubbing with electrolyte generates less fines (10% by wt) than two- stage DI water scrubbing (13% fines). Electrolyte scrubbing performs better probably due to its effectiveness in preventing readsorption and its enhanced leaching action. We are planning to conduct a two-stage electrolyte scrubbing test to measure any additional improvement in removal efficiencies.

100 Area Soil Washing Bench Scale Data, DRAFT

Attrition Scrubbing of 116-D-1B (Batch III) Samples

Replicate\Scrubbing Treatment	Wt % fines <60 mesh	^{137}Cs (pCi/g)	^{152}Eu (pCi/g)	^{60}Co (pCi/g)	Cs % Reductio n	Eu % Reductio n	Co % Reductio n
1. Two-stage in DI water	12	63	15	0.8	33	71	83
2. Two-stage in DI water	13	62	15	0.6	34	71	88
1. One-stage in electrolyte	10	57	9	0.2	39	83	96
2. One-stage in electrolyte	10	57	9	0.4	39	83	92

Measured activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in 2-0.25 mm soil fraction were 94, 52 and 4.8 pCi/g respectively.
The electrolyte solution consisted of 0.5 M ammonium citrate with pH adjusted to 3 with citric acid.

November 11, 1993
<u>100 Area Soil Washing Bench-Scale Procedures: Weekly Progress (Nov 1 - 5)</u>

Two-stage attrition scrubbing data (Table 1) shows that scrubbing with electrolyte removes on average 14% more Cs and 23% more Eu than DI water scrubbing. Two-stage scrubbing with electrolyte reduces average Cs activity to 49 pCi/g, and the Eu and Co activities to well below the performance levels.

Static leaching of cobbles and gravel from 116-C-1 sample (Table 2) at 24 and 96 C for 6 hours indicate that both Eu and Co activities can be reduced below performance levels by leaching at either temperature. Even though leaching at higher temperature decreased the initially high Cs activity (587 -1046 pCi/g) by about 40%, the residual activity is well above the performance levels. We need to explore other options such as modifying the composition of the extractant to improve the Cs removal efficiency.

Tabulated chemical extraction data (Table 4) for 116-D-1B soil fraction (2-0.25mm) confirm that the Extractant II is the most effective solution for removing significant fractions of all three radionuclides. Data also show that the extractant II achieves its highest removal efficiency within 3 hours whereas, the extractant I definitely requires longer time period to attain its maximum removal efficiency.

The particle-size distribution data for all three samples are listed (Table 4). We have previously reported the activities of all nuclides in <2mm material of all samples.

The 100-F sample has been air-dried, homogenized, and dry screened. The dry-screening of air-dried soil show that about 78.8, 2.1, 0.4, and 18.4% (by wt.) of material occur in >13.2mm, 13.2-4.75mm, 4.75-2mm, and <2mm size fractions respectively. The moisture content of the <2mm air-dried material is approximately 1.58% Subsamples of <2mm size fraction has been sent out to ACL for analyses of Pu, Sr, U, gamma emitters, and metals. Starting next week, we will be conducting the characterization and related tests.

100 Area Soil Washing Bench Scale Data, DRAFT

Table 1. Attrition Scrubbing of 116-D-1B (Batch III) Samples

Replicate\Scrubbing Treatment	Wt % Fines <60 mesh	^{137}Cs (pCi/g)	^{152}Eu (pCi/g)	^{60}Co (pCi/g)	Cs % Reduction	Eu % Reduction	Co % Reduction
1. Two-stage in DI water	12	63	15	<1	33	71	>79
2. Two-stage in DI water	13	62	15	<1	34	71	>79
1. One-stage in electrolyte	10	57	9	<1	39	83	>79
2. One-stage in electrolyte	10	57	9	<1	39	83	>79
1. Two-stage in electrolyte	12	48	1.6	<1	49	97	>79
2. Two-stage in electrolyte	13	50	5	<1	47	90	>79

Measured activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in 2-0.25 mm soil fraction were 94, 52 and 4.8 pCi/g respectively.
The electrolyte solution consisted of 0.5 M ammonium citrate with pH adjusted to 3 with citric acid.

Table 2. Chemical Leaching of 116-C-1 (Batch II) Samples

Extraction Temp.	Before Leaching (pCi/g)			After Leaching (pCi/g)			Reduction in Activity (%)		
	Cs	Eu	Co	Cs	Eu	Co	Cs	Eu	Co
1. 96 C	1046	30	11	584	3	2	44	90	82
2. 96 C	587	28	11	376	2	2	36	93	82
1. 24 C	424	24	9	365	11	5	14	54	44

All leaching were conducted with Extractant II under static conditions for 6 hrs.

Table 3. Chemical Extraction of 116-D-1B Soil: Reduction (%) in Radionuclide Activities

Radionuclide	Replicate	Extractants							
		Ext II	Ext II	Ext II	Ext II	Ext I	Ext I	HAH	CD
^{137}Cs	1	84	84	84	83	68	80	30	40
	2	85	86	85	85	70	82	33	44
^{152}Eu	1	>99	>99	>99	>99	55	63	84	92
	2	>99	>99	>99	>99	71	65	84	92
^{60}Co	1	>90	>90	>90	>90	>90	79	>90	>90
	2	>90	>90	>90	>90	>90	85	>90	>90
Time hrs		3	4	6	6	3	6	6	3
Temperature C		95	95	95	95	80	95	96	80

The initial activities of ^{137}Cs, ^{152}Eu, and ^{60}Co in the 2-0.25 mm fraction of the soil were 90-94 pCi/g, 38-52 pCi/g, and 3-5 pCi/g respectively. Solid:Solution ratio in Ext I and II experiments were 1:4.

Table 4. Particle-Size Distribution of 116-C-1 and 116-D-1B Soils

Particle Size (mm)	116-C-1 (Batch I)	116-C-1 (Batch II)	116-D-1B (Batch III)
	Wt %		
>2	90.0	97.2	46.9
2 - 0.25	3.6	1.3	42.3
0.25 - 0.074	3.4	0.5	3.7
<0.074	3.0	1.0	7.1

Particle size data for <2mm fractions were obtained through wet sieving.

ATTACMENT

100 AREA HANFORD SOIL WASHING TREATABILITY TESTS

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ABSTRACT

Soil washing laboratory tests performed at Hanford in support of 100 Area Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) feasibility studies included characterization of soils, physical separation, chemical extraction, and water treatment. Results to date show that <20% of the soil is finer than 0.25 mm (-40 mesh). The highest concentration of ^{60}Co, ^{152}Eu, and ^{137}Cs contaminants is generally associated with fine soil particles. However, measurable concentrations of contaminants were found in all sizes of soil particles. In initial testing, attrition scrubbing was generally sufficient to treat soils to meet selected performance levels for ^{60}Co and ^{152}Eu. However, more intense attrition scrubbing, autogenous grinding, or chemical extraction was required to enhance removal of ^{137}Cs. Additional tests and assessment of the feasibility of using soil washing techniques are in progress.

INTRODUCTION

A test plan was developed by Westinghouse Hanford Company (WHC) outlining treatability studies to be conducted to assess the viability and feasibility of applying physical separation/soil washing technologies to reduce the volume of contaminated soils in the 100 Areas of the Hanford Site. The test plan was developed in line with EPA guidance for conductive treatability studies under CERCLA (1) and considering previous and ongoing work conducted at other government sites (e.g., INEL, Johnston Atoll, China Lake). The studies consist of remedy screening and remedy selection tests.

Remedy screening tests are being conducted during FY 93 by the Pacific Northwest Laboratory (PNL) under contract to WHC. These are laboratory and bench-scale tests to characterize Hanford soils from three locations in the 100 Area and to assess soil washing processes using these soils. The development, purposes, and results of these tests are described.

Remedy selection/field-scale tests are scheduled for FY 94, contingent on the outcome of laboratory tests, to demonstrate system reliability and performance, utility requirements, environmental impacts, and secondary waste handling. Field-scale tests are needed for scale-up and to help optimize integrated process systems and conditions.

Preliminary field-scale treatability tests in the Hanford 300 Area were completed between June and September 1993 using modified equipment transferred to the U.S. Department of Energy (DOE) from the U.S. Environmental Protection Agency (EPA) Risk Reduction Engineering Laboratory. These tests show promising results for using physical separation processes to reduce the volume of uranium-contaminated soils by 90% or more in that area. The modified EPA equipment may also be used for 100 Area field-scale tests.

BACKGROUND

Between 1944 and 1970, effluent generated during reactor operations was discharged to many cribs or trenches in the 100 Area at Hanford. Trenches were later covered with 4 to 5 m of soil from the site. These types of waste sites are part of several 100 Area operable units at Hanford included on the EPA's National

Priorities List under the CERCLA/Superfund Program and managed in accordance with the *Hanford Federal Agreement and Consent Order* (Tri-Party Agreement) (2). Phase I and II 100 Area feasibility studies identified physical separation of soils by particle size/soil washing as alternatives to reduce the volume of contaminated soils in these sites. In a treatability study program plan, soil washing was recommended as one of the high priority, near-term, treatability study needs because the largest fraction of contaminated material in the 100 Area is soil, and because few other options were identified for treating metal/radionuclide contaminated soils (3). The study will provide data to compare cost/benefit of soil treatment versus bulk disposal or other remediation alternatives.

Cleanup Levels

Fundamental to determining if soil washing is a suitable technology for remediation is establishing cleanup levels for soils. To date, no agreement has been reached between DOE and the regulatory agencies designating cleanup levels for soils at the Hanford Site. For evaluating the results of 100 Area soil washing tests, DOE and regulators agreed that chemical contaminants of concern should be at or below residential standards for soils established by the Model Toxics Control Act (WAC-173-340). For radioactive isotopes, accessible soil concentration limits specified in the WHC Environmental Compliance Manual (4) have been proposed as test performance levels (Table I). These standards have been approved by EPA and Ecology for 300 Area soil washing tests. However, they are less stringent than previous WHC release limits and are being reviewed for 100 Area tests.

Table I. Performance Levels for the 100 Area Soil Washing Test.

Contaminant	Proposed Performance Level
Radionuclides[1]	(pCi/g)
^{60}Co	7.1
^{90}Sr	2,800
^{134}Cs	10
^{137}Cs	30
^{152}Eu	15
^{154}Eu	15
^{155}Eu	630
^{235}U	170
^{238}U	370
$^{239/240}Pu$	190
Chemical Contaminants[2]	(ppm)
Chromium (total)	1,600

[1]Accessible soil concentration limits, pCi/g (2. Table 6-2).

[2]Value based on Method B of WAC 173-340-740(3)(a)(iii)(A).

Objectives

The primary purpose of conducting laboratory tests was to assess the feasibility of using physical separation/ chemical extraction processes as a means of separating chemically and radioactively contaminated soil fractions from uncontaminated soil fractions in the Hanford 100 Area. Data from these tests will be used to define the requirements for a system for pilot-scale testing.

Laboratory/bench-scale tests were planned to answer the following questions:

- What is the size distribution of soil particles?
- To what degree are the coarse fractions separated from the fines by wet screening?
- Where does contamination reside in the soil fractions?
- Are soils well dispersed in the initial scrubbing processes? If not, what means are necessary to ensure adequate separation of agglomerated material?
- Are there surface coatings that can be abraded away?
- What, if any, chemical treatment is required to decontaminate soil fractions?
- Can heap leaching clean the entire soil matrix?
- What combinations of particle size separation, scrubbing, chemical extraction and leaching appear most feasible?
- What treatment is required to recycle or dispose of wash water?

FIELD SAMPLING

Soil samples for laboratory tests were collected from two trenches in the 100 Area. The trenches were considered representative of similar sites in the 100 Area, contained a variety of contaminants over a range of concentrations, and were identified as potential sites for early remediation. Two test pits were excavated in a trench located in the 100-B/C Area, one about the middle of the trench and one 15 m from the inlet. A third test pit was excavated near the inlet of a trench located in the 100-D Area. The two trenches selected for the tests contain an estimated 100,000 yd^3 of soil contaminated by disposal of fuel storage basin effluent and reactor cooling effluent. Test pits were excavated to depths of 7 to 8 m below grade.

Eleven, 5-gal buckets of soil were collected from each of the pits with radioactivity levels measured in the field at 500 counts per minute (cpm) for two of the pits and up to 20,000 cpm at a depth of about 6 m in the other. Soils from the two test pits in 100-B/C Area contained cobble material and gravel with very little sand or fine soils. The 100-D pit was mostly sand with some gravel and cobble material. The primary radionuclides in the soils were ^{60}Co, ^{137}Cs, ^{152}Eu, and ^{154}Eu. Chromium was the only nonradioactive contaminant of concern.

Borehole tailings samples were also taken from a pluto crib in the 100-F Area because higher levels of ^{238}Pu and ^{90}Sr were found at this site as compared to the 100-B/C and 100-D Area samples. However, these samples were also low activity waste. The 100-F Area samples will be characterized and tested starting October 1993.

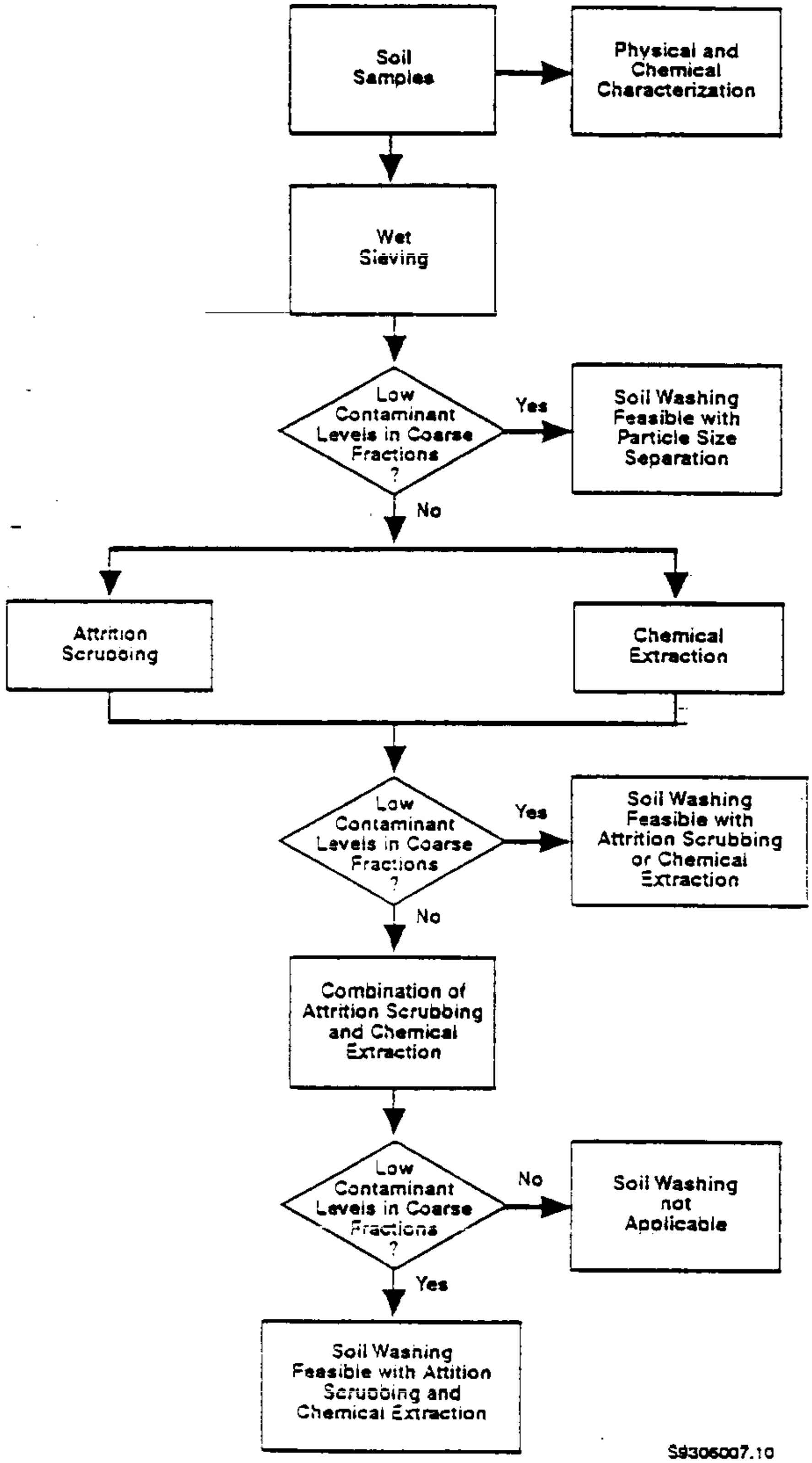
LABORATORY TEST PROCEDURES

Treatability tests included:

- Detailed Soil Characterization
- Attrition Scrubbing/Autogenous Grinding
- Chemical Extraction
- Attrition Scrubbing/Chemical Extraction Combined
- Waste Water Treatment.

All the tests were conducted in accordance with the *"100 Area Soil Washing Treatability Test Plan"* (5) and *"100 Area Soil Washing Bench-Scale Test Procedures"* (6) using American Society for Testing and Materials, EPA, or other methods approved by WHC. Fig. 1 shows the test flow process and decision points.

Figure 1. 100 Area Bench-Scale Soil Washing Test Flow Process and Decision Points.



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Detailed Soil Characterization

The objectives of soil characterization were to measure the concentrations of contaminants in the different size fractions of the soils, and to determine the physical, chemical, and mineralogical properties that govern the contaminant partitioning and release behavior.

Initial measurements included determining particle size distribution and performing chemical and radiological measurements on whole soils and wet sieved soil size fractions. This was followed by measuring slurry pH, specific gravity, cation exchange capacity, soil water content, and surface area. Other tests included measuring total organic carbon, Toxic Characteristic Leach Procedure (TCLP), sequential extraction, gradient density separation, optical and scanning microscopy, and x-ray diffraction analysis.

Attrition Scrubbing/Autogenous Grinding

These tests were conducted to determine whether contaminants could be removed from the surfaces of sand-sized particles through scrubbing actions. A laboratory attrition scrubber was used to simulate a larger scale commercial unit. Solids density, impeller speed, residence time, energy input, and use of surfactants to enhance performance were evaluated.

Wet and dry autogenous grinding tests were conducted to assess scrubbing of gravel and cobble material. A rotating 2.5-kg capacity rod mill with 9- by 22-cm interior dimensions was used for these tests. Rocks 2 to 25 mm in size were tumbled, and energy input determined. The concentration of radionuclides was measured before and after scrubbing.

Chemical Extraction

Because physical scrubbing and separation may not be sufficient to achieve the desired cleanup levels for all 100 Area soils, chemical extraction tests were conducted using low concentrations (0.5 M) of various chemical solutions. Preliminary tests included ammonium acetate, acetic acid, citric acid, and hydrochloric acid solutions. Other chemical extracts were also tested.

Combination Tests

Combination tests will include one- and two-stage attrition scrubbing, with and without surfactants, and combined attrition scrubbing-chemical extraction. The objective of these combination tests is to examine the effectiveness of contaminant removal using both physical and chemical treatment simultaneously or sequentially. These tests are in progress, but no results were available as of September 15, 1993.

Status

As of September 15, 1993, only characterization, attrition scrubbing, and chemical extraction tests were completed. Attrition scrubbing/chemical extraction combination tests and waste water treatment are expected to be completed by October 30, 1993.

RESULTS AS OF SEPTEMBER 1993

Preliminary characterization showed that the highest concentration of contaminants was associated with fine fractions of soils, but gravel and cobble activity levels also exceeded performance goals for the primary radionuclides and required some treatment.

Europium and cobalt isotopes were removed to below performance goals for soil particles >0.25 mm in diameter using attrition scrubbing or autogenous grinding. Application of chemicals was not required to treat these isotopes. However, ^{137}Cs contaminant concentrations, while higher in the fine soils, were still too high in the more coarse soil fractions and required more intense treatment.

Detailed Soil Characterization

A summary of activity levels of radioactive isotopes measured in the samples is included in Table II. Wet screening results (Table III) showed that over 95% of the soils sampled near the inlet end of the 100-B/C trench were >2 mm in diameter. There was much more sand in the soil samples from the center of the 100-B/C trench and the 100-D Area sample site, but still 85% of the material was >0.25 mm.

Table II. Radionuclide Data for 100 Area Soil Samples.

Sample	^{40}K	^{60}Co	^{134}Cs	^{137}Cs	^{152}Eu	^{154}Eu	^{155}Eu	Soil Fraction <2mm
116-C-1 (Batch I)	16	7	<0.8	0.74	28	4.4	0.54	10%
116-C-1 (Batch II)	<7	525	<10	5,495	2,320	337	70	3%
116-D-1B (Batch III)	7	15	<2	205	177	17	1.4	53%

Reported values are averages of duplicate values. All measurements conducted on <2-mm material.

Table III. Radionuclide Data for Size-fractioned Soils.

Fraction size, mm	^{60}Co, pCi/g	^{137}Cs, pCi/g	^{152}Eu, pCi/g	Weight %
116-C-1 Sample[1]				
>2	<3	675	21	97.2
<2	1,621	28,300	4,856	2.8
116-D-1B Sample[2]				
13.5 to 9.51	<3	13	<5	7.9
9.5 to 2	<3	41	<5	5.3
2 to 0.25	<3	56	17	40.7
0.25 to 0.074	5	213	47	4.8
0.074 to 0.028	30	380	277	7.4
<0.028	252	1,110	2,350	0.2

[1]Activity levels (pCi/g) are from grab samples of highest activity soils only.
[2]33.7% of particles >13.5 mm.

For both samples, contaminants were generally more concentrated in the fine soil particles.

TCLP tests showed that all metals in the acetic acid leachate were below levels of concern. Results of these tests and other physical measurements are shown in Table IV.

Table IV. TOC, pH, and TCLP Measurements for 100 Area Soil Samples.

Measurement	116-C-1, I	116-C-1, II	116-D-1B
Total organic compounds (mg/kg)	1,130.0	1,640.0	600.0
pH	6.5	7.4	7.7
TCLP (mg/L):			
Silver	NC	0.03	ND
Arsenic	NC	0.20	0.20
Barium	NC	0.35	0.29
Cadmium	NC	0.01	0.02
Chromium	NC	ND	ND
Lead	NC	ND	ND
Selenium	NC	ND	ND

NC = TCLP tests not conducted.

Microscopy and x-ray diffraction analyses were performed on feed soils <2 mm in diameter and after attrition and chemical extraction tests. The untreated soil particles (2- to 0.25-mm fraction) were angular and consisted of feldspars, quartz, basaltic hornblende, and mica. A noticeable feature is the yellow/orange coatings that are enriched in iron and whitish coatings consisting mainly of aluminum and silicon.

Attrition Scrubbing/Autogenous Grinding

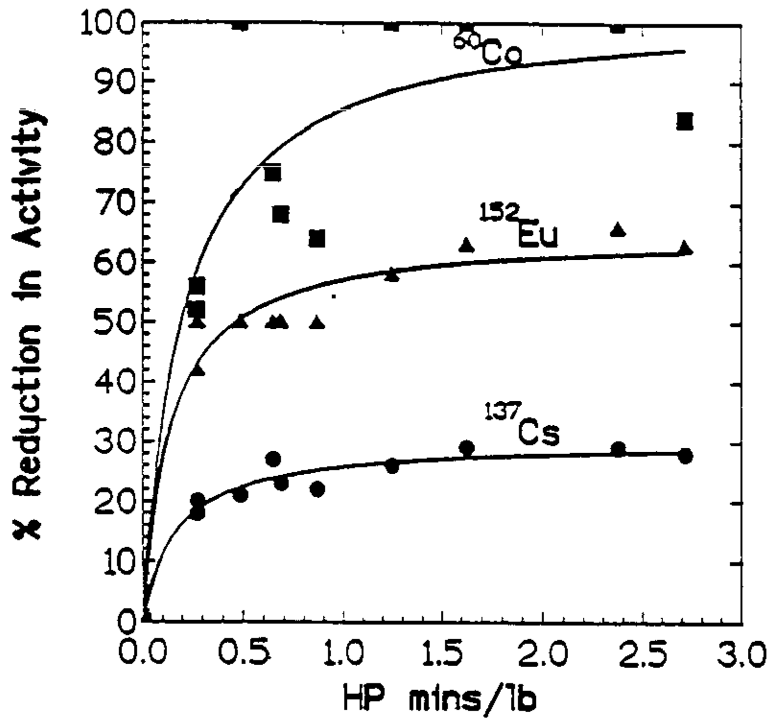
Results of attrition scrubbing tests are shown in Fig. 2. Impeller speed, and solids density were held constant whereas the time of scrubbing was adjusted for different tests. Soil particles <2 mm in diameter from 100-D Area were tested. It was found that the effectiveness of attrition initially increased with energy input, but then tended to level off. Up to 65% of ^{152}Eu and almost all ^{60}Co were removed by attrition, but only 29% of the ^{137}Cs.

Microscopic analyses showed that the iron and aluminum/silicon coatings were largely removed except in cracks or pits in the sand-sized particles. Angular corners of the sand were also removed and particles rounded creating an additional 2 to 5% of fine material.

Test results indicate that ^{152}Eu and ^{60}Co are tied up in the particle coating and, therefore, were reduced significantly. ^{137}Cs appears to be adsorbed to the surface of the particles themselves, and the 15 to 20% reduction in activity due to partial grinding and removal of mica from the particle matrices. It is well established that mica minerals have very high affinity for cesium and that cesium occupies high-energy interlayer sites in these minerals. X-ray diffraction analyses are in progress to further corroborate these observations/hypotheses.

Dry autogenous grinding was performed on gravel-size material. This may be required to remove fine soils and contaminants from larger particles in the field. Preliminary autogenous grinding data showed that after 1 hr of grinding low-activity rocks the activities of cesium, europium, and cobalt were reduced by 43, 44, and 8%, respectively, with 2% fines being generated during the grinding activity. Longer tests are being performed to assess whether additional grinding or higher energy input will further reduce contaminant concentrations. Wet autogenous grinding tests are also planned.

Figure 2. Attrition Scrubbing Test Results.



Chemical Extraction

Based on the results of sequential extraction tests, several chemical extractants were tested. Results are shown in Fig. 3. Compared to attrition scrubbing, chemical extraction was more effective in removing contaminants. Almost all of the ^{60}Co, >90% of the ^{152}Eu, and up to 40% of ^{137}Cs could be removed using a reductive extractant such as sodium dithionite and citric acid. Another extractant removed almost 70% of the ^{137}Cs present in the 2- to 0.25-mm fraction, but was less effective in removing ^{60}Co and ^{152}Eu. Most recently, a chemical extractant has been found to remove more than 80% of the ^{137}Cs activity. Combination tests will include this chemical and others in sequence with attrition scrubbing.

CONCLUSIONS

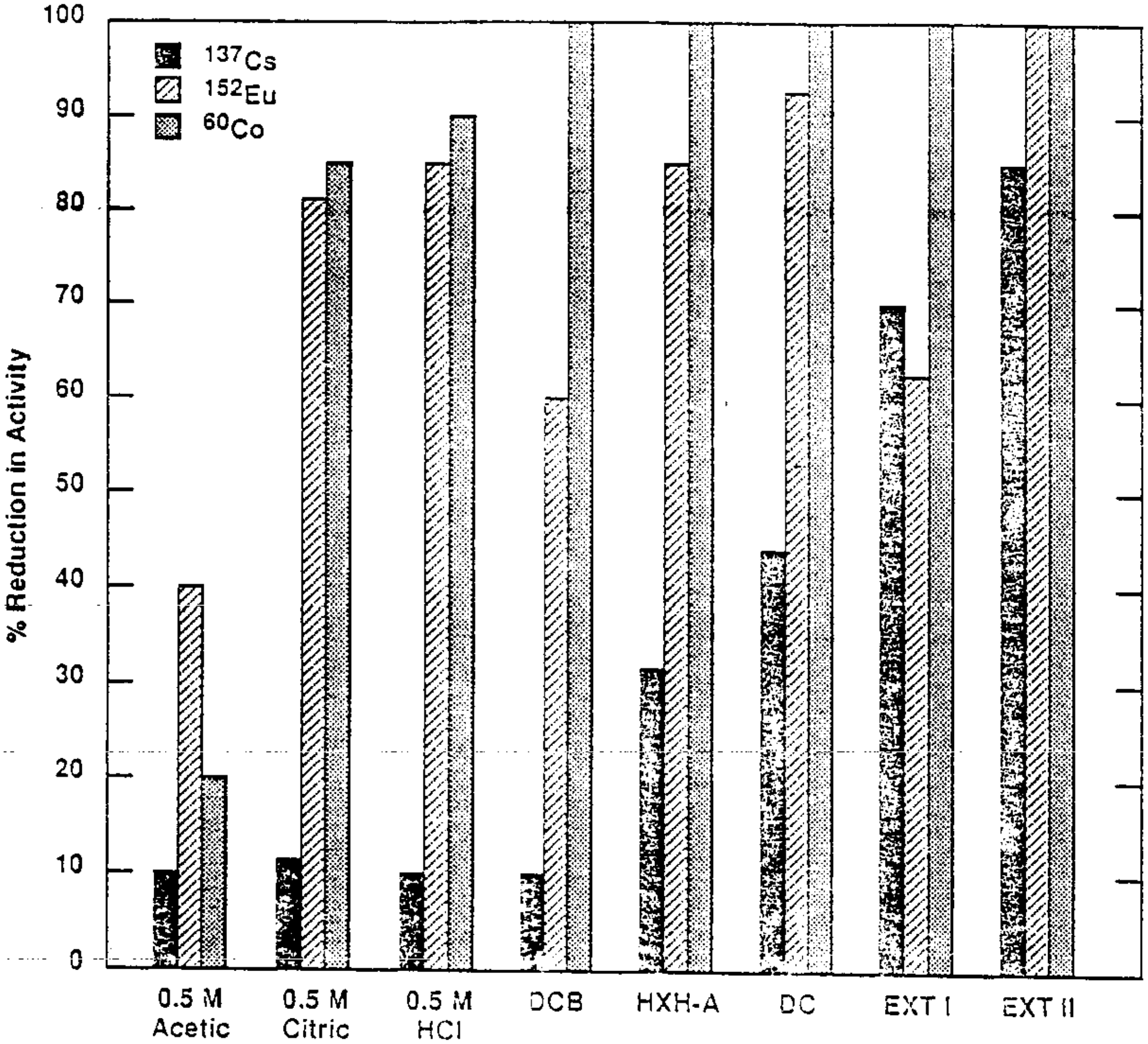
A great deal of new information has been obtained to further define and assess the feasibility of using soil washing as a volume reducing process for 100 Area waste sites. Additional tests are still in progress.

Preliminary indications show that proposed performance levels established for the test could be met at a cutpoint of 0.25 mm or less for low activity soils in the 100-D and most of the 100-B/C Area sites that were investigated. Applications to other sites and selection of a cutpoint will need to be assessed on a case-by-case basis, contingent on the distribution of soil particles and contaminants throughout the soil matrix.

For example, at the inlet end of the 100-B/C trench, a more coarse cutpoint could be made since 97% of these soil particles were >2mm, and it appears less likely at this time that soil washing will be effective in removing the higher radioactivity levels in particles between 0.25 and 2 mm.

In addition to assessing whether selected technologies meet cleanup levels, the benefit of soil washing versus costs involved must be assessed.

Figure 3. Chemical Extraction Test Results.



DCB: Sodium Dithionate, Citric Acid, and Sodium Bicarbonate
HXH-A: Hydroxyl Amine, Hydrochloride and Acetic Acid
DC: Citrate Dithionite, 75°C
EXT I, EXT II: Non-Toxic, Biodegradable, Organic Acids, 80°C

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Additional physical and chemical separation techniques to remove a higher percent of ^{137}Cs from coarse soil particles are being investigated as well as beginning testing using 100-F Area soils to assess volume reduction techniques for soils containing low levels of ^{90}Sr and $^{239/240}Pu$.

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