Non-Operational Property Evaluation for the Hanford Site River Corridor – 12409

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ABSTRACT

The Hanford Site River Corridor consists of the former reactor areas of the 100 Areas and the former industrial (fuel processing) area in the 300 Area. Most of the waste sites are located close to the decommissioned reactors or former industrial facilities along the Columbia River. Most of the surface area of the River Corridor consists of land with little or no subsurface infrastructure or indication of past or present releases of hazardous constituents, and is referred to as non-operational property or non-operational area.

Multiple lines of evidence have been developed to assess identified fate and transport mechanisms and to evaluate the potential magnitude and significance of waste site-related contaminants in the non-operational area. Predictive modeling was used for determining the likelihood of locating waste sites and evaluating the distribution of radionuclides in soil based on available soil concentration data and aerial radiological surveys.

The results of this evaluation indicated: 1) With the exception of stack emissions, transport pathways associated with waste site contaminants are unlikely to result in dispersion of contaminants in soil away from operational areas, 2) Stack emissions that may have been associated with Hanford Site operations generally emitted short-lived and/or gaseous radionuclides, and (3) the likelihood of detecting elevated radionuclide concentrations or other waste sites in non-operational area soils is very small.

INTRODUCTION

The Hanford Site River Corridor consists of the former reactor areas in the 100 Areas and the former industrial (fuel processing) area in the 300 Area. Most of the waste sites are located close to the decommissioned reactors or former industrial facilities along the Columbia River. Cleanup of the land surface along the River Corridor focused on known waste sites located in operational areas (often within perimeter fences) and sites that have been identified through surveillance or other activities. However, the operational areas comprise a small fraction of the total land surface in the River Corridor. Most of the surface area of the River Corridor consists of land with little or no subsurface infrastructure or indication of past or present releases of hazardous constituents, and is referred to as non-operational property (NP) or non-operational area.

The non-operational property evaluation (NPE) supports the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Remedial Investigation (RI) and allows a more comprehensive look at the contamination and associated risks. This NPE is not directly part of the RI process, in that it has no role in determining the basis for remedial action or in evaluating remedial alternatives for contaminated soils or groundwater. However, the National Contingency Plan requires that the nature and extent of contamination be evaluated and that appropriate remedial action be taken. Results from the NPE can identify additional waste sites that might warrant further consideration and provide a level of certainty that such waste sites have been identified The NPE also documents the conditions in NP for use in risk communication.

At the Hanford Site there are mechanisms that could potentially distribute or have distributed contaminants to NP: (1) human disposal activities; (2) dispersion by wind-blown dust; (3) dispersion of emissions to the air from historical stacks; (4) overland flow; and (5) biological vectors (intrusion by plants and animals). Multiple lines of evidence have been developed to assess the magnitude and significance of these mechanisms on waste site related contaminants in the NP. One goal was to develop a conceptual model that could explain the distribution and significance of contaminants in the NP.

METHOD

The principal objective of this evaluation is to examine multiple lines of evidence to confirm that hazardous or radioactive substance releases are not likely to be present in the NP. Because the NP has no history of releases of hazardous or radioactive substances, it is presumed to have a low likelihood that contamination would be present that would require a response action under CERCLA. However, the evaluation was undertaken to identify areas where potential releases or contaminant transport could have occurred that may require further evaluation.

The approach to the NPE for the River Corridor is to develop a conceptual model of mechanisms that would warrant further evaluation in the NP, and then apply multiple lines of evidence to examine the likelihood that such contamination is present. The lines of evidence include:

- results of long-term surveillance and monitoring programs and other studies,
- results of statistical analyses (including a spatial model for predicting the location of man-made features, such as waste sites) based on proximity to man-made and topographic features;
- spatial modeling of elevated radionuclide concentrations (specifically Cs-137) in soils based on aerial radiological surveys; and
- results from the Orphan Sites Evaluation (OSE) program.

A conceptual model was developed to serve as the framework for evaluating the available data. Key elements of the conceptual model are the potential pathways for the occurrence of hazardous or radioactive substances in the NP. These potential pathways are: (1) human disposal activities; (2) dispersion by wind-blown dust; (3) dispersion of emissions to the air from historical stacks; (4) overland flow; and (5) biological vectors (intrusion by plants and animals).

SURVEILLANCE AND MONITORING PROGRAMS

Several programs at the Hanford Site collect environmental surveillance and monitoring data to address regulatory requirements for emissions, effluent discharges or DOE Orders regarding radiological control. Other programs perform environmental monitoring of soil, water, air or vegetation. Most of these programs are summarized in the Annual Environmental Report for the Hanford Site [1].

Sixteen existing programs were identified at the Hanford Site that identify waste sites and/or collect environmental monitoring and surveillance data, but the information from programs involved with soil, air or vegetation monitoring or radiological control were of most use the NPE. Information and data from these programs were evaluated to identify trends in how hazardous substances or radionuclides may have been transported from operational areas or waste sites to NP within the River Corridor. The evaluation of the results from these programs as they pertain to the NP portions of one of the 100 Areas is summarized below for the 100-K Decision Area.

Anthropogenic Disposal Activities

Information on past and present activities provide confidence that waste site locations within the River Corridor are known. Waste site identification activities in the River Corridor fall into two categories: systematic and observational. Various systematic programs have been conducted at different times since the beginning of Hanford Site transition from production to cleanup in the 1980s, with the most recent being the OSE program that was initiated in 2004. An inventory of known and potential waste sites has been maintained in the Waste Information Data System (WIDS) database since the early 1980s, and is continually maintained through the TPA-MP-14 discovery process [2]. Between 1985 and 1988, preliminary assessment/site inspection activities were completed to identify waste sites and prioritize the relative hazards. Waste disposal information was collected through exhaustive reviews of literature and maps, employee interviews, and visual inspection of all sites and unplanned releases. Results were organized and sites were ranked with respect to potential environmental impacts in accordance with a slightly modified version of the CERCLA hazard ranking system. The results from this process provided information to support addition of the 100 and 300 Areas to the National Priorities List (NPL) and subsequent listing of waste sites in Appendix C of the TPA in 1989 [2].

A variety of characterization activities conducted as part of the RI process has further characterized potential release and disposal activities in the 100 and 300 Areas. These historical activities are summarized in the RI Work Plan for the 100 Areas [3] and the 300 Area [4]. It must be stated that the Remedial Investigation/Feasibility Study decision documents have not been approved by the regulatory agencies yet.

Windblown Dust Emissions

Emissions sources which could release contaminants through transport of wind-blown dust are described variously as "fugitive", "diffuse" or "non-point" emissions sources [5]. The potential for fugitive dust emissions from waste sites (prior to their cleanup) generally occurs subsequent to erosion of soil covers or bio-intrusion by exposing erodible material containing radionuclides. Other areas also could contain erodible contaminated material that could produce fugitive emissions from re-suspension of windblown dust [5].

The potential magnitude of windblown dust transport can be evaluated from the frequency of restrictions to visibility and ambient air monitoring for particulate matter and radionuclides in air. Dust, blowing dust and smoke from field burning are described as phenomena causing restrictions to visibility (i.e. visibility less than or equal to 9.6 km [6 mi]. Reportedly, at Hanford there are few such days [6]. Particulate air monitoring shows that annual average PM_{10} (particulate matter finer than 10 µm in diameter) concentrations at the Hanford Meteorological Station are similar to PM_{10} concentrations at a station located in the nearby city of Kennewick.

Stack Emissions

Radionuclide emissions from formerly utilized stacks in the 100 and 200 Areas had the potential to impact the River Corridor through deposition from the air. Based on studies conducted as part of the Hanford Environmental Dose Reconstruction (HEDR) project, most of the emissions occurred between 1944 and 1972 from facilities that separated plutonium and uranium from irradiated reactor fuel [7]. The largest releases from these facilities occurred in 1945, before effective collection devices were installed. Most of the inventory emitted consisted of gaseous and/or short-lived radionuclides, which would be unlikely to result in measurable concentrations in soil in Hanford Site non-operational areas.

Releases of longer-lived radionuclides (those with half lives greater than 20 years), including Am-241, Cs-137, I-129, Sr-90, Pu-238, Pu-239/240, and Pu-241, from the 2 stacks, were a very small fraction of the total inventory. A review of dose reconstruction information indicates that most of the total radiological releases consisted of Cs-137 and Sr-90 with a minor contribution of the other radionuclides. Potential long-term impacts from these emissions within the Hanford Site have been assessed through air and soil sampling conducted as part of the NFM and SESP programs [1]. For example, air sampling at the 100–K Decision Area is performed at a sampling station located south of the fenceline of the operational area. Particulate sampling for gross alpha and beta radiation, conducted at the 100–K area since 1991, shows either a flat or declining trend in concentrations. Direct measurements of gamma dose made at this location since 1970 have shown background levels of radioactivity, with the exception of an elevated level measured in 2005. While concentrations at some near facility sampling locations are higher than offsite locations, average concentrations are low and show no changes in trends over several years[1]. In general, concentrations of sampled radionuclides, including Cs-137, Sr-90, Pu-239/240, U-235 and U-238 fall within the range of Hanford Site background concentrations in soil.

Overland Flow

The Hanford Site is in a semiarid region and thus experiences many dry periods. January, March and December are the only months that have always received measurable precipitation, reported from 1946 through 2004. Normal annual precipitation at the Hanford Site is 177 mm (~7 inches) [8]. Based on the water balance in a semiarid climate, precipitation is more than balanced by evaporation and transpiration such that substantial overland flow from precipitation is an unlikely occurrence. A more likely source for overland flow is spills or releases from liquid waste disposal facilities. Liquid effluents generated as a direct result of reactor operations consisted primarily of reactor cooling water, fuel storage basin water, and decontamination solutions.

Leaks from the liquid waste disposal sites in the 100 Area that resulted in overland flow are described in the report of the 1975 sampling event [9]. In general, these leaks resulted in localized contamination around the periphery of the disposal sites and have been characterized as part of the RI process, or cleaned up as part of remediation conducted in accordance with the Interim Action RODs. The identification of leaks or spills from waste sites is also incorporated into the procedure for maintaining WIDS in accordance with the Tri-Party Agreement Procedure TPA-MP-14 [2]. Based on the available information, overland flows from liquid waste disposal facilities are limited in lateral extent, and that unplanned liquid release sites are identified through existing programs such as WIDS. The factors considered in this evaluation indicate that contamination in non-operational areas through overland transport is unlikely to occur.

Biointrusion

The Quarterly Environmental Radiological Survey Summary [10] identifies mud dauber wasp nests as potential animal intrusions in the 100 Area sites. Radiological surveillance monitoring or vegetation sampling conducted as part of the Near Facility Monitoring Program [10],[1] generally identifies relatively fewer animal intrusion or contaminated vegetation episodes around identified waste sites within the River Corridor.

Orphan Sites Evaluation

The Orphan Sites Evaluation (OSE) is a systematic approach to evaluate land parcels in the River Corridor to ensure that all waste sites or releases requiring characterization and cleanup have been identified. Two of the key elements of an orphan sites evaluation included historical reviews and field investigations. Review of historical information was conducted to identify potential orphan sites and to target areas for further evaluation during the course of conducting the associated field investigation. Historical research focused on identifying specific items or features typically associated with a waste site. Common features associated with a waste site in reactor areas include drains, cribs, drywells/French drains, burial grounds, pipelines, above- and below ground storage tanks, septic systems, drain fields, burn pits, trenches, ditches, pits, spills, sumps, vaults, ash pits, disposal areas, pumps, and buildings and facilities that contain chemicals and radiological contaminants.

The field investigation for regions of the River Corridor between the operational areas utilized a graded approach which included High resolution, four-band orthophotography and Light Detection and Ranging (LiDAR) topography data. The orthophotography and LiDAR data were used to conduct "virtual walk-downs" of the areas. Based on results of these "virtual walk-downs," areas were selected to conduct walking surveys. Vehicle surveys along accessible roads and utility easements are also part of the field investigation for the non-operational areas.

STATISTICAL ANALYSES

The statistical analyses are focused on the following primary lines of investigation:

1. Developing a predictive model for potential waste site locations.
2. Establishing association between soil measurement of Cs-137 and high resolution aerial survey data in the BC Controlled Area (BCCA).
3. Developing a model of soil Cs-137 based on the results of lower resolution aerial surveys across the Hanford Site to the full NP.

The results of these analyses were applied to specific areas within the NP providing estimates of: (1) the likelihood of finding previously undiscovered waste sites in the NP and (2) potential for exposure to Cs-137 exceeding selected threshold concentrations in surface soils.

Predictive Modeling of Waste Site Locations

Known waste sites have largely been located in proximity to anthropogenic features and relatively particular topographic conditions. For example, most waste sites found to date tended to be close to roads, in low lying areas such as ditches or ponds, or proximate to operational areas. The spatial distributions of these geographic variables, measured at known Waste Information Data System (WIDS) sites, were compared with the distribution of the same variables calculated at an unbiased set of locations systematically distributed across the Hanford Site. A statistical relationship was established to rank the likelihood that an available location might contain a previously unknown waste site. Logistic regression was used to develop the statistical relationship between waste site locations and geographic variables. Factors considered in developing geographic variables expected to predict locations of known waste sites and sources included: distance to operational areas; distance to roads, railroad grades, lakes, streams, utility right-of-ways (e.g., power lines); and topography.

The geographic characteristics of the known waste sites were investigated to determine if their locations exhibited predictable spatial patterns. The purpose of this analysis was to develop a quantitative predictive model describing relationships so that areas within the River Corridor could be prioritized based on the relative probability that a previously unidentified waste site might be present. This analysis does not provide an absolute probability that a waste site exists, but rather provides a relative probability that allows locations to be ranked to identify the more likely location for a waste site. The possibility exists that there may be no additional waste sites in the River Corridor that have not already been found. The predictive model provides direction to the most likely places for a waste site to occur if indeed one exists.

The predictive model was developed based on a set of known waste site locations obtained from WIDS (referred to as a "training set"). The results of this model were used to predict the relative probability of encountering a potential waste site at areas that had may not have been investigated in the field. This provided a ranking of locations within the NP that could then be investigated in the field, compared with previous field or desktop investigation results to determine the potential that additional previously undetected waste sites may remain within the NP. In the River Corridor area the modeled predictions were compared with information generated from the OSE. The modeled predictions were compared with miscellaneous remediation points and waste site points observed during aerial photography and LiDAR imagery, field walk-downs and vehicular road surveys conducted as part of the OSE. These comparisons provided independent validation of the predictive model.

Establishing Model Associations Utilizing Data from Aerial Surveys and Soil Radionuclides

Measurements of the presence of radionuclides were available from direct soil measurements, as well as from laterally extensive radiological aerial surveys. Soil measurements were expressed as activities per unit mass (Bq/kg) suitable for estimation of exposure for risk assessment, but provide only limited understanding of the spatial distribution of concentrations. Data obtained from aerial surveys interrogates much larger areas, but expressed as gross counts for gamma emitting radionuclides. The aerial survey data were not directly applicable to estimation of potential exposure without calibration to directly measured soil concentrations.

For purposes of the NPE, aerial survey data were calibrated against measured soil Cs-137 activity data. Geostatistical methods were used in a preliminary study to develop a spatially explicit relationship between soil activity measurements and aerial survey gross counts within the BC Controlled Area (BCCA). Detailed geostatistical analysis was conducted within the BCCA because high-resolution aerial survey data and relatively high-density soil sampling data were available for this area. The preliminary analysis of the BCCA data was used as a pilot study to support determination to proceed with development of a more extensive site wide model based on less resolved, but more laterally extensive aerial surveys of all of the Hanford Site. The results of the site-wide model were used to draw conclusions regarding the distribution of Cs-137 (a contaminant of potential concern related to Hanford Site operations) specific to the NP.

Aerial surveys conducted in 1996 [11] and 2009 [12] were combined with ground radiological surveys and soil sampling and analytical data for Cs-137 in the BCCA to establish a relationship to the aerial survey results and measured concentrations in soil. A statistical model of the probability that soil Cs-137 levels exceed selected threshold levels of 3.9, 5.6, 11.5, and 22.9 Bq/kg (1,05, 1.5, 3.1 and 6.2 pCi/g) was developed as a function of gross counts of gamma emitting radionuclides using site-wide aerial survey results. The statistical model was validated against a set of waste sites in the 200-MG-1 OU, where radiological surveys and soil sampling and analysis had been conducted as part of interim remedial actions.

RESULTS

The NPE is based on multiple lines of evidence including the results from surveillance and monitoring programs, and other studies conducted in the River Corridor; the results from statistical analyses performed to identify the potential presence of waste sites and to evaluate the spatial distribution of selected radionuclides in soil; and the results from the OSE. To illustrate the NPE approach, results are described for the 100-K Decision Area.

The 100-K Area covers an area of approximately 9.0 km^2(3.5 mi^2) and includes the 100-KR-1 and 100-KR-2 Source OUs, the 100-KR-4 groundwater OU and nonoperational area. It is situated on relatively flat and level ground, except near the Columbia River where the land surface changes to gentle, low relief slopes. A perimeter fence surrounds a 3.1 km^2(1.2 mi^2) area where the majority of active operations took place. Within the perimeter fence the ground surface and upper vadose zone has been highly disturbed and reworked by human activities that include pre-WWII agriculture activities followed by intense reactor construction and operations and, eventually, waste site and ground water remedial activities that extend to the present [13]; [14]. A significant additional area of disturbance extends about 1.5 km outside of the northeast corner of the perimeter fence where a large cooling water disposal trench was operated (116-K-2). The trench has been excavated, contaminated soil and debris removed, the excavation backfilled, and the site re-vegetated with native plants. Otherwise, the area outside of the perimeter fence is relatively undisturbed.

Results from Surveillance and Monitoring Programs

Hanford site programs which provided information characterizing conditions in the NP in and around the 100-K Decision Area included the soil, air and vegetation sampling conducted as part of the Near Facility-Monitoring program and the Surface Environmental Surveillance Program (SESP), the radiological control program with emphasis on radiological surveys and activities for identifying and controlling biological vectors (bio-intrusion from plants and animals), and external radiation monitoring conducted as part of the SESP. Other activities that contributed to characterizing conditions in the NP include the waste site discovery process under TPA-MP-14, which results in identified waste sites being inventoried in WIDS and the OSE. Historically, interim actions conducted under the Radiation Area Remedial Action (RARA) project contributed to stabilizing and controlling releases from waste sites.

Near-facility ambient air monitoring was conducted in 2007, 2008 and 2009 at eight locations in the 100-K Area, for gross alpha, gross beta, Cs-137, Sr-90, and Pu and U isotopes. Low concentrations of all of these radionuclides were detected in air at the near-facility sampling locations, in some cases exceeding 10% of EPA's action levels for compliance with the radionuclide NESHAPS [15], [16], and [17]. In 2008, examination of the bi-weekly air sampling results for gross alpha and gross beta activity indicated that elevated levels were attributable to increased demolition activities [16]. The Annual Environmental Reports state that in general, air samples collected from locations at or directly adjacent to Hanford Site facilities had higher radionuclide concentrations than samples collected farther away. However, reported concentrations fall below the EPA action levels in air based on 0.1 mSv/yr (10 mrem/yr) for compliance with the radionuclide NESHAPS.

Biointrusion episodes reported in the 100-K Area were related to mud dauber nests seen during radiological control activities in 2010 [10]. Other plant or animal bio-intrusion episodes have not been reported in the 100-K Area.

No near-facility soil samples were collected from the 100-K Area. External dose rates measured near facilities using thermoluminescent detectors (TLD) from 2007 through 2009 ranged from 1.92 mSv/yr (192 mrem/yr) to 2.78 mSv/yr (278 mrem/yr), based on an annual average [15], [16], and [17]. The highest annual dose, reported in 2009, was attributed to cleanup of contaminated soil being conducted at the K-East Basin.

A long-term ambient air station maintained as part of the SESP is located near the 100-K Area. Particulate air samples from this station are analyzed for gross alpha and gross beta. Gross alpha activity measured between 1971 and 2009 was less than 0.00002 Bq/m^3 (0.005 pCi/m^3), with the exception of short-term elevations occurring in 1991 and 1992, producing concentrations in air up to 0.000056 Bq/m^3 (0.015 pCi/m^3). Gross beta activity measured since 1971 has generally declined with some short-term elevations (e.g. 0.003 Bq/m^3 or 0.8 pCi/m^3 in 1986); activities measured since 1981 generally are less than 0.00037 Bq/m^3 (0.1 pCi/m^3).

A long-term soil and vegetation monitoring station maintained as part of the SESP is located near the 100-K Area. Cs-137 in soil measured this station between 1993 and 2009 was 1.85 Bq/kg (0.5 pCi/g) or lower, with the exception of one sample which detected approximately 7.4 Bq/kg (2 pCi/g), in 2001.Co-60 in soil generally was 0.074 Bq/kg (0.02 pCi/g) or lower between 1993 and 2009, with the exception of one sample which detected approximately 0.37 Bq/kg (0.1 pCi/g) in 2001. Pu-239/240 concentrations measured between 1993 and 2009 fluctuated between 0.037 and 0.074 Bq/kg (0.01 and 0.02 pCi/g), with the exception of a peak concentration of 0.3 Bq/kg (0.09 pCi/g) measured in 2001.Sr-90 concentrations measured between 1993 and 2009 generally were around 0.7 Bq/kg (0.2 pCi/g) or lower. U-235 concentrations measured between 1992 and 2009 were 0.24 Bq/kg (0.7 pCi/g) or lower. U-238 concentrations measured between 1992 and 2009 were 2.6 Bq/kg (0.7 pCi/g) or lower. Cs-137, Co-60 and Sr-90 were the only radionuclides detected in vegetation; generally the concentrations detected were very low, often 0.074 Bq/kg (0.01 pCi/g) or lower. Figures 1 illustrates results of air monitoring during the SESP.

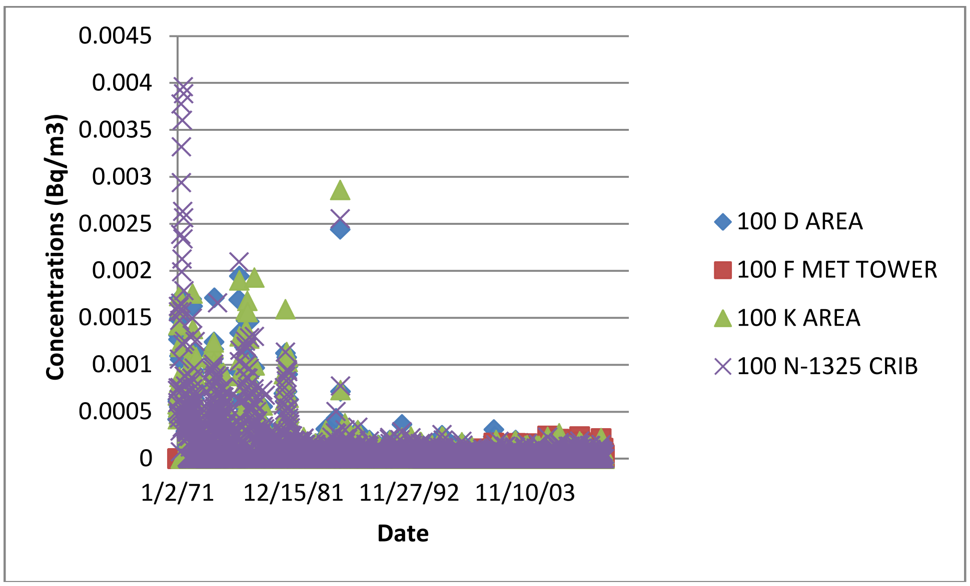

Figure 1. Trends in Gross Beta in Air in River Corridor at 100 Area SESP Stations

The results for Cs-137 in soil presented in Figure 2 indicate that concentrations in soil at the SESP locations were 7.4 Bq/kg (2 pCi/g) or lower throughout the 1971 to 2009 monitoring period. With the exception of one analytical result in the 100-K Area in July 2001, Cs-137 concentrations in soil appear to be declining over time. Similar results were demonstrated for Co-60 and Pu-239/240. Different trends but similar conclusions were also demonstrated for Sr-90 and uranium isotopes U-235 and U-238.

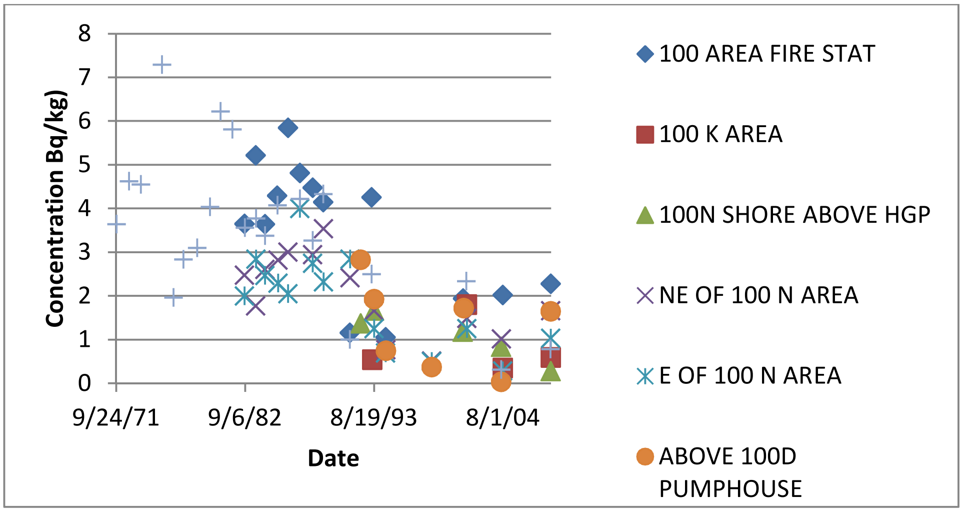

Figure 2. Trends in Cs-137 in Soil in River Corridor at SESP Locations

Vegetation monitoring data for Cs-137, Co-60, Pu-239, Sr-90, U-235 and U-238 collected since 1971 were also examined. Results show that concentrations of Cs-137, Co-60, and Sr-90 in vegetation appear to have a declining trend with time. The concentrations of transuranic elements sampled during the SESP (Pu-239/240, U-235 and U-238) were detected too infrequently in vegetation for plotting.

Results from the Orphan Sites Evaluation

The results from historical research, field walk-downs, GIS mapping and geophysical surveys for the 100-K Area are summarized in OSR-2008-0003, Rev. 0. A field walk-down was conducted over 329 hectares (813 acres) of the 100-K Area. A total of 16 orphan sites (new discovery sites) were identified through the 100-K OSE, 6 of which are within the 100-K Exclusion Area.

Relative Probability of Missing an Existing Waste Site

In the vicinity of 100-K Area none of the validation waste site points are located in areas with relative probability less than 10% and most are within areas with relative probabilities of 20% or greater (Figure 3). The probability of an undetected waste site that could require enrollment in the MP-14 process is less than approximately 2% to 5%. A small area south east of the area that was walked in the field was predicted to have greater than a 20% relative probability that a waste site could be located there, however no waste site points or miscellaneous remediation (MR) points were identified in this area. Additional MR points were identified outside the areas walked and none were identified for subsequent enrollment in the M-14 process.

Spatial Analysis of Soil Radionuclides and Aerial Surveys

The probability that Cs-137 activity exceeds 3.9 Bq/kg (1.05 pCi/g) in the vicinity of the 100-K reactor is shown in Figure 4. Areas South of the Columbia River with probabilities exceeding 10% (i.e. indicative of Hanford background levels) are restricted to known operational areas identified as waste sites or within the interstitial areas between the waste sites but contained within the fenced area. On the north side of the Columbia River, there is a narrow area proximate to the river with probabilities between approximately 10% and 20% indicating apparent soil Cs-137 activity levels that may exceed background levels. Because this area is North of the River, it is anticipated that the normal course of RI processes at the 100-K Area would not include evaluation of soil Cs-137 levels in this area. It is anticipated that available data and information will be brought to bear on this area to evaluate the potential need for additional. As a preliminary screen, it could be helpful to identify any radiological surveys that may have been conducted in this area in the past.

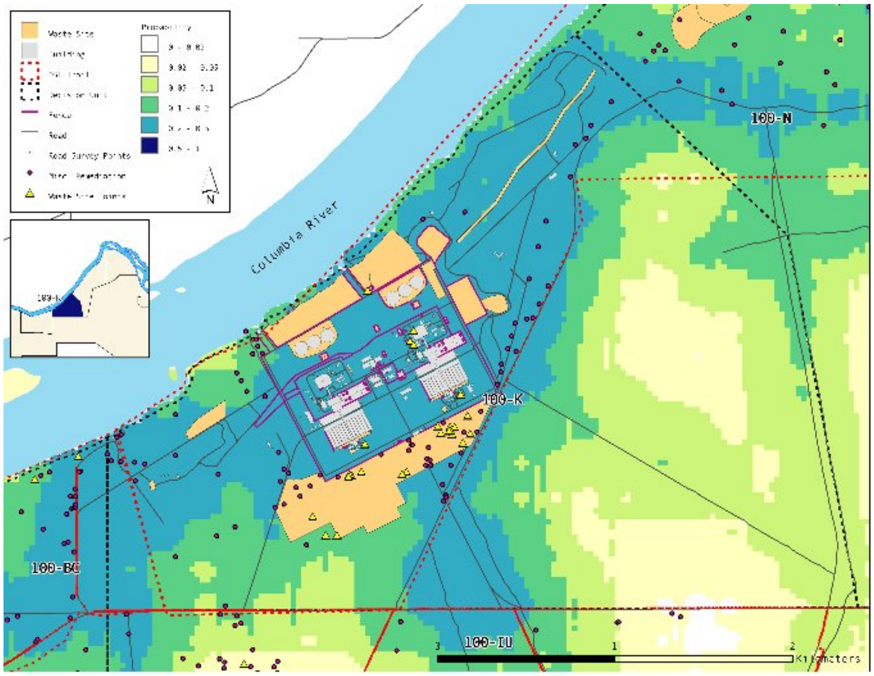

Figure 3. Relative Probability of Waste Site Locations in the 100-K Area of the River Corridor

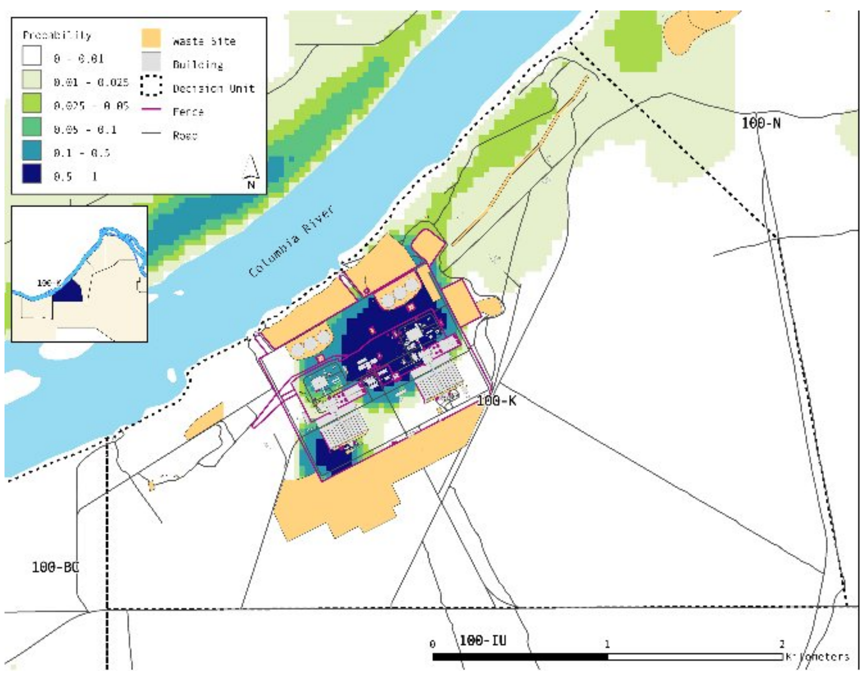

Figure 4. Modeled Probability that Soil Cs-137 Exceeds 3.9 Bq/kg (1.05 pCi/g) in the 100-K Area of the River Corridor

CONCLUSIONS

Multiple lines of evidence were reviewed to evaluate conditions in the non-operational areas within the River Corridor, and identify the potential for contaminants from waste sites to be transported to non-operational areas. A conceptual model of potential release and transport mechanisms was developed to provide the framework for the data collection and analysis conducted as part of this NPE. Hanford Site surveillance and monitoring programs provided various sets of data identifying potential waste site locations, documenting actions to control potential contaminant migration and transport pathways, and monitoring the occurrence of contaminants in soil, air and biota in non-operational areas. The OSE program conducted in the River Corridor provided a comprehensive process for identifying with a high degree of resolution and sensitivity, all waste sites or potential areas of contamination within the River Corridor. Statistical analyses of the relationship of waste sites to man-made and landscape features and analyses of the distribution of an indicator contaminant of potential concern in soil provide confirmation of the findings from the surveillance and monitoring programs and the OSE program.

The overall conclusions from the NPE evaluation of the River Corridor are:

- With the exception of stack emissions to the air, transport pathways associated with waste site contaminants are unlikely to result in dispersion of contaminants in soil away from operational areas. While pathways such as windblown dust, overland transport and biointrusion have the potential for dispersing waste site contaminants, the resulting transport is unlikely to result in substantial contamination in non-operational areas.
- Stack emissions that may have been associated with Hanford Site operations generally emitted short-lived and/or gaseous radionuclides; these radionuclides either would have decayed and would be undetectable in soil, or likely would not have deposited onto Hanford Site soils. A small fraction of the total historical emissions consisted of long-lived particulate radionuclides, which could have deposited onto the soil. Soil monitoring studies conducted as part of surveillance and monitoring programs do not indicate a build-up of radionuclide concentrations in soil, which might indicate potential deposition impacts from stack emissions. Aerial radiological surveys of the Hanford Site, while effective in detecting gamma-emitting nuclides, also do not indicate deposition patterns in soil from stack emissions.
- The surveillance and monitoring programs also have verified that the limited occurrence of biointrusion observed in the River Corridor has not resulted in a spread of contamination into the non-operational areas.
- Monitoring of radionuclides in ambient air conducted as part of the surveillance and monitoring programs generally show a low and declining trend of detected concentrations in air. Monitoring of radionuclides in soil and vegetation correspondingly show declining trends in concentrations, particularly for nuclides with short half lives (Cs-137, Co-60 and Sr-90).
- Statistical analysis of the geographical distribution of waste sites based on man –made features and topography describes the likely locations of waste sites in the River Corridor. The results from this analysis reinforce the findings from the Orphan Site Evaluation program, which has systematically identified any remaining waste sites within the River Corridor.
- Statistical analysis of the distribution of radionuclide concentrations observable from aerial surveys has confirmed that the likelihood of detecting elevated radionclide concentrations in non-operational area soils is very small; the occurrences and locations where potentially elevated concentrations may be found are discussed below.

In addition, statistical analysis showed that there is a relatively high probability (>50%) that concentrations of Cs-137 higher than background (3.9 Bq/kg or 1.05 pCi/g) are located outside of the operational portion of the 100-BC, 100-K, and 100-N Areas. This observation is based on modeled concentrations in soil derived from aerial radiography data. However, the extent is limited to a few meters from the respective facilities fencelines or known operational activities. Evaluation of the extent of contamination is being conducted as part of the RI process for each decision area. No unanticipated waste sites were identified either from the OSE program or statistical analysis of waste site proximity to known features.

Based on the evaluation of these multiple lines of evidence, the likelihood of identifying waste sites or contaminant dispersal from Hanford site operations into non-operational areas can be considered very small.

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