

OPERATIONAL IMPLEMENTATION OF THE MARSSIM PROCESS AT THE WAYNE INTERIM STORAGE SITE

D.C. Hays, Jr.

WISS FUSRAP Team – United States Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue, Tulsa, OK 74128

P.A. Trujillo, IV, S.G. Zoller

WISS FUSRAP Team – Environmental Chemical Corporation
999 18th Street, Suite 2350, Denver, CO 80202

ABSTRACT

This paper describes the methodologies behind the operational implementation of the Multi Agency Radiation Site Survey and Investigation Manual (MARSSIM) process at the Wayne Interim Storage Site (WISS). The United States Army Corps of Engineers (USACE) and Environmental Chemical Corporation (ECC) have implemented the MARSSIM process using various surveys producing raw data. The final remedial status of a survey unit is derived through data reduction, while maintaining a high degree of efficiency in the construction aspects of the remedial action. Data reduction of field measurements is accomplished by merging the data outputs of a Digital Global Positioning System, an exposure rate meter, and laboratory analyses to produce maps which present exposure rates, elevations, survey unit boundaries, direct measurement locations, and sampling locations on a single map. The map serves as a data-posting plot and allows the project team to easily judge the survey unit's remedial status. The operational implementation of the MARSSIM process has been successful in determining the eligibility of survey units for final status surveys at the WISS and also in demonstrating final status radiological and chemical conditions while maintaining an efficient remedial action effort.

INTRODUCTION

The United States Army Corps of Engineers (USACE) administers and executes the Formally Utilized Sites Remedial Action Program (FUSRAP) under a Congressional mandate. The FUSRAP program currently encompasses 46 sites in 14 states. These sites are in various stages of closure, from site identification to past site closure. The Wayne Interim Storage Site (WISS) is included in the FUSRAP program.

Location

The 6.4-acre WISS Site is located in Wayne Township, Passaic County, New Jersey. The Site is located in a highly developed area of northern New Jersey, approximately 20 miles north-northwest of Newark, New Jersey, and approximately 36 miles northwest of New York City, New York. Contamination of the Site and several vicinity properties originated from the processing of monazite sand to extract thorium and rare earth metals from 1948 to 1971. During this time, some process wastes from the thorium operations were buried on the Site.

An active agricultural area is located 200 feet from the site, and residential homes are located directly north and east of the site. Many commercial businesses lie within three miles of the site. Residences within three miles of the site rely on groundwater from the lower aquifer for drinking, and water from the upper aquifer for household and irrigation purposes. The municipal well system serves 51,000 people, and the nearest well is 3,200 feet from the site. Local surface water is used for recreation.

Contaminants

The primary radiological contaminants at WISS are radium (Ra)-226, thorium (Th)-232, and uranium (U)-238. The primary metallic contaminants are antimony, arsenic, chromium, lead, molybdenum, thallium, and mercury. Ra-226 has been detected with a maximum concentration 8,805 picoCuries/gram (pCi/g).

Th-232 has been detected with a maximum concentration 9,246 pCi/g. Uranium is present in the subsurface materials at concentrations less than those of Th-232 and Ra-226. Other radionuclides present in the subsurface material are typically decay progeny of Th-232 and U-238.

Regulatory Status and Removal Actions

In 1948, Rare Earths, Inc. began processing monazite sand at WISS to extract thorium and rare earths. The Davidson Chemical Division of W.R. Grace and Company acquired the facility in 1957. The property immediately to the south of the W.R. Grace site was leased by W.R. Grace for occasional storage of monazite sand and was later sold for use as a school bus maintenance facility. Processing continued at the W.R. Grace facility until 1971 when the plant was closed. Applied Health Physics, Inc., decontaminated the buildings in 1974, and the property was released by the Nuclear Regulatory Commission (NRC) in 1975, provided that the deed indicate the presence of radioactive material under the facility's surface (1).

In 1980, the New Jersey Department of Environmental Protection (NJDEP) requested that an aerial survey be conducted over the former W.R. Grace facility to determine the radiological conditions. This survey was conducted by EG&G in 1981 (2). The NRC Division of Fuel Cycle and Material Safety requested walkover surveys of the former W.R. Grace facility and the property immediately south. The Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU) performed this survey in 1982(3). A similar survey was performed by NJDEP in 1982 (4). Both the NJDEP and ORAU surveys indicated surface radionuclide concentrations in excess of those acceptable under the United State Department of Energy (USDOE) remedial action guidelines.

Under the Energy and Water Appropriations Act of fiscal year 1984, Congress directed the USDOE to initiate a research and development decontamination project for the former W.R. Grace facility and vicinity properties in the Townships of Wayne and Pequannock. These properties were assigned by the USDOE to FUSRAP, and in 1984, the USDOE acquired the property from W.R. Grace and Company. FUSRAP is a USDOE effort to identify, decontaminate, or otherwise control sites where low-level radioactive contamination remains from either the early days of nation's atomic energy program or commercial operations causing conditions that Congress mandated the USDOE to remedy.

The Environmental Protection Agency (EPA) amended the NPL on September 21, 1984, to include the Wayne Interim Storage Site. 49 FR 37070. The revision to the NPL listed WISS as *W.R. Grace & Co (Wayne Plant)*, with a hazard ranking system score of 200. 49 FR 37070, 37083.

From 1985 to 1987, the USDOE, acting under its authority through the 1984 Energy and Water Appropriations Act, investigated and removed contaminated soils from the school bus maintenance facility, Township Park, and the banks of the Sheffield Brook. This material, approximately 38,500 cubic yards (yd³) was stockpiled at the former W.R. Grace facility, which then became known as the Wayne Interim Storage Site.

The USDOE and the EPA signed a Federal Facility Agreement that established the cleanup responsibilities for each agency under the National Contingency Plan in 1991. The USDOE cleanup activities were completed in 1993 at a railroad spur where monazite sands ore was offloaded prior to processing. These activities were conducted under an Engineering Evaluation/Cost Assessment (EE/CA) that under went public comment and revision. (5). The USDOE issued a certification docket for the projects following successful remediation of the vicinity properties. (6).

The USDOE released a final EE/CA for a non-time critical removal of the storage pile in 1995 (7). The storage pile contained contaminated soils and debris generated from previous removal actions. Removal of the pile commenced in 1995 and was completed in 1997.

The Energy and Water Appropriations Act of fiscal year 1998 provided appropriations for the USACE to administer and execute the USDOE's FUSRAP program. Responsibility for the cleanup of WISS was then transferred to the USACE in October 1997. An Interagency agreement between USACE and the EPA

WM'02 Conference, February 24-28, 2002, Tucson, AZ

dated March 1998, outline's the USACE's responsibilities for WISS and EPA's oversight role for the remedial action process.

In November 1997, the USACE issued an EE/CA to remove 40,000 yd³ of subsurface contamination (8). USACE awarded a contract to Environmental Chemical Corporation (ECC) to complete the EE/CA and perform the remaining remediation of the site. The subsurface EE/CA removal action was completed in 1999.

A feasibility study and proposed plan evaluating cleanup alternatives were released to the public in June 1999. The Record of Decision (ROD) identifying "Excavation to Residential Use and Disposal" was signed on May 15, 2000 (9).

The ROD for WISS lists soil cleanup criteria that are based on acceptable dose equivalent limits. The soil cleanup criteria is an average combined concentration of 5 pCi/g of Ra-226 and Th-232 above naturally occurring background, and an average concentration of 100 pCi/g of total uranium above naturally occurring background. The ROD also lists metal contaminants of concern, along with metals concentrations calculated to be protective of groundwater or protective for unrestricted use of the property. Remediating the site to these levels meets the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risk threshold criteria and the requirements of 10 Code of Federal Regulations (CFR) 20.1402.

ECC excavated and transported off-site for disposal, an additional 10,500 yd³ of buried contaminated materials in the year 2000 under an Interim Soil Remediation Work Plan. ECC also transported for off-site disposal 400 yd³ of debris from the demolition of the site operations building in 2000.

Execution of the Remedial Design and Implementation Plan occurred in 2001. ECC excavated and transported 13,000 yd³ of waste and debris by June 2001. ECC performed Final Status Surveys of the first survey units and backfill of WISS commenced on 04/17/01.

MARSSIM PROCESS

The Multi-Agency Radiation Survey and the Site Investigation Manual (MARSSIM) presents a nationally consistent consensus approach to conducting radiation surveys and investigations at potentially contaminated sites. The MARSSIM major components are summarized below:

- Perform a Historical Site Assessment and determine whether areas are impacted or non-impacted;
- Establish Background Reference Area and background values;
- Establish proposed Derived Concentration Guidelines (DCGLs) for a wide area (DCGL_w) and elevated measurement comparison (DCGL_{EMC});
- Initially classify areas according to the MARSSIM;
- Conduct a Scoping Survey and review the classification of each area;
- Conduct a Characterization Survey and review the classification of each area;
- Determine areas requiring cleanup and determine cleanup alternatives;
- Perform cleanup;
- Conduct cleanup action support surveys;
- Review data and establish final classifications for each area;
- Establish survey units and perform Final Status Survey (FSS); and
- Document the results in the FSS Report

The USDOE and the USACE prior to the ROD signature conducted the first components of the MARSSIM process. The latter stages of the MARSSIM process required interagency and public approvals prior to implementation.

One objective set forth in the ROD is to release the WISS for unrestricted use. MARSSIM defines a *survey unit* as “a geographical area of specified size and shape for which a separate decision will be made whether or not that area meets the release criteria”. This decision is made following a Final Status Survey (FSS) of the survey unit. Thus, a survey unit is an area for which a FSS is designed and conducted; data is evaluated; and, ultimately, results in a release decision. The FSS obtains data required for making the unrestricted release decision, while avoiding the collection and analysis of an excess number of samples.

Usually, one of the following two conditions will lead to the determination that a particular survey unit requires further cleanup prior to being released for unrestricted use:

- If the average level of residual radioactivity within the survey unit exceeds the cleanup criteria, or
- If there are small areas within the survey unit with elevated residual radioactivity that exceed the cleanup criteria.

The sampling of discrete points within the survey unit will address the first condition (i.e., relatively uniform contamination). As used here, the term sampling refers to obtaining data from a subset of a population. Sampling includes both direct insitu measurements and the collection of physical samples for laboratory analysis.

Sampling at discrete points within a survey unit may not be an efficient method of determining whether the second condition exists. Generally, scanning is not as sensitive as sampling; it is however, the preferred method for detecting isolated areas of elevated activity.

A major component of survey designs is the efficient use of sampling at distinct locations combined with scanning to accurately determine the final status of a survey unit. Statistical procedures are used to establish the number of samples taken at distinct locations needed to determine if the average concentration in the survey unit exceeds the regulatory limit, with a specified degree of precision.

The survey and sampling approach for WISS described below encompass both sampling at discrete points and scanning of the excavation. In this manner, both the average concentration and elevated areas of residual radioactive material exceeding the cleanup criteria are addressed.

SURVEY UNIT CLASSIFICATION

Information gathered in previous investigations at WISS was used to initially classify the site as impacted or non-impacted. According to MARSSIM, impacted areas have a potential for radioactive contamination (based on historical data) or contain known radioactive contamination (based on past or preliminary radiological surveillance). This includes areas where:

- Radioactive materials were used and stored;
- Records of spills, discharges, or other unusual occurrences resulting in the spread of contamination; and
- Radioactive material was buried or disposed.

Areas immediately surrounding or adjacent to these locations are included in this classification due to the potential for the inadvertent spread of contamination.

Non-impacted areas are those areas identified through knowledge of site history or previous survey information where there is no reasonable possibility for residual radioactive contamination. The criteria used for this segregation need not be as strict as those used to demonstrate final compliance with site cleanup criteria.

Areas with the potential for residual contamination (impacted areas) are further divided into one of three groups, as defined by MARSSIM:

WM'02 Conference, February 24-28, 2002, Tucson, AZ

Class 1 Areas - Areas that have, or had prior to remediation, a potential for radioactive contamination based on site operating history or known contamination based on previous radiological surveys. Examples of Class 1 areas include:

- Site areas previously subjected to remedial actions;
- Locations where leaks or spills are known to have occurred;
- Former burial or disposal sites;
- Waste storage sites; and
- Areas with contaminants in discrete solid pieces of material high specific activity.

MARSSIM recommends Class 1 survey units to be less than 2000 meters squared (m^2) and surface scans over 100 percent (%) of the area.

Class 2 Areas - These areas have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_w$. To justify changing an area's classification from Class 1 to Class 2, the existing data (from the HSA, scoping surveys, or characterization surveys) should provide a degree of confidence that no individual measurement would exceed the $DCGL_w$. Other justifications for this change in an area's classification may be appropriate based on the outcome of the DQO process. Examples of areas that might be classified as Class 2 for the FSS include:

- Locations where radioactive materials were present in an unsealed form (e.g. process facilities);
- Potentially contaminated transport routes;
- Areas downwind from stack release points;
- Upper walls and ceilings of some buildings or rooms subjected to airborne radioactivity; and
- Areas on the perimeter of former contamination control areas.

MARSSIM recommends Class 2 survey units to be between 2000 and 10,000 m^2 and surface scans over 10 to 100 % of the area.

Class 3 Areas - Impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_w$, based on site operating history and previous radiological surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification.

The entire WISS property is designated a Class 1 Area as a conservative measure. The WISS property is approximately 26,000 m^2 . The area known to be impacted by site operations is approximately 70% of the site, or approximately 18,000 m^2 . Locations of areas that exceed the cleanup criteria are presented in the WISS ROD.

SURVEY UNIT DELINEATION

For operational implementation of the MARSSIM process, numbered 10-meter (m) by 10 m grids were overlaid onto the site. The numbered grids allow greater communications between technicians, management, and off-site personnel regarding unit status and operational considerations. The grids also ease the computations in estimating initial survey unit size. The grids correspond to a State plane north and east's coordinates and are skewed 55.4 degrees from the true State north.

Multiple operational issues were considered in the design of survey units. The survey units must have a remediated ten-meter buffer area around the entire survey unit in order for the unit to have a FSS performed. A berm is constructed along the perimeter of the buffer area to prevent contaminated surface water from entering the clean survey unit. Survey units must be less than 2000 m^2 . Survey units included excavation slopes of up to 25 feet, requiring physical measurements and reconfiguration. Survey units must also be designed to allow access and continuous movement of backfill trucks.

Survey units were also designed to reduce costs. The physical size of the survey unit must be optimized to minimize costs associated with additional sampling and analysis of FSS samples. Both the upper and lower aquifers at WISS are actively dewatered 24 hours a day to allow excavation of the northern portion of the site. A multi-phased approach is being considered to the shut down of the dewatering system, as northern most survey units are released and backfilled, associated well groups will be deactivated. The thrust of this effort will ultimately eliminate the need for 24-hour continuous water treatment, health and safety, health physics, and operator coverage.

The survey units must also consider construction needs. To enable excavation activities to extend to the southern boundary of the site, a sheet pile structure was designed and installed to protect the integrity of private property south of the site. The sheet piling was designed to be continuous along the southern boundary of the site within the area of anticipated excavation. Due to the potential for artesian pressures in the underlying confined aquifer, careful design was required to ensure that sheets did not fully penetrate the underlying confining clay layer above the confined aquifer. In the same way, it was imperative that the sheets are embedded within the clay layer to ensure that contaminated water did not migrate to the south in the soil above the clay layer. Shoring was installed in a series of interlocking, grade 50 steel plate sheet piling to the design depth ranging from 15 to 25 feet below the ground surface for a distance of 215 feet. In order for the shoring to retain structural integrity, a soil block of 20 ft long by 5 ft deep must be present at the base of the shoring. Southern boundary survey units had to consider the possibility of performing FSS surveys on the southern boundary 20-m at a time, and allowing backfill to commence prior to excavation of the next survey unit.

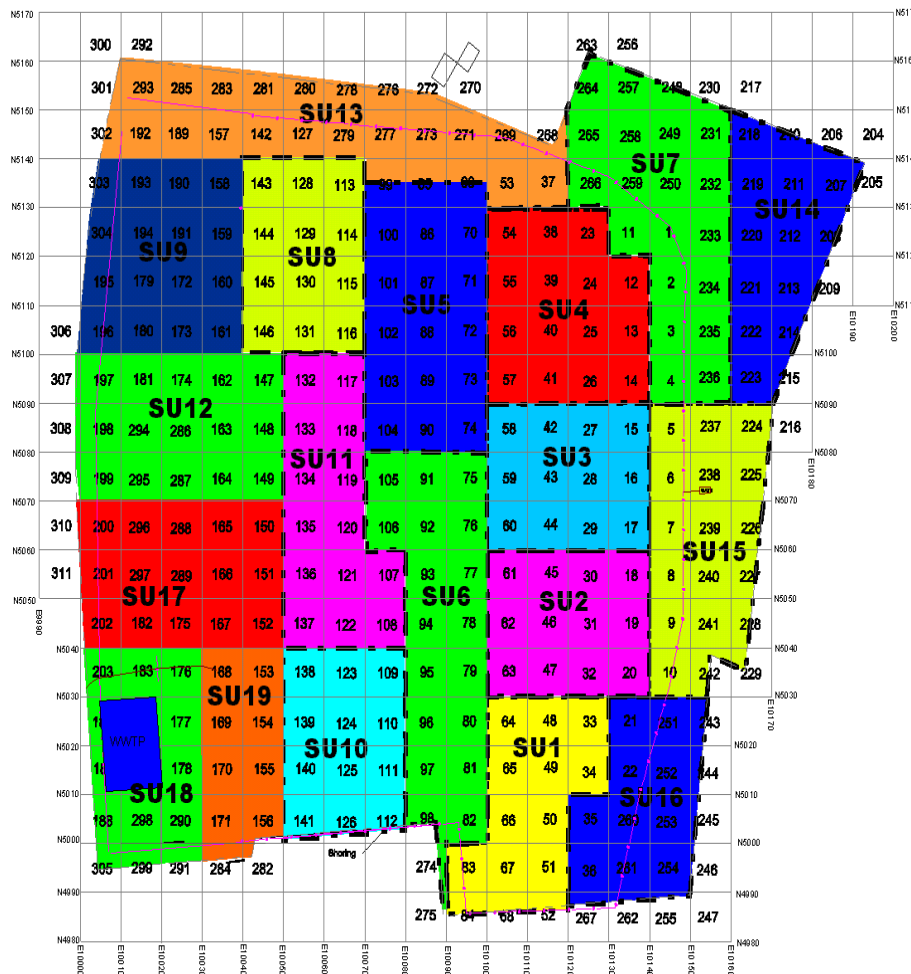


Fig. 1. WISS GRID MAP WITH SURVEY UNITS

ECC also owns and operates a wastewater treatment plant for treatment of water which comes into contact with the excavation. The plant consists of a semi-ridged structure, which contains an inclined plate clarifier, ion-exchange vessels, various filters and pumps. The preprocessed and treated water is contained in a series of nine 20,000-gallon tanks. The tanks and the wastewater treatment plant lie on the southeastern portion of the site on approximately 3,500 m² of contaminated soil. This area is scheduled to be the last excavation of the site. Collection sumps in which contact water is pumped from the excavation are also necessary for the operation of the plant. The design of the survey units for the majority of the site included considerations for both the dismantlement of the treatment plant and the movement and remediation of collection sumps.

EXPOSURE RATE TO ACTIVITY CONCENTRATION CORRELATION

In order to effectively implement the MARSSIM process, a correlation between exposure rate in microRoentgens per hour (uR/hr) and activity concentration in pCi/g was established. Failure in the correlation would result in additional excavation, walkover surveys, resampling, and analysis of areas.

In the early stages of the execution of the Remedial Design and Implementation Plan, the correlation was investigated. The contaminated soils at WISS have relatively stable ratios of contaminants. This is particularly true of soils at activities at or near the ROD cleanup criteria. The activity ratio of Th-232 to Ra-226 is typically 3 to 1. A varying ratio of activities would result in differing exposure rates for the same activities of soil since Th-232 and Ra-226 produce different exposure rates per pCi. The relatively constant ratio present at WISS allows for the use of a correlation throughout the entire site.

The initial correlation-sampling event occurred in early 2001. Thirty-five sample locations were selected placing an emphasis in areas where subsurface contamination was thought not to be present. The locations also emphasized areas of the site where activity concentrations were thought to range from 2 to 15 pCi/g combined Ra-226 and Th-232.

At each sampling location, contact and one-meter exposure rates were collected. Soil samples were collected to a depth of 15 cm after the exposure rate measurements. The soil samples were then sent to the on-site laboratory and analyzed for Ra-226 and Th-232 via gamma spectroscopy. Sample results and exposure rates from each sampling location were then compiled and regression analysis performed. The regression analysis indicated that soils with a uniform activity of 5 pCi/g of Ra-226 and Th-232 above background combined would yield an exposure rate of 75 uR/hr, including background. This exposure rate was used as an initial action level for the decision to proceed with FSS at WISS. The FSS samples from the initial survey units had activities of Th-232 and Ra-226 combined averaging 2.6 pCi/g with a maximum of 7.57 pCi/g combined.

It was known throughout the team that the correlation may need to be adjusted and rework in the initial survey units may be needed. The correlation was adjusted after the initial survey units in response to two main components. The influence from gamma fields of source material adjacent to measurement location (shine) and the correlation lacked a site specific in-growth factor for radon-222. The on-site laboratory developed an in-growth factor for on-site analysis of Ra-226 in soils. The correlation sampling and analysis was performed prior to the development of the radon in-growth factor, and did not incorporate the factor for the results. The radon and shine corrected correlation factor is a variable of 25 – 75 uR/hr.

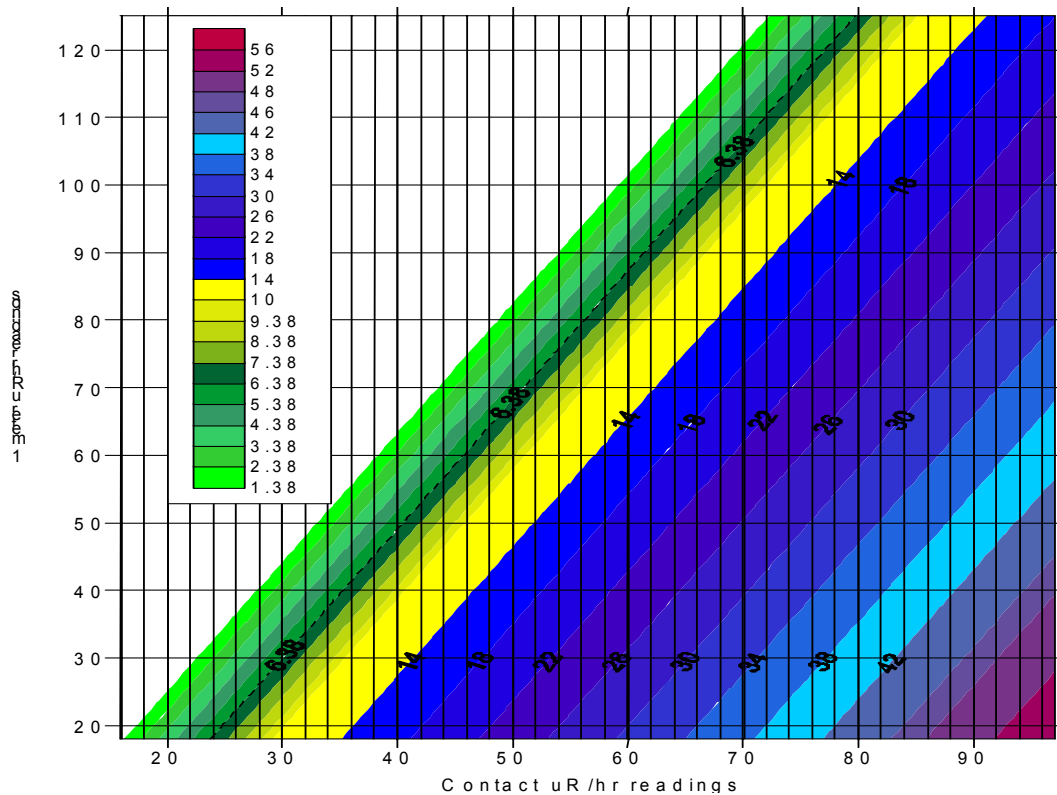


Fig. 2. WISS IN SITU RADIUM & THORIUM COMBINED TO MICRO-ROENTGENS PER HOUR

This action level has proven effective in the remediation of WISS. As of November 2001, a total of 239 FSS samples have been taken indicating an average of 1.98 pCi/g and a standard deviation of 0.83 pCi/g.

The correlation along with the scanning methodology also proves effective in guiding the excavation and continuing production rates. The use of the correlation prevents heavy equipment from tracking through previously cleaned areas. This allows the excavator to track materials from one side of the excavation to the other, without having to re-enter the survey unit. The excavation proceeds in a serpentine pattern throughout the site. When one survey unit is ready for fine cleaning, bulk removal from the next survey unit is performed. This reduces heavy equipment down time in which an excavator and operator are waiting in a survey unit for scanning and sample results. Production rates have not dropped significantly since the execution of the Remedial Design and Implementation Plan (RDIP). Daily soil shipping rates for the RDIP phase of the project are 304 tons per day. In comparison, tonnage rates from the EE/CA and the Interim Soil Remedial Work Plan removals, which did not include FSS surveys, were 309 and 208 tons per day, respectively.

SCANNING METHODOLOGY

The soil sampling program for remedial activities at the WISS consists of Cell Characterization Surveys (CCS), Remedial Action Support Surveys (RASS), and Final Status Surveys (FSS). The purpose of the CCS is to determine residual radiological concentrations present in soil that is to be either excavated or made available for the RASS. The CCS is a reasonable method of characterization that determines if a volume of soil meets or exceeds the radiological DCGLs. The primary objective is to determine the nature and extent of residual radioactive contamination and to generate data for latter consideration during the

RASS and the FSS. However, if analytical results are greater than the DCGL, the primary use of the data collected during the CCS is for verification of previous subsurface characterization data, determination of waste packaging and transportation requirements, and to ensure that the excavated material meets the designated off-site disposal facility Waste Acceptance Criteria. Excavated material from grid(s) is stockpiled in preparation for packaging.

The design of the CCS is based on the specific data quality requirements for transportation and disposal of the excavated material and the exigent demands of the RASS and FSS. The CSS provides information on variations in the contaminant distribution in an area. If the data acquired from the CCS indicates the radioactive activity is above the radiological DCGLs, the soil will be removed from the grids to the predetermined depth, and stockpiled for shipment. If the data acquired during the CCS indicate that the residual radioactive contamination present within a grid(s) is at or below the radiological DCGLs, the grids may become eligible for a RASS.

Remedial Action Support Surveys are performed when analytical results from the CCS indicate that residual radiological concentrations in grids are at or below the radiological DCGLs. The RASS will be performed to investigate whether the DCGL_w was exceeded, and if so, the surface area and concentration of the exceedance. The entire survey unit is surveyed with a two inch by two inch sodium iodide (NaI) detector coupled to a ratemeter/scaler. Results of these surveys will be used to determine if further excavation is required or if the grids are eligible for a FSS.

Additional soil sampling during the RASS was performed if determined necessary by survey personnel. Examples of when additional soil sampling is conducted are:

- If the RASS indicates additional excavation is required but CCS samples in close proximity to elevated gamma readings indicate the cell is ready for FSS; or
- If an adjacent grid requires remediation but no CCS samples (in the current grid) were collected near that grid (grid requiring remediation) and the RASS shows the current grid to pass.

Additional remediation may be performed if an area of residual radioactive material is detected above the DCGL_w. If further excavation is required in an area that is at or below the clay layer, additional excavation options will be evaluated. The elevated area will be flagged on an excavation map if further remediation is not feasible. The flagged area is then sampled to a depth of 15 cm to determine the average concentration of the residual contamination. The Project Health Physicist estimates and documents the surface area of the elevated location. A comprehensive appraisal of the impact of the area of elevated contamination is completed during the FSS phase.

A Final Status Survey (FSS) is performed only after the RASS indicates that an area is available for verification sampling to demonstrate compliance to the cleanup criteria. A surface scan is performed that effectively detects residual contamination at levels at least 50% of the radiological DCGL. The scanning also permits the surveyor to identify elevated areas of contamination that may be present in a survey unit. The PHP evaluates areas of elevated contamination according to the Elevated Measurement Comparison (EMC) procedures in MARSSIM. Soil sampling is performed once the scanning survey has been completed and documented.

The RASS and FSS surveys are both performed using a two by two-inch NaI detector and a Digital Global Positioning System (DGPS) unit. The data obtained from the DGPS is used to correlate exposure rate, radiological, and chemical sampling data to a physical location at WISS. The use of the DGPS allows for documented readings within 3 feet of the true coordinates. Survey teams typically consist of two technicians. One technician operates the DGPS, and the other scans the surface soils. The scan is performed approximately 5 cm from the ground surface. The use of the DGPS system allows the team to collect gamma measurements in multiple forms such as counts per second, uR/hr, or an integrated dose. The system also allows documentation of readings within a

three-foot radius in multiple coordinate systems, such as; UTM, 1927 and 1983 state plane coordinates. Further, these coordinate systems can be integrated with previously existing and / or site specific grid systems.

The scanning methodology has identified localized hotspots smaller than six inches in diameter. For instance, two boreholes have been found in the excavation. Each borehole was six inches in diameter and filled with waste. The borings appeared to have originated from the original processing of the monazite sands. The borings reached a depth of approximately 30 feet below ground surface and terminated in bedrock. The borings were discovered in the RASS surveys and were remediated using hand tools and pumps.

DATA REDUCTION AND PRESENTATION

Data reduction of field measurements is accomplished by merging the data outputs of the DGPS, the scaler, laboratory analyses, and CAD drawings produced by civil surveyors to produce maps which present exposure rates, elevations, survey unit boundaries, direct measurement locations, and sampling locations on a single map.

The data reduction process involved the decoding and filtering the data from; the scaler, the DGPS, and the laboratory results in a series of database tables to be processed by the geostatistical program employed by the WISS project team. The data were processed using the geostatistical methodology known as kriging. Kriging is a gridding methodology with the capability to produce visually appealing maps from irregularly spaced data. Kriging attempts to express trends within a given data set.

The data reduction process involves the generation of multiple kriged maps utilizing a unified coordinate system. In the case of the WISS, the pre-remedial CAD maps of the site were generated using the 1927 state plane of New Jersey. This coordinate system was employed throughout the data generation process. The data reduction and compilation requires the following data plots to be created:

- The conversion of the WISS specific grid intersection “construction grid blocks” to 1927 state plane coordinates.
- The conversion of the DGPS and gamma measurement coordinates in to 1927 state plane coordinates after which time the data were then used to create a kriged map.
- The conversion of the DGPS coordinates and elevations in to 1927 state plane coordinates after which time the data were then used to create a kriged map.
- The conversion of the DGPS coordinates and elevations of the soil sample locations in to 1927 state plane coordinates after which time the data were then used to create a plot map.
- The four preceding maps were then merged with the CAD map of the WISS to create a single map.

The resulting maps produced were then combined with scaled CADD maps of the site. The map serves as a data-posting plot and allows the project team to easily judge the survey unit’s remedial status.

REFERENCES

1. Bechtel National, Inc. Post Remedial Action Report for the Wayne Site – 1986, DOE/OR/20722-142, Oak Ridge, TN, April 1987.
2. McCloskey, M. Health Physics Report for W.R. Grace and Co., Wayne, New Jersey, Applied Health Physics, Bethel Park, PA, June 1984.
3. EG&G Energy Measurement Group. An Aerial Radiological Survey of the W.R. Grace Property, Wayne Township, New Jersey, EG&G Survey Report NRC-8113, November 1981.
4. Oak Ridge Associated Universities. Radiological Survey of the W.R. Grace Property, Wayne, New Jersey, Oak Ridge, TN, January 1983.
5. United States Department of Energy. Engineering Evaluation/Cost Analysis for the Proposed Removal of Contaminated Materials from Vicinity Properties at the Wayne Site, Wayne and Pequannock Townships, New Jersey, 1993.
6. United States Department of Energy. Certification Docket for the Remedial Action Performed at the Wayne Site Vicinity Properties in Wayne, New Jersey, 1993. Department of Energy, Former Sites Restoration Division, Oak Ridge Operations Office, December 1995.
7. United States Department of Energy. Engineering Evaluation/Cost Analysis for the Removal of the Wayne Site Storage Pile, Wayne, New Jersey, July 1995.
8. United States Army Corps of Engineers. Engineering Evaluation/Cost Analysis for the Removal of Subsurface Materials at the Wayne Site, Wayne, New Jersey, March 1998.
9. United States Army Corps of Engineers. Record of Decision for the Wayne Interim Storage Site, Wayne, New Jersey, April 2000.
10. Golden Software Incorporated. Surfer 7 Users Guide.