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REMEDIAL TECHNOLOGY AND CHARACTERIZATION AT THE SRS F/H RETENTION BASINS USING THE DOE SAFER METHODOLOGY (U)

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ABSTRACT

The Streamlined Approach For Environmental Restoration (SAFER) is a strategy used to accelerate and improve the environmental assessment and remediation of the F/H Retention Basins at the Savannah River Site (SRS). This strategy combines the data quality objectives (DQO) process and the observational approach to focus on data collection and converge on a remedial action early. This approach emphasizes stakeholder involvement throughout the Remedial Investigation/Feasibility Study (RI/FS) process.

The SAFER methodology is being applied to the characterization, technology development, and remediation tasks for the F/H Retention Basins. This "approach" was initiated in the scoping phase of these projects through the involvment of major stakeholders; Department of Energy (DOE)-Savannah River Field Office, DOE-Headquarters, Westinghouse Savannah River Company, United States Environmental Protection Agency (EPA) Region IV, and the state of South Carolina Department of Health and Environmental Control (SCDHEC), in the development of the Remedial Investigation (RI) workplans. A major activity that has been initiated is the development and implementation of a phase I workplan to identify preliminary contaminants of concern (pCOCs). A sampling plan was developed and approved by the major stakeholders for preliminary characterization of wastes remaining in the F/H Retention Basins. The involvement of stakeholders, development of a site conceptual model, development of remedial objectives for probable conditions, identification of the problem and reasonable deviations, and development of initial decision rules in the planning stages will ensure that preliminary data needs are identified and obtained prior to the initiation of the assessment and implementation phases of the projects resulting in the final remediation of the sites in an accelerated and more cost effective manner.

I. BACKGROUND

The F/H Retention Basins at SRS are open, unlined basins which provided temporary emergency storage for potentially contaminated cooling water from the chemical separations process. Upon indication of radioactivity, cooling water was diverted from surface drainage streams to the retention basins via underground pipelines. The F-Area Retention Basin includes approximately 1200 feet of pipeline while the H-Area Retention Basin includes only about 100 feet of pipeline.

During the holding period, seepage of cooling water into the ground occurred. Upon testing, process waters above release levels were processed by deionization to reduce contamination. Exact quantities of water disposed of in the retention basins are unknown.

II. F/H-AREA RETENTION BASIN HISTORY

The F-Area Retention Basin was used from 1955 to 1973. In 1978, soil cores were taken from the bottom of the basin. Primary radionuclides present in the soil cores were Cs-137 and Sr-89,90. Most of the Cs-137 was found at a depth of 0 to 45 cm, while most of the Sr-89,90 was found in the top half of the column. Maximum soil concentrations were 80,600 pCi/g of Cs-137 in a 15 to 30 cm depth segment and 15,400 pCi/g of Sr-89,90 in a 0 to 15 cm depth segment. In 1979, 970 cubic meters of soil were excavated and transported to the onsite disposal facility for low level radioactive waste with a calculated transferred inventory of 11.5 Ci of Cs-137 and 0.5 Ci of Sr-89,90. After excavation, additional soil cores were taken from the basin floor estimating the remaining radionuclide inventory at the F-Area Retention Basin to be 54 mCi of Cs-137 and 530 mCi of Sr-89,90. The basin was then backfilled with clean soil and seeded with grass.

The H-Area Retention Basin was used from 1955 to 1973. Soil cores taken from the basin in 1973 estimated the inventory for radionuclides at 0.35 to 0.5 Ci of Pu-238, 8.5 to 10 Ci of Cs-137, and 2.5 to 3.5 Ci of Sr-89,90. Radiation surveys of soil and vegetation around the basin were performed in 1977. Radiation levels were measured at levels up to 90 mrad/hr at 8 cm from the edge of the basin. Vegetation near the basin exhibited levels of Cs-137 at 8,200 to 8,900 pCi/g and Sr-89,90 at 58,000 pCi/g. Sediments outside and adjacent to the retention basin, covering an area of approximately 930 square meters, have shown levels of radioactivity. In 1979, soil was taken from the basin floor and moved to the sides of the basin. Standing water and soil samples were taken from the basin and analyzed prior to soil movement showing the water contained 0.8 pCi/ml of alpha emitters and 120 pCi/ml of Cs-137 and the soil contained alpha concentrations of 6,700 pCi/g and beta concentrations of 54,000 pCi/g. The H-Area Retention Basin is fenced, is identified as a radiologically controlled area, contains standing water, and is overgrown with vegetation. Sediments from the bottom of an adjacent basin are piled within the fenced area and are also included as part of this unit.

III. CHARACTERIZATION

Developing a technical team and holding periodic stakeholder meetings has resulted in the definition of decision rules and thresholds which are essential in the development of statistically defensible characterization plans. Since the process line at the F-Area Retention Basin is a major portion of the basin requiring investigation and due to its unique characteristics, it has been separated from the basin proper and is being developed with its own unique sampling and characterization strategy. Resulting from this effort is the use of robotics, fitted with a video camera and an alpha/beta detector, to investigate the process line utilizing a radioactive contamination screening tool along with direct push technology for a cost effective identification of areas where contamination has been released from the process line.

Basin history, process knowledge, and previous sampling all indicated the absence of metal and organic contaminants from the basins. However, this could not be supported at a sufficient quality level to focus strictly on radioisotopes during the characterization of the basins. As a result, with EPA and SCDHEC approval, a Phase I preliminary sampling event was conducted.

A. Phase I Investigation

The Phase I investigation was performed to identify the specific environmental contaminants at the F/H Retention Basins. Sample locations were identified because of their unique importance to each basin. Three soil samples were collected from the H-Area Retention Basin corresponding to the basin edge, basin overflow area, and a large soil pile within the waste unit area. Four soil samples were collected from the F-Area Retention Basin; one each from the basin inlet, basin outlet, basin overflow area, and along the process sewer line leading to the basin.

As expected, results of the Phase I sampling indicated radionuclides to be the only contaminants of concern (COCs) at each basin. At the F-Area Retention Basin cesium-137 and strontium-90 were detected in significant amounts (70-170 pCi/g) with other isotopes such as carbon-14, technetium-99 and tritium detected in smaller quantities. The H-Area Retention Basin showed significantly higher activity as well as a larger number of isotopes than the F-Area Retention Basin. Cesium 137 was measured at 33,000 pCi/g with several other isotopes including strontium-90, plutonium-238, and iodine-129 measuring above 100 pCi/g. In addition, analysis of the basin edge sample has been delayed due to its excessive activity. The COC list for the F/H Retention Basins is included as Tables 1 and 2.

Table 1
F-Area Retention Basin Chemicals of Concern [1]

Analyte	Concentration
Tc-99	1.6 pCi/g
Cs-137	70.0 pCi/g
Sr-90	170.0 pCi/g
C-14	1.3 pCi/g
H-3	22.0 pCi/g
K-40	1.8 pCi/g

Table 2
H-Area Retention Basin Chemicals of Concern [2]

Analyte	Concentration
K-40	5.6 pCi/g
I-129	180.0 pCi/g
Tc-99	56.0 pCi/g
Pu-239/240	12.0 pCi/g
Cm-245/246	0.1 pCi/g
Cs-137	33,000.0 pCi/g
Sr-90	7,700 pCi/g
Eu-154	33.0 pCi/g
Eu-152	47.0 pCi/g
Co-60	1.8 pCi/g
Pm-147	43.0 pCi/g
Na-22	10.0 pCi/g
C-14	0.79 pCi/g
Am-241	5.6 pCi/g
Pu-238	360.0 pCi/g
Cm-243/244	41.0 pCi/g

Under a prior agreement with the EPA and SCDHEC a list of COCs was developed to include only those analytes which were detected in Phase I sampling and which were detected above background or risk based action levels as determined from the RESRAD computer model. In this way the COC list for each basin was narrowed to only radionuclides. Future analysis at the basins will focus only on those contaminants identified as COCs.

B. Robotics Investigation of F Process Line

An additional preliminary investigation was performed at the F-Area Retention Basin process pipe line since it is a major portion of the basin and due to its unique characteristics. The pipe line was installed in 1955 and constructed of reenforced concrete. The purpose of the investigation was to identify areas of the pipe where leakage may have occurred or has the future potential to occur. Specific identification needs included areas of cracks, failures, joint separations, or contaminated sediment buildup. The pipe crawler was developed at the SRS by personnel at the Savannah River Technology Center.

This investigation consisted of visual inspection of the pipe interior through the use of a robotics pipe crawler. The crawler was equipped with a color video camera as well as two radiation detectors capable of measuring beta/gamma radiation on the pipe sides and bottom. In addition, the cable fed to the crawler was incremented in ten foot lengths to ensure accurate positioning should future soil sampling be required.

Results of the investigation indicated that the pipe has retained exceptional integrity. Only one area was identified to have a small crack running around the circumference of the pipe. In fact, sealant is still clearly visible at most joints. The investigation clearly shows the absence of structural problems with the pipe even at the point where it crosses underneath a site road. However, contaminated sediment has accumulated in at least one manhole estimated to be at a concentration of 9,000 pCi/g (a confirmatory sample will be obtained during the Phase II characterization). The radiation detectors also indicate contamination has been fixed on the concrete walls of the pipe.

C. Phase II RI Workplan Development

From the results of the Phase I sampling and in conjunction with preliminary remedial technology and alternative selection and development, a Phase II sampling plan was developed for each basin and the F Retention Basin process sewer line. The investigation plan focuses on obtaining data to fill critical data needs.

As throughout the SAFER process, sampling strategies, as well as detailed sampling plans were presented to the stakeholders. Agreement was reached on all issues of the investigation. The agreements reached at these meetings are currently being incorporated into the Phase II Remedial Investigation work plans for each basin. In addition, because of their involvement in each phase of the process, expedited regulatory approval for the remedial investigation is expected.

1. 281-3F Process Pipeline. Characterization of the process sewer line at the F-Area Retention Basin will focus on past and potential for future leakage from the pipe. One soil sample will be collected from the outside of each manhole (recognized as the weakest link along the pipe line) as well as areas where the pipe crawler has indicated cracks or leaks. In addition, a sediment/water sample will be collected from inside each manhole to assess internal contamination levels as well as give an indication of the potential for future release.

2. 281-3F Retention Basin. Preliminary remedial alternatives at the F-Area Retention Basin focus on containment of radionuclides within the present boundaries. As a result, the characterization sampling will focus on identification of the lateral boundaries of the contamination zone. Depth of contamination will also be determined and used to evaluate the proximity of the contamination zone to the water table. Finally, four ground water samples will be collected from the perimeter of the basin to validate the results of the RESRAD computer model.

3. 281-3H Retention Basin. Preliminary remedial alternatives at the H-Area Retention Basin focus on consolidation of contaminated soils into the basin followed by containment. As a result, the characterization sampling plan was developed to identify the volume and depth of contaminated material at the H Basin. Determination of volume is essential to confirm that all contaminated soil will fit into the basin before as well as after treatment. In addition, identification of contamination depth will ensure all affected soil will be treated during remediation. During the characterization phase, several samples will be obtained from the basin to be used in the treatability tests to ensure effective remedial alternative selection.

IV. TECHNOLOGY DEVELOPMENT

Preliminary screening of remedial technologies and alternatives has been completed for the F/H Retention Basins based on historical information such as soil borings for radioactive contamination, construction drawings of the basins and process lines, and preliminary contaminants of concern . Upon completion of the preliminary technology screening, major data requirements, limitations, preliminary cost estimates, major cost drivers, and potential graded responses for developed alternatives have been developed. This effort has proved to be effective in identifying cost drivers and in development of remediation units for comparison with the sampling plan to determine the level of detail required in delineating the extent of contamination.

A. Preliminary Technology Identification

Based on the identified chemicals of concern and the media of concern (soils/sediments for the F-Area Retention Basin and soils/sediments/groundwater for the H-Area Retention Basin) general response actions (GRAs), remedial technologies types (RTTs), and remedial process options (RPOs) were identified.

Preliminary technologies and process options were identified using available databases. Sources initially used for the identification of preliminary technologies included databases which identify technologies that are currently available (ReOpt 2.0 [3], ATTIC [4]), innovative treatment technologies (VISITT [5]), and key word search programs (Technology Needs Assessment Crosswalk Report [6]).

B. Preliminary Technology Screening

Based upon the effectiveness and implementability evaluations the remedial process options listed in Tables 3 and 4 have been retained for further evaluation. Due to the innovative nature of magnetic separation, this process option was retained until further evaluations could be performed. Specific process options and entire technology types were screened due to their long term effectiveness to protect human health and the environment, excessive maintenance, difficulty in implementation, and long term permanence. Tables 3 and 4 identify GRAs, RTTs, and RPOs that have been retained for further consideration in the development of preliminary alternatives.

C. Preliminary Alternative Development

Based on the preliminary technology screening summarized above, preliminary alternatives have been developed for the F-Area Process Pipeline, F-Area Retention Basin, and H-Area Retention Basin. Table 5 identifies the focused technologies for each of these units.

Of the focused technologies identified, selected technologies have been identified as requiring additional data for further consideration and development. These short list technologies have been identified in Table 6.

Table 3
281-3F Process Pipeline Retained Technologies

GRAs	RTTs	RPOs
No Action	No Action	No Action
Containment	Capping	Clay and Soil Asphalt/Pavement Concrete Multimedia
In Situ Treatment	Physical/ Chemical	Vitrification (ISV) Solidification/ Stabilization (S/S)
Ex Situ Treatment	Physical/ Chemical	Molten Solids Processing (MSP) S/S Soil Washing
Extract/Remove Collect (E/R/C)	Removal	Excavation
Disposal/ Discharge	SRS Disposal	Onsite Burial Grounds Saltstone
Residuals Management	Sludge	S/S Vitrification Onsite Disposal
	Water	Surface Discharge
	Offgas	Vitrification Ab/Adsorption Particulate Removal

Table 4
281-3F/281-3H Basin Retained Technologies

GRAs	RTTs	RPOs
No Action	No Action	No Action
Containment	Capping	Clay and Soil Asphalt/Pavement Concrete Multimedia
In Situ Treatment	Physical/ Chemical	ISV S/S
Ex Situ Treatment	Physical/ Chemical	MSP S/S Magnetic Separation Soil Washing
E/R/C	Removal	Excavation
Disposal/ Discharge	SRS Disposal	Onsite Burial Grounds Saltstone
Residuals Management	Sludge	S/S Vitrification Onsite Disposal
	Water	Surface Discharge
	Offgas	Vitrification Ab/Adsorption Particulate Removal

Table 5
Focused Technologies for the F/H Retention Basins

Focused Technology	281-3F Pipeline	281-3F Basin	281-3H Basin
No Action	X	X	X
Manhole Grouting	X		
In Situ S/S	X	X	X
Ex Situ S/S	X	X	X
ISV	X	X	X
MSP	X	X	X
Multimedia Cap	X	X	X
Disposal	X	X	X
Excavation	X	X	X
Slurry Wall			X

Table 6
Short List Technologies for the F/H Retention Basins

Short List Technology	281-3F Pipeline	281-3F Basin	281-3H Basin
No Action			
Manhole Grouting	X		
In Situ S/S			
Soil Mixing		X	X
Jet Grouting	X		
Ex Situ S/S	X	X	
ISV			X
MSP			
Multimedia Cap	X	X	X
Disposal	X	X	X
Excavation	X	X	X
Slurry Wall			X

D. Remedial Assessment of Alternative Short List

Optimum remediation volumes and rough fixed costs have been estimated to enable the development of a cost effective characterization strategy. Hydraulic conductivity, minimum remediation unit, and threshold for complete area remediation have been determined for each short list technology for each of the three waste units. This information is provided in Tables 7, 8, and 9.

E. Treatability Data Requirements

Since early efforts have been made to preliminarily identify and screen remedial technologies and alternatives during the scoping and characterization workplan phases, treatability data requirements have been identified for short list technologies and efforts have been made to embody the acquisition of this data with characterization workplan development and field activities. Maximizing the use of existing data within the areas of both waste sites, limiting data gathering within radiologically

Table 7
281-3F Pipeline Short List Remedial Assessment

Short List Technology	Hydraulic Conduct. (cm/sec)	Minimum Remedial Unit	% Remedial Threshold
No Action	10^{-4} to 10^{-6}	N/A	N/A
Cap			
Natural Clay	3×10^{-6}	0.5 ac	75
Tertiary Clay	10^{-7}	0.5 ac	75
Composite	10^{-12}	0.5 ac	75
Grout Manhole	10^{-7} to 10^{-8}	1 manhole	100
Insitu S/S	10^{-5} to 10^{-9}	1 cyd	100
ISV	10^{-7} to 10^{-11}	250 cyd	100
Exsitu S/S	10^{-5} to 10^{-9}	40	40
MSP	10^{-7} to 10^{-11}	40	40
Excavation	N/A	40	40

Table 8
281-3F Retention Basin Short List Remedial Assessment

Short List Technology	Hydraulic Conduct. (cm/sec)	Minimum Remedial Unit	% Remedial Threshold
No Action	10^{-4} to 10^{-6}	N/A	N/A
Cap			
Natural Clay	3×10^{-6}	0.5 ac	75
Tertiary Clay	10^{-7}	0.5 ac	75
Composite	10^{-12}	0.5 ac	75
Insitu S/S	10^{-5} to 10^{-9}	1 cyd	100
ISV	10^{-7} to 10^{-11}	265 cyd	100
Exsitu S/S	10^{-5} to 10^{-9}	10	100
MSP	10^{-7} to 10^{-11}	10	100
Excavation	N/A	10	100

Table 9
281-3H Retention Basin Short List Remedial Assessment

Short List Technology	Hydraulic Conduct. (cm/sec)	Minimum Remedial Unit	% Remedial Threshold
No Action	10^{-4} to 10^{-6}	N/A	N/A
Cap			
Natural Clay	3×10^{-6}	0.5 ac	75
Tertiary Clay	10^{-7}	0.5 ac	75
Composite	10^{-12}	0.5 ac	75
Insitu S/S	10^{-5} to 10^{-9}	8.5 cyd	100
ISV	10^{-7} to 10^{-11}	265 cyd	100
Exsitu S/S	10^{-5} to 10^{-9}	10	100
MSP	10^{-7} to 10^{-11}	10	100
Excavation	N/A	10	100

controlled areas, and centering data acquisition on short list remedial technologies and alternatives have been made to streamline technology development.

Additional sampling points, data requirements, and engineering parameters for each viable technology have been determined for the 281-3F Process Pipeline, 281-3F Basin, and 281-3H Basin.

1. 281-3F Process Pipeline. General engineering data requirements include topography, contaminant characteristics, areal/vertical extent of contamination, contaminant profile, depth to groundwater, location of underground/surface structures, and contaminant leachability. A lithological description of the pipeline area is proposed to be obtained through the use of three piezicones to a depth of thirty feet. This in addition to physical characteristics of the soils will support development of jet grouting and multimedia capping technologies.

2. 281-3F Retention Basin. General engineering data requirements are consistent with the 281-3F process Pipeline. A determination of the physical characteristics of the soil in addition to lithologic information is required to support the development of soil mixing and multimedia capping technologies. This is proposed to be accomplished through the use of four continuous cores, two within the basin to ten feet in depth and two outside the basin to thirty feet in depth. Specific engineering data requirements include soils classification, atterberg limits, permeability, bulk density, moisture content, specific gravity, grain size analysis, water retention drainage curves, and exchanagable acidity.

3. 281-3H Retention Basin. General engineering data requirements are consistent with the 281-3F process Pipeline. Existing data exists to support the development of soil mixing and multimedia capping technologies. Additional data is required for these two technologies in addition to vitrification. Soil mixing data requirements include lithologic and stratigraphic data from four existing cores to the west and east of 281-3H and from four additional continuous cores outside of the basin area to a depth of thirty feet. Additive selection and determination of optimum admixture ratio for soil mixing will be supported through testing on three samples, a composite in the overflow area to a depth of five feet, a split spoon sample from the basin bottom to a depth of four feet, and from a clean composite sample from the treatment zone of one of the continuous cores identified. Specific engineering requirements are consistent with the 281-3F Retention Basin . The use of x-ray florescence to determine the presence and concentrations of oxides, which may enhance ISV, in basin sediments is also being explored.

V. CONCLUSIONS

Streamlined planning requires a shift from normal operating procedures of developing regulatory documents without regulatory input and then transmitting them to the regulatory agencies for review, comment, and approval. Following the SAFER process involved real time input from key stakeholders in the development of sampling strategies and in the preliminary screening of remedial technologies and alternatives. This working environment has saved valuable time in the creation and understanding of final sampling plans, focused technologies, and treatability testing data requirements. Use of this process on the F/H Retention Basins has improved the focus of planning and scoping, linked decision making needs directly to data collection, and involved early stakeholders participation in decision making.

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