Abbreviated Work Plan for Remedial Investigation Addendum and Final Feasibility Study

West Lake Landfill Operable Unit-1

Prepared for

The United States Environmental Protection Agency Region VII

Prepared on behalf of

Bridgeton Landfill, LLC ("Bridgeton"), Rock Road Industries, Inc. ("Rock Road"), Cotter Corporation (N.S.L.)("Cotter"), and the United States Department of Energy ("DOE")(collectively, the "West Lake Landfill OU-1 Respondents")

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December 18, 2015 Revised February 5, 2016

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List of Acronyms

ARAR	Applicable or Relevant and Appropriate Requirements
ASAOC	Administrative Settlement Agreement and Order on Consent
ASPECT	Airborne Spectral Photometric Environmental Collection Technology
Auxier	Auxier & Associates, Inc.
BRA	Baseline Risk Assessment
CBRN	Chemical Biological Radiological and Nuclear
CERCLA	Comprehensive Environmental Recovery, Compensation, and Liability Act
CMAT	Consequence Management Advisory Team
COC	Chemical of Concern
CSM	Conceptual Site Model
EMSI	Engineering Management Support, Inc.
EPA	United States Environmental Protection Agency
EVOH	ethyl vinyl alcohol
FAA	Federal Aviation Administration
FEI	Feezor Engineering, Inc.
FS	Feasibility Study
FFS	Final Feasibility Study
IB	Isolation Barrier
MDNR	Missouri Department of Natural Resources
MOU	Memorandum of Understanding
NCP	National Contingency Plan
OEM	Office of Emergency Management
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
pCi/g	picocuries per gram
PRG	Preliminary Remediation Goals for Radionuclides
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDWP	Remedial Design Work Plan
RESRAD	Residual Radioactive materials
RI	Remedial Investigation
RIM	Radiologically Impacted Material
ROD	Record of Decision
SFS	Supplemental Feasibility Study
SOW	Statement of Work
SSE	Subsurface Event
SSR	Subsurface Reaction
UAO	Unilateral Administrative Order

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List of Acronyms (continued)

UCL	Upper Confidence Limit
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACOE	United States Army Corps of Engineers
USGS	United States Geological Survey
VOC	Volatile Organic Compound

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1 INTRODUCTION

This work plan describes the work to be performed to prepare an addendum to the Remedial Investigation (RI) report (RI Addendum) and a Final Feasibility Study (Final FS or FFS) for Operable Unit 1 (OU-1) at the West Lake Landfill Superfund Site (the Superfund Site or the Site). This work plan has been developed pursuant to EPA's December 9, 2015 letter to Bridgeton Landfill, LLC ("Bridgeton"), Rock Road Industries, Inc. ("Rock Road"), Cotter Corporation (N.S.L.)("Cotter"), and the United States Department of Energy ("DOE")(collectively, the "West Lake Landfill OU-1 Respondents" or simply the OU-1 Respondents) and the attached Statement of Work (SOW) for RI Addendum and FFS (EPA, 2015a) and the results of discussions with EPA during the scoping meeting that was held on November 3, 2015.

Engineering Management Support, Inc. (EMSI), the Project Coordinator designated by the OU-1 Respondents under the 1993 Administrative Order on Consent for the West Lake Landfill Site (as amended) (AOC), will act as project lead for preparation of the RI Addendum and FFS. EMSI will be assisted by Auxier & Associates, Inc. (Auxier), who will prepare the updates to the Baseline Risk Assessment (BRA), and by Feezor Engineering, Inc. (Feezor), who will assist EMSI in performing the engineering evaluations of the various remedial alternatives in support of the FFS.

1.1 Purpose, Objectives and Scope

The purpose of the work described in this work plan is to build on the information, evaluations and data collected prior to and as part of the RI (EMSI, 2000), FS (EMSI, 2006), Supplemental Feasibility Study (SFS) (EMSI, 2011) and the Record of Decision (ROD) (EPA, 2008a) and to incorporate the information, evaluations, and data collected since the RI/FS, ROD and SFS were completed. The nature and types of additional information, evaluations and data collected in the period since the RI/FS, ROD and SFS were completed are described in the next subsection of this work plan.

The overall objectives and scope of this work are as follows:

1. Prepare an updated RI report that incorporates the results of all of the additional investigations that have been performed since the RI was finalized in 2000, including, at a minimum, updated discussions of the nature and extent of occurrences of radiologically-impacted material (RIM) within OU-1 and radionuclide and chemical extent, fate and transport, and an updated Conceptual Site Model (CSM);

2. In conjunction with the updated RI report, update the BRA calculations and evaluations included in the RI to incorporate the results of the various additional investigations and to update the toxicity information and values as necessary; and

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3. Prepare a Final FS that incorporates the results of the prior FS and SFS along with the results of the additional investigations and evaluations that have been performed since the FS and SFS were completed, and that also includes evaluation of partial excavation remedial alternatives identified by EPA.

Although the hydrogeology and nature and extent of contamination sections of the RI will be updated to include the results of the four comprehensive groundwater sampling events conducted in 2012-2013, EPA has indicated that it intends to establish a third operable unit for the Site (OU-3) that will focus on evaluation of groundwater conditions at the Site.

The work to be conducted pursuant to this work plan will be performed in accordance with the National Contingency Plan, 40 CFR Part 300 and the following EPA guidance:

- "Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (1988 RI/FS Guidance) OSWER Directive 9355.3-01 (October 1988, or subsequently issued guidance);

- "Guidance for Data Useability in Risk Assessment", OSWER Directive 9285.7-09A (April 1992);

- "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination", OSWER Directive 9200.4-18, (August 1997);

- "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA", OSWER Directive 9200.4-23, (August 1997);

- "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites", OSWER Directive 9200.4-25 (February 1998);

- "Remediation Goals for Radioactively Contaminated CERCLA Sites Using the Benchmark Dose Cleanup Criteria in 10 CFR Part 40 Appendix A, I, Criterion 6(6)", and OSWER Directive 9200.4-35P (April 2000);

- Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (various parts as applicable including Part A, Part C, Part D, Part E and Part F);

- Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups, OSWER Directive No. 9355.0-74FS-P (September 2000);

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- Guidelines for Ecological Risks Assessment, EPA/630/R-95/002F (May 1998);
- Land Use in the CERCLA Remedy Selection Process, OSWER Directive No. 9355.7-04 (May 1995); and
- Radiation Risk Assessment at CERCLA Sites: Q&A, OSWER Directive No. 9200.4-40, (May 2014).

1.2 Work Plan Organization

Section 2 of this work plan summarizes the additional investigations of the site conditions that have been completed since EPA issued the ROD in 2008 or that are currently being performed in response to various requests from EPA. Section 3 describes the nature of the expected revisions and updates to the RI report including updates to the BRA. Section 4 describes the nature of the anticipated revisions and updates to the prior SFS, including the engineering analyses and other evaluations necessary to develop and evaluate the three partial excavation alternatives identified by EPA and the preparation of a Final FS report. Section 5 presents the anticipated schedule for completion of the various ongoing and outstanding investigations and evaluations and the preparation of the RI Addendum, updated BRA, and FFS reports. Section 6 presents a listing of the various site reports, EPA guidance and other documents cited in this work plan.

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2 SITE BACKGROUND AND RECENT INVESTIGATIONS/EVALUATIONS

The West Lake Landfill Superfund Site is located in Bridgeton, Missouri approximately four miles to the west of Lambert-St. Louis International Airport and approximately 17.5 miles from downtown St. Louis (Figure 1). The Site is an inactive solid waste landfill facility that consists of various contiguous and discrete areas historically used for disposal of municipal solid wastes and construction and demolition debris.

EPA previously divided the Superfund Site into two Operable Units (OUs). OU-1 addresses Areas 1 and 2, the two areas of the inactive landfill where radiologically contaminated materials have been identified, and portions of an adjacent property formerly identified as the Ford Property, and now referred to as the Buffer Zone and Crossroads Lot 2A2 (Figure 2). The landfill areas that are not impacted by radionuclide contaminants are encompassed within OU-2. EPA is currently planning a third Operable Unit (OU-3) to the Superfund Site to address Site groundwater. The Bridgeton Landfill is also regulated by the Missouri Department of Natural Resources (MDNR) as a permitted solid waste facility pursuant to the state solid waste regulations.

2.1 2008 ROD-Selected Remedy for OU-1

Remedial Investigations (RI) and Feasibility Studies (FS) were previously completed for both OU-1 (EMSI, 2000 and 2006) and OU-2 (Herst & Associates, 2005 and 2006). Based on the results of the RI/FS, EPA developed a Proposed Plan for OU-1 (EPA, 2006), held three public meetings, and provided for an extended period for public comment on the Proposed Plan. Based on the above documents and activities, EPA selected a containment remedy for OU-1 to protect human health and the environment by providing source control for the landfilled waste materials. The source control methods prevent human receptors from contacting the waste material and control contaminant migration to air or groundwater.

The description and basis for the selected remedy was documented in the May 2008 ROD for OU-1 (EPA, 2008). The major components of the ROD-selected remedy include the following:

- Installation of landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements consistent with the standards for uranium mill tailing sites, *i.e.*, armoring layer and radon barrier;

- Consolidation of radiologically contaminated surface soil from the Buffer Zone/Crossroads Property to the containment area;

- Application of groundwater monitoring and protection standards consistent with requirements for uranium mill tailing sites and sanitary landfills;

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- Surface water runoff control;
- Gas monitoring and control, including radon and decomposition gas, as necessary;
- Institutional controls to prevent land and resource uses that are inconsistent with a closed sanitary landfill site containing long-lived radionuclides; and
- Long-term surveillance and maintenance of the remedy.

2.2 Post-ROD Site Investigations

In anticipation of performance of Remedial Design/Remedial Action (RD/RA) for OU-1, the OU-1 Respondents prepared and submitted to EPA a Remedial Design Work Plan (RDWP) on November 25, 2008, which described the additional investigations and other activities necessary to develop design documents for implementation of the ROD-selected remedy.

One of the anticipated activities was clearing of the vegetation from Areas 1 and 2 in order to facilitate development of a detailed topographic surface map for these areas and to provide access for the Remedial Design (RD) investigations. To address the potential for release of radionuclides during the vegetation clearing, the OU-1 Respondents collected and analyzed samples of site vegetation from Areas 1 and 2 in advance of receipt of EPA approval or comments on the RDWP. The results of the vegetation sampling were presented in a March 2009 Vegetation Sampling Results Summary in Support of Health and Safety Plan for Vegetation Clearing and Grubbing (TA Woodford and Associates, 2009).

On May 10, 2012, EPA requested that the OU-1 Respondents perform an additional groundwater monitoring event to include all groundwater monitoring wells located at the West Lake Landfill and the adjacent Bridgeton Landfill. This monitoring was performed in July and August 2012 and a report of the monitoring results was submitted to EPA in December 2012 (EMSI, 2012b). On January 31, 2013, EPA requested that the OU-1 Respondents conduct three additional rounds of groundwater monitoring that again included all groundwater monitoring wells located at the West Lake Landfill and the adjacent Bridgeton Landfill (EPA, 2013a). These additional groundwater monitoring events were conducted in April, July, and October and November 2013 and reports of the monitoring results were submitted to EPA in 2013 and 2014 (EMSI, 2013a, 2013b and 2014a).

At the request of EPA and pursuant to an Interagency Agreement, the U.S. Geological Survey (USGS) conducted additional groundwater sampling in offsite private water wells and reviewed the results of the additional groundwater sampling performed at the Site. Based on these studies, the USGS performed an evaluation of background groundwater

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quality relative to radionuclides and the potential origin of radium in groundwater at the West Lake Site (USGS, 2014).

On March 8, 2013, EPA conducted radiological and infrared surveys over the West Lake Landfill using the Airborne Spectral Photometric Environmental Collection Technology (ASPECT) program managed by the EPA Office of Emergency Management (OEM) Chemical Biological Radiological and Nuclear (CBRN) Consequence Management Advisory Team (CMAT). The results of the surveys were presented in a May 2013 report (EPA, 2013b). In addition, in November 2012 EPA also conducted downhole gamma logging in select groundwater monitoring wells at the West Lake Landfill. No report of this work was issued by EPA but a summary table of the results of this downhole logging has been provided to the OU-1 Respondents.

In December 2010, Bridgeton Landfill detected changes in the landfill gas extraction system; specifically, elevated temperatures and elevated carbon monoxide levels (Bridgeton Landfill, LLC, 2013). Further investigation indicated that the South Quarry area of the Bridgeton Landfill was experiencing an exothermic subsurface chemical reaction or event, which has been referred to variously as an "SSR" or "SSE" (Bridgeton Landfill, LLC, 2013).[1] Bridgeton Landfill, LLC has implemented measures such as installation of an ethylene vinyl alcohol (EVOH) liner, installation of additional landfill gas extraction wells, installation and monitoring of temperature probes, and other activities to address the occurrence of an SSE in the South Quarry area of the Bridgeton Landfill. Pursuant to an order from the State of Missouri, Bridgeton Landfill, LLC also began evaluating potential options for installation of a thermal isolation barrier (IB) between the North Quarry portion of the Bridgeton Landfill and Area 1. As part of these evaluations, Bridgeton Landfill, LLC initiated an investigation of subsurface conditions along the boundary between Area 1 and the North Quarry portion of the Bridgeton Landfill to assist with identification of possible alignments and to provide preliminary information relative to possible design criteria for a potential isolation barrier. This investigation was performed in three phases (the Phase 1A, 1B and 1C Investigation) during the fall of 2013 and the winter of 2014, and a report of the results of the investigation was provided to EPA on December 19, 2014 (FEI, 2014).

In response to the SSE, on April 16, 2014, EPA issued an Administrative Settlement Agreement and Order on Consent (ASAOC) to Bridgeton and Rock Road for performance of a removal action for preconstruction work related to a potential thermal isolation barrier (EPA, 2014b). Included as part of the preconstruction work was the design and installation of a perimeter air monitoring program. An Air Monitoring, Sampling and QA/QC Plan was prepared (Auxier & Associates, Inc., 2014), and was approved by EPA on December 5, 2014. Installation of the air monitoring stations was

[1] Bridgeton Landfill and Rock Road prefer the acronym "SSR" because it more accurately describes what's occurring at Bridgeton Landfill (that is, a chemical reaction). However, the acronym "SSE" has been used in prior reports and submittals to EPA by the OU-1 Respondents, so for the sake of consistency, it will continue to be used in future reports and submittals to EPA.

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performed in early 2015, and continuous air monitoring began on May 1, 2015. A report of the results from the first quarter of air monitoring activities (May, June and July 2015) was submitted to EPA on December 9, 2015 (Auxier & Associates, Inc., 2015).

Between April 2014 and January-February 2015, EPA performed air quality monitoring at five locations around the West Lake Landfill Superfund Site. Air quality monitoring also occurred at the residential area known as Spanish Village from April 2014 through July 30, 2015. EPA collected samples for measurement of ionizing radiation (alpha, beta and gamma) by specific exposure pathways (dust/particulates, radon and ambient gamma exposure). EPA also collected samples for volatile organic compound (VOC) analyses. The results of EPA's offsite monitoring have been presented in various reports (Tetra Tech, 2015a, 2015b, 2015c, 2015d and 2015e).

Based on the results obtained from the Phase 1A/1B/1C investigation, EPA determined that additional investigation was needed to delineate the nature and extent of RIM in the south and west portions of Area 1, and on January 15, 2015, EPA requested the OU-1 Respondents to perform the additional investigation (EPA, 2015b). A Work Plan for this additional characterization work was prepared and finalized on May 1, 2015 (EMSI, 2015a) and subsequently approved by EPA on May 5, 2015. The additional investigation (Phase 1D) was performed in the summer of 2015 and, pursuant to direction from EPA, the results of the additional investigation were presented as part of a Comprehensive Phase 1 report that also included the results of the prior Phase 1A, 1B, and 1C investigation. The Comprehensive Phase 1 report was submitted to EPA on December 16, 2015 (EMSI et al., 2015).

On April 20, 2015, EPA requested that the OU-1 Respondents perform additional characterization of Areas 1 and 2 for purposes of providing additional data for evaluation of potential partial excavation remedial alternatives and to support updated calculations of the volume of RIM at the Site (EPA, 2015c). A Work Plan for the Additional Characterization of Areas 1 and 2 was submitted to EPA on September 22, 2015 (EMSI, 2015b), and approved by EPA on September 29, 2015. It was also determined that the additional characterization of Areas 1 and 2 provided an opportunity to collect samples and perform laboratory testing specifically designed to support the fate and transport evaluations requested by EPA in October 2012 as one of six additional evaluations (discussed further in Section 3.2 below). Therefore, this testing was also incorporated into the Work Plan for Additional Characterization of Areas 1 and 2. In addition, a Quality Assurance Project Plan (QAPP) describing the objectives and procedures for this testing was prepared and submitted to EPA on October 14, 2015 (SSPA, 2015), and EPA approval of the QAPP was received on November 3, 2015. The additional characterization work began in October 2015. The field investigation portions of this work were completed in December 2015. Laboratory analyses of the samples and evaluation of the field data are ongoing as of the date of this RI/FFS Work Plan. The collection of samples for the fate and transport laboratory testing was completed in December 2015 and analyses and testing of these samples will continue throughout the winter of 2015 – 2016.

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In addition, on behalf of Cotter Corporation (N.S.L.), Arcadis U.S., Inc. prepared a work plan (Arcadis, 2015) for drilling, collection, and laboratory testing of samples from seven additional borings in Areas 1 and 2. EPA approved this work plan on September 8, 2015, and the drilling and collection of samples from these borings was completed in early January 2016. Laboratory analyses of these samples are ongoing.

On December 9, 2015, EPA issued a Unilateral Administrative Order for Removal Action ("UAO") to Bridgeton, Rock Road, and Cotter (Docket No. CERCLA-07-2016-0002), requiring, among other things, the installation of a non-combustible cover over any portions of Areas 1 or 2 where RIM is present at or near the ground surface (EPA, 2015d). As part of installation of the non-combustible cover, it is possible that additional soil samples may be collected and tested for radionuclides, and additional samples of site vegetation may also be obtained and tested. In addition, EPA has suggested that once the cover is installed, additional radon flux testing could be performed in Area 2 to provide an updated measurement of the overall radon flux from Area 2 reflective of the presence of the non-combustible cover. To the extent that such additional data are collected, the results of such testing will need to be incorporated in the RI Addendum (provided that inclusion of such data does not delay or otherwise effect the schedule for completion of the RI Addendum or Final FS). The presence of this non-combustible cover will also need to be considered as part of the update to the BRA. Specifically, the effects of such a cover will need to be included as part of the evaluation of potential future commercial worker exposures to gamma radiation and radon flux under the baseline (no action) condition.

2.3 Additional Remedial Alternative Evaluations Since the ROD

In January 2010, EPA determined that additional work was necessary to accomplish the objectives of the RI/FS for OU-1. Specifically, EPA directed the OU-1 Respondents to perform a Supplemental Feasibility Study (SFS) consisting of an engineering and cost analysis of remedial alternatives that would remove all RIM from the radiologically-contaminated areas (Areas 1 and 2 and the Buffer Zone/Crossroads properties) in OU-1. This was referred to by EPA as "complete rad removal" (EPA, 2010a). EPA defined "complete rad removal" for purposes of this work as attainment of risk-based radiological cleanup levels specified in OSWER Directives 9200.4-25 and 9200.4-18 (EPA, 1998 and 1997a).[2]

[2] Although it has been termed "complete rad removal," it must be recognized that the remedial alternatives identified by EPA would not result in complete removal of all radionuclides from the landfill. Rather, this was intended to remove radionuclides from Areas 1 and 2 to the degree feasible, such that additional engineering and institutional controls would not be required due to the radiological content of these areas. As these areas may still contain solid wastes after removal of the radiologically-impacted materials, regrading, capping and establishment of institutional controls would still be required for these areas.

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In its January 11, 2010 letter (EPA, 2010a) and the attached SOW (EPA, 2010b) EPA identified two "complete rad removal" alternatives that should be developed and evaluated:

1. Excavation of radioactive materials with off-site commercial disposal of the excavated materials; and

2. Excavation of radioactive materials with on-site disposal of the excavated materials in an on-site engineered disposal cell with a liner and cap if a suitable location outside the geomorphic flood plain can be identified.

The SFS was completed and accepted by EPA in December 2011 (EMSI, 2011).

As mentioned above, in October 2012, EPA requested six additional evaluations be performed to support further evaluations of potential remedial alternatives (EPA, 2012). The six additional evaluations requested by EPA included:

1. Alternative Excavation Volume for Area 2
2. Partial Excavation Alternative
3. Apatite Treatment Technologies
4. Additional Present Worth Calculations
5. Alternative Landfill Cap Design
6. Fate and Transport Modeling

Work Plans have been prepared for all six of these activities and the subsequent status of these activities is described below:

- Alternative Excavation Volume for Area 2 – An initial work plan and a revised work plan were previously prepared for this task; however, moving forward and at EPA's direction, this item is now being addressed through collection of additional site data as part of the Additional Characterization of Areas 1 and 2 and will be further evaluated in the RI Addendum and FFS. Accordingly, EPA has indicated that no further separate work needs to be performed under this work plan.

- Partial Excavation Alternative – A work plan and revised work plan for evaluation of partial excavation alternatives were previously prepared; however, per direction from EPA, these evaluations will now be performed as part of the FFS and therefore, no separate work needs to be conducted for this item.

- Apatite Treatment Technologies – A work plan was prepared and approved by EPA and work under this task is ongoing and will be included in the Final FS to the extent appropriate. Portions of this evaluation may more appropriately be included as part of the evaluations associated with the separate groundwater OU-3.

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- Additional Present Worth Calculations – A work plan for this task was prepared and approved by EPA and a memorandum documenting the results of these evaluations was submitted to EPA on October 31, 2014. EPA has indicated that the results of this evaluation will be incorporated into the Final FS and no further work on this submittal is required.

- Alternative Landfill Cover Design – A work plan for this task was prepared and approved by EPA and a memorandum documenting the results of these evaluations was submitted to EPA on January 27, 2015. EPA has indicated that the results of this evaluation will be incorporated into the Final FS and no further work on this submittal is required.

- Fate and Transport Evaluations – A revised work plan was submitted to EPA on July 31, 2015. Subject to schedule constraints, portions of the fate and transport evaluations will be incorporated into the RI Addendum (e.g., the updated fate and transport evaluations section) and the FFS (e.g., the evaluation of anticipated landfill cover and alternative landfill cover design performance and effectiveness) while the remaining portions will be conducted in conjunction with future groundwater evaluations anticipated to be performed under a separate Operable Unit (OU-3).

On July 3, 2013, EPA directed the OU-1 Respondents to expand the risk analysis section of the SFS to include qualitative assessment of potential risk in the event that (a) the SSE within the South Quarry portion of the Bridgeton Landfill were to migrate to (and reach) OU-1, or (b) if such an event were to otherwise originate in OU-1, including how the design of the ROD-selected remedy would address the presence of an SSE, should one occur (EPA, 2013c). EPA also requested that a qualitative assessment of the effects of a tornado on the integrity of the remedial action be performed. Per EPA's request, work plans for these evaluations were prepared in July 2013 (EMSI, 2013c and 2013d) and subsequently approved by EPA in August 2013 (EPA, 2013d). The tornado evaluation was completed and submitted to EPA on October 13, 2013 (EMSI, 2013e), but has not been approved or commented on by EPA. The SSE evaluation was submitted to EPA on January 14, 2014 (EMSI, 2014b). EPA and MDNR comments on the SSE evaluation were received in April 2014 and discussed in May 2014, at which time EPA indicated that a final report was not required but that any revisions arising out of the comments should be incorporated into the FFS report.

On August 26, 2014, EPA provided Bridgeton Landfill with an Isolation Barrier Alternatives Assessment Report for the West Lake Landfill Site prepared by the U.S. Army Corps of Engineers (USACE, 2014). EPA also requested Bridgeton Landfill to develop more detailed plans for the Isolation Barrier (IB), including bird management and control plans. An Isolation Barrier Alternatives Analysis was prepared and submitted to EPA on October 10, 2014 (EMSI, 2014c). MDNR provided comments on November 24, 2014, and EPA provided comments on this report on March 10, 2015. Per

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EPA direction, responses to agency comments related to potential radon flux were provided on June 9, 2015, and responses to the remaining comments were provided on October 6, 2015.

As part of its April 20, 2015 letter requesting additional characterization of Areas 1 and 2, EPA stated that the Supplemental SFS report (now to be addressed in the Final FS report) should include evaluation of three partial excavation scenarios (EPA, 2015c). EPA requested that revised work plans for the partial excavation scenarios and the alternative Area 2 excavation volume be prepared. The revised work plans were submitted to EPA on July 23, 2015 (EMSI, 2015c and 2015d). However, EPA subsequently indicated that evaluation of the three partial excavation alternatives will be addressed in the FFS.

As previously discussed, pursuant to the UAO issued by EPA on December 9, 2015, Bridgeton, Rock Road, and Cotter are engaged in planning and implementation of placement of a non-combustible cover over those portions of Areas 1 and 2 where RIM is present at or near the ground surface (EPA, 2015d). The presence of such a non-combustible cover will need to be considered as part of the evaluation of potential remedial alternatives for OU-1. Specifically, subject to the timing of completion of the non-combustible cover relative to the schedule for completion of the FFS, the effects of such a cover will need to be included as part of the evaluation of the long term protectiveness of each of the alternatives associated with gamma radiation and radon flux. Subject to the same qualification with regard to the timing of the completion of the non-combustible cover, the volume of material associated with such a cover will also need to be included as part of evaluation of any remedial alternatives that include excavation or regrading of the landfill surface and installation of a new landfill cover.

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3 RI ADDENDUM

This section describes the anticipated updates and revisions to the RI and the BRA.

3.1 RI Updates and Revisions

The RI report was finalized in April 2000, over 15 years ago. In addition to the additional investigations and evaluations previously described in Section 2 of this work plan, numerous other changes have occurred at and around the Site. Some of the changes include the cessation of waste acceptance by the Bridgeton Landfill pursuant to an agreement with the City of St. Louis, development of the Crossroads development on the former Ford property, acquisition of the Buffer Zone by Rock Road Industries, Inc., and the occurrence of the SSE within the South Quarry area of the Bridgeton Landfill, among others. In addition to incorporation of the results of the additional site characterization data obtained since the RI was completed, the changes that have occurred at and near the Site will also be described and addressed, as appropriate, in the RI Addendum report.

The RI Addendum will be prepared consistent with the requirements set forth in the SOW for the RI Addendum/FFS and EPA's RI/FS guidance, and will also reflect the scope and content of the existing RI report. The overall outline and scope of the RI Addendum report is expected to be similar to that of the prior RI report and the outline for an RI report provided in EPA's RI/FS Guidance; however, the content of the report is anticipated to require substantial revision to incorporate the new data and new information obtained since the RI was completed. As a result of the numerous additional investigations and the changes that have occurred at and near the Site since the RI was completed, as described above, the substantial revision and updating of the prior RI will result in an RI Addendum that is effectively a new RI report.

Review of the contents of the prior RI report indicates that the following changes are expected to be required to update the RI:

1. Introduction – Revise to reflect the updated nature of the RI and the SOW for RI Addendum and FFS.

2. Summary of Previous Investigations – Update to include the various investigations conducted since the RI was completed and also to include additional discussion of the prior NRC investigations.

3. Site Background – Update to reflect changes in the understanding of the relationship of the various solid waste units at the Site, cessation of waste acceptance by the Bridgeton Landfill, the occurrence of the SSE within the South Quarry area, and changes in the surrounding land uses.

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4. Site Investigation Activities – This section is anticipated to be significantly revised from being a discussion of the methods used, results obtained, and data quality issues associated with the RI field investigations, to a broader summary of the results of all of the various investigations including the pre-RI investigations such as the NRC investigations, the RI investigations, and the various post-RI investigations.

5. Physical Characterization of the Study Area

    a. Climate – Minimal revisions are anticipated to this section, although it will be updated to reflect additional information obtained from both onsite and offsite meteorological stations as appropriate;

    b. Land use – Minimal revisions are anticipated to this section, although it will be updated to reflect expansion of the west runway at Lambert – St. Louis International airport, cessation of waste acceptance by the Bridgeton Landfill, construction and operation of the solid waste transfer station, and changes in the adjacent land ownership (e.g. the Buffer Zone) and development of the Crossroads property;

    c. Surface features – This section will be updated to describe the limits of the historical and current Missouri River floodplain including a description of the Earth City levee and flood control features;

    d. Biota – No revisions to this section are anticipated as no additional data have been obtained since the RI was completed;

    e. Subsurface Features – Extensive revision of this section is anticipated to be required to reflect the results of the additional drilling, sampling and logging activities that have been performed since the RI, and the presence of the SSE within the South Quarry portion of the Bridgeton Landfill; and

    f. Hydrogeology – To be revised to incorporate the results of the additional water level monitoring data obtained in 2012 and 2013 and the more recent inventory of water supply wells in the area performed by the USGS.

6. Nature and Extent of RIM – This section will be extensively revised to reflect:

    - Revisions to the procedures used to characterize the RIM;

    - Additional information on background levels of radionuclides in soil in the St. Louis area;

    - Revisions to the discussions of numerical standards consistent with the procedures used to identify RIM in the SFS;

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- Revisions to the descriptions of the extent of RIM at the ground surface and in the subsurface and the distribution and volumes of RIM in Areas 1 and 2;

- Updates to the boundaries of Areas 1 and 2 to reflect the updated extent of RIM and the actual extent of the Area 1 and 2 waste disposal boundaries;

- Changes to the summary of RIM occurrences reflecting the results of the additional data obtained since the RI was completed; and

- Changes to the conditions on the former Ford property (now the Buffer Zone and Crossroads Lot 2A2) including changes in land use and discussions of the grading and capping previously performed by AAA Trailer on the Buffer Zone and Crossroads Lot 2A2.

7. Contaminant Extent, Fate and Transport

   a. Extent of Contamination and Potential Contaminant Migration – This section is expected to be revised to incorporate:

      - The results of EPA's offsite air quality monitoring and the ongoing air quality monitoring at the Site;

      - The results of the 2009 vegetation sampling and any additional vegetation sampling that may be performed as part of the work associated with the installation of a non-combustible cover;

      - Additional radon flux measurements if such measurements are performed in conjunction with installation of the non-combustible cover in Areas 1 and 2;

      - Results of any additional surface water or sediment sampling that may be performed if such results are available at the time of development and submittal of the RI Addendum; and

      - Post-ROD groundwater data that are relevant to OU-1 such as the results of the additional groundwater monitoring activities, the USGS evaluation of background water quality and potential origin of radium in groundwater will be included in the RI Addendum as appropriate; however, extensive updates to the existing groundwater discussions for the Site will be addressed under a new Operable Unit for the Site, which will be designated as OU-3.

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b. Contaminant Fate and Persistence – This section will be updated to present any revisions to the radium ingrowth calculations required to reflect the results of the various additional investigations, the results of the fate and transport evaluations particularly the potential leaching and sorption evaluations, and the results of testing being conducted as part of the Cotter additional work.

8. Non-Radiological Chemical Occurrences in Areas 1 and 2

   a. Non-Radiological Constituents in Soil Samples – This section will be updated to reflect the results of the trace metals analytical data obtained during the Phase 1D, Additional Characterization of Areas 1 and 2, and the Cotter investigations;

   b. Non-Radiological Constituents in Erosional Sediments – This section will be revised to include the results of any additional sediment samples that were collected since the ROD was issued if such results are available at the time of development and submittal of the RI Addendum;

   c. Non-Radiological Constituents in Rainwater Runoff Samples - This section will be revised to include the results of any additional surface water samples that were collected since the ROD was issued if such results are available at the time of development and submittal of the RI Addendum;

   d. Non-Radiological Constituents in Perched Water and Area 2 Seep - No revisions to this section are anticipated as no additional data have been obtained since the RI was completed; and

   e. Non-Radiological Constituents in Groundwater – This section is anticipated to require significant revision to incorporate the results of the additional groundwater monitoring performed in 2012 and 2013.

9. Baseline Risk Assessment Summary

   a. Summary of changes to the previous BRA – This section will include a brief summary or listing of significant changes that were made to the final BRA published in April 2000 (Auxier & Associates, 2000).

   b. Human Health Evaluation – The summary of the Human Health Evaluation is expected to be revised to reflect updates to the various source term activity levels and radium ingrowth calculations based on the results of the additional investigations, any changes in exposure scenarios, exposure factors or the toxicity values that may have occurred since the prior BRA was completed, and revisions to the risk characterization and

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the uncertainty assessment resulting from such changes (see additional discussion under Section 3.2 below).

c. Ecological Evaluation – The summary of the Ecological Risk Assessment will be revised as necessary to reflect the results of any changes that may be made to the ecological assessment (see additional discussion under Section 3.2 below).

10. Summary and Conclusions – This section is expected to be revised to reflect the results of the additional investigations and evaluations that have been performed since the RI was completed and the revisions to all of the preceding sections of the RI as described above. This section will also present a new Conceptual Site Model (CSM).

3.2 BRA Updates

Both the Human Health Risk Assessment and to a lesser extent the Ecological Assessment portions of the BRA will be updated as described below.

3.2.1 Updates to the Human Health Risk Assessment

The following is a listing of potential updates to the Human Health Risk Assessment:

1) Evaluate impacts of new concentration and toxicity data on Constituents of Concern selected for quantitative assessment.

   a) Compile a list of Constituents of Potential Concern (COPCs) from historical search and available analytical data.

   b) Select Chemicals of Concern (COCs) from the COPC list by comparing their maximum concentrations to current EPA Regional Screening Levels.

   c) Tabulate selected COC list alongside the two previous COC lists developed in April 2000 for the original baseline and in December 2011 for the SFS.

2) Review previously approved Conceptual Site Model (CSM) relative to potential receptors and exposure pathways and update as necessary.

   a) Receptor behavior will be re-evaluated to conform with changes in the CSM.

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b) Evaluate whether new information about the Site or receptors changes the exposure pathways identified in the accepted conceptual model of potential receptors and exposure pathways.

c) Descriptive exposure parameter values will be reviewed and updated as necessary using guidance provided in OSWER Directive 9200.1-120 (EPA, 2014a).

d) Present CSM of potential receptors and exposure pathways pictorially as an updated figure.

3) Assess impact of new data on location and delineation of RIM

a) Evaluate potential effects of the updated extent of RIM on exposure point locations; and

b) Evaluate updated exposure point locations on receptor selection and descriptions.

4) Revised Representative Concentrations

a) Identify population distributions of COC concentrations – Evaluate the population distributions using graphical representations like scatter plots and column charts to illustrate distributions and trends and tests for normal, log-normal or non-parametric distributions using ProUCL software.

b) If the distribution of concentrations in a given population can be represented by a normal distribution, calculate 95% upper confidence limit (UCL) on the arithmetic mean. If the population exhibits a log-normal distribution, perform a log-transform on the data and calculate the 95% UCL on the mean of the log-transformed data. Use ProUCL to evaluate population distributions and calculate UCL and mean values.

c) Tabulate 95% UCL results and use them as the representative exposure point concentrations for subsequent risk calculations.

5) Updated Toxicity Assessment

a) Tabulate Slope Factors, Unit Risks, Reference Doses, and Reference Concentrations, as appropriate using most recent EPA web calculator data tables and present tabulated summaries of the revised values.

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6) Updated Risk Characterization

   a) Use EPA web-based risk calculator to calculate risks to target receptors from baseline conditions. These calculators incorporate post-baseline changes to toxicity data and exposure parameter values. The results of these evaluations will be tabulated and/or presented as spreadsheets consistent with the recommendations in EPA's Risk Assessment Guidance for Superfund – Part D.

   b) Update risk characterization in baseline risk assessment to include criteria in RAGS Part E (Dermal) and Part F (Inhalation) as appropriate.

3.2.2 Updates to the Ecological Risk Assessment

The Ecological Risk Assessment will be reviewed and updated as needed including:

1) Problem Formulation

   a) Biological Characterization – no updates to this section are anticipated as no additional characterization of the flora and fauna in the site area has been performed since the original BRA was completed.

   b) Identification of Potential Chemicals of Concern – no updates to this section are anticipated as no additional chemicals have been identified since the original BRA was completed and the additional site data collected since the BRA was completed were obtained from the subsurface below the depths of concern (e.g., 5 ft.) for ecological exposures identified in the BRA; however, the additional data will be reviewed to determine if any data were obtained from within the upper five feet that would necessitate changes to the exposure concentrations.

   c) Identification of Exposure Pathways – no updates to this section are anticipated because the potential exposure pathways have not changed.

   d) Selection of Assessment Endpoints – no updates to this section are anticipated as the assessment endpoints have not changed.

   e) Site Ecological Conceptual Model – because the factors listed above have not changed, no changes to the ecological conceptual model are anticipated.

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2) Ecological Exposure Assessment

   a) Selection of Representative Receptor Species - no updates to this section are anticipated as no additional characterization of the flora and fauna in the site area has been performed since the original BRA was completed.

   b) Exposure Pathways – because the representative receptor species will not have changed, no updates to this section are anticipated.

   c) Quantification of Exposure – EPA risk assessment guidance and databases will be reviewed to assess whether any changes to the bio-concentration factors need to be made.

3) Ecological Effects Assessment – EPA risk assessment guidance and databases will be reviewed to assess whether any changes need to be made to the Benchmark Values used in the prior ecological risk assessment.

4) Ecological Risk Characterization – to the extent that any factors associated with the criteria listed above are revised, the characterization of potential risks to the ecological receptors will be revised.

5) Uncertainty Analysis – to the extent that the ecological risk characterization is revised, the uncertainties associated with the site data, exposure assessment, effects assessment and/or risk characterization will be re-evaluated.

6) Conclusions – to the extent that any revisions are made to the ecological risk assessment, the conclusions section will be updated.

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4 FINAL FEASIBILITY STUDY

EPA's SOW for the RI Addendum and FFS identifies three partial excavation alternatives and two other remedial alternatives which, in addition to the No Action Alternative, results in the following six remedial alternatives to be evaluated in the FFS:

1. No Action – Required by the National Contingency Plan (NCP) and RI/FS guidance to provide a baseline against which all of the other alternatives are evaluated[3];

2. Partial Excavation 1,000 pCi/g – Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 1,000 pCi/g[4];

3. Partial Excavation 52.9 pCi/g – Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 52.9 pCi/g down to a total depth of 16 foot beneath the 2005 topographic surface[5];

4. Partial Excavation Based on Expected Land Use – Partial excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than a risk-based level to be developed based on the reasonably anticipated future land use of the Site; and

5. Full Excavation with Offsite Disposal – Excavation of all soil/waste containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) with activity levels greater than 7.9 pCi/g;

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[3] The SOW identifies an alternative no. 3 "Leaving all RIM in place on-site." Subsequent discussions with EPA indicated that this alternative was the No Action Alternative.

[4] In all cases evaluated in the baseline, thorium-230 and radium-226 (plus decay products) accounted for more than 95% of the risk to the target receptors. Other radionuclides are co-located with radium-226 and thorium-230 and are projected to produce risks to the future groundskeeper of $<10^{-7}$. Remediation of the thorium-230 and radium-226, by themselves, would reduce the total risks from RIM to below 10^{-4}. Any remediation of radium-226 and thorium-226 would also lower the negligible risks from these ancillary radionuclides still further.

[5] The SOW indicates that the Respondents have the ability to propose in the Work Plan for the RI Addendum and Final FS a different depth to be used for this alternative. However, given that the additional characterization work is ongoing, it is premature to propose an alternative depth at this time. In the event that an alternative depth interval reflective of the actual site data is identified during evaluation of the data during preparation of the RI Addendum and FFS reports, the Respondents will contact EPA to discuss any proposed alternative depth and obtain EPA approval for such a proposal at that time.

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6. 2008 ROD-Selected Remedy (Former Alternative L4 and Alternative F4) – Containment consisting of regrading and installation of a new landfill cover and other remedial components for the landfill, as described in Section 2.1, and consolidation of any radiologically-impacted soil that may remain on the former Ford property (now known as the Buffer Zone and Crossroads Lot 2A2) into the containment areas in Area 1 and 2 prior to placement of additional fill and construction of the new landfill cover.

The EPA definition of the "complete rad removal" alternative is based on combined radium and combined thorium activities as specified in OSWER Directive No. 9200-4.18 and 9200-4.25. In addition to combined radium and combined thorium, the combined uranium activity will also be considered as appropriate. However, based on the prior SFS evaluations of the "complete rad removal" alternatives, uranium was not found to be a driver for identification of RIM because any locations/depth intervals that contained uranium above its criteria for "complete rad removal" (54.5 pCi/g) also contained radium and/or thorium activity levels greater than their respective criteria for unrestricted land use. In addition, no uranium equivalent criteria were identified by EPA for the partial excavation alternatives, therefore, these alternatives are based solely on the combined radium and combined thorium activity levels. As noted above, use of the combined radium and combined thorium activity levels to define the materials to be included in the scope of the partial excavation alternatives should also result in inclusion of any materials with commensurate uranium activity.

4.1 Additional Evaluations Required by the SOW for RI Addendum and FFS

Various additional engineering and other types of evaluations need to be performed prior to the evaluation of the remedial alternatives listed above against the threshold and balancing criteria specified in the NCP. The nature and scope of the additional evaluations are described in the following subsections of this work plan.

4.1.1 Additional Technology Evaluations

EPA's SOW for the RI Addendum and FFS requires additional evaluations of several technologies including:

- Volume separation techniques and other physical and/or chemical treatment technologies as they relate to partial and full excavation alternatives;

- Evaluation of the long-term effectiveness of proposed landfill caps/covers in addressing both humid region conditions and long-term shielding of the RIM;

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- Evaluation of the long-term effectiveness of a landfill cap/cover on potential migration of COCs to leachate and groundwater;

- Evaluation of apatite/phosphate based treatment technologies as appropriate to solid matrices (note: evaluation of these technologies relative to possible groundwater applications may be further considered and/or implemented under the pending new operable unit, OU-3); and

- Additional evaluation of potential technologies to control bird populations based on the methods described in the draft Bird Mitigation Plan developed by LGL, Ltd (2015) as part of the IB Alternatives Assessment (EMSI, 2014c and 2015e).

4.1.2 Other Additional Evaluations

EPA's SOW for the RI Addendum and FFS requires several other additional evaluations to be performed as part of the FFS including:

- Discussion and consideration of the occurrence of an SSE and evaluation of an Isolation Barrier, including a brief discussion of pending/on-going IB-related design and field work;

- Acknowledgement of any environmental justice concerns;

- Updates to the evaluation of potentially applicable or relevant and appropriate requirements of other environmental regulations (ARARs) in particular additional detailed assessment of the requirements associated with the Uranium Mill Tailings Remediation Control Act (UMTRCA) and the Resource Conservation and Recovery Act (RCRA) Subtitle C landfill cover design requirements as appropriate;

- Discussion of climate change and vulnerabilities associated with extreme weather events such as potential impacts associated with possible flooding or tornadoes and any system vulnerabilities to potential climate change in accordance with EPA's "Climate Change Adaptation Technical Fact Sheet: Landfills and Containment as an Element of Site Remediation (EPA, 2014c) and the EPA Region 7 Climate Change Adaption Implementation Plan (EPA, 2014d); and

- Potential impacts of an SSE within OU-1 and the effects of an Isolation Barrier.

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4.2 Additional Engineering Evaluations for the Remedial Alternatives

In addition to the evaluations listed above, additional engineering evaluations will need to be performed to support evaluation of the remedial alternatives against the threshold and balancing criteria specified in the NCP. The nature and scope of the additional engineering evaluations are described below.

4.2.1 Development of a Risk-Based Criteria Based on Land Use

In accordance with previously established controls for the allowable land uses at the West Lake Landfill Site, future land use will be limited to industrial and commercial uses that do not permit construction of buildings or invasive activities such as digging or drilling in Radiological Areas 1 and 2. Based on the existing land use restrictions, the following approach will be used to develop appropriate risk-based criteria reflective of the allowable future land uses:

1) Develop a conceptualization of potential sources, media, transport mechanisms, and receptors for the Site relative to potential exposures associated with the anticipated current and future land use including the following:

    a. Identify plausible uses for the property;

    b. Identify hypothetical receptors that may participate in activities on the property;

    c. Identify types and sources of radioactivity on the property; and

    d. Identify potential exposure transport pathways that may result in radioactive exposures to postulated receptors.

2) Estimate potential exposures including:

    a. Evaluate transport of radioactive materials to receptor locations;

    b. Quantify the behaviors of postulated receptors;

    c. Use 1 pCi/g as the initial concentration for each radionuclide of concern to establish site-specific unit risk factors for those radionuclides;

    d. Quantify the potential uptake of radioactive material in the body; and

    e. Quantify direct radiation exposure from material remaining outside the body.

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3) Convert the exposure rates calculated from the 1 pCi/g initial activity level to isotope specific doses and risks.

4) Calculate allowable activity levels using a mixture of radionuclides present at the Site and the depth-specific unit risk factors.

Under CERCLA, risk assessment generally follows a prescribed method except where site-specific considerations apply, as they do in this case. Areas 1 and 2 at the West Lake Landfill contain subsurface deposits of radioactive material, some of which emits gamma radiation. Gamma radiation can result in direct, proximal exposures to nearby individuals. The intensity of this gamma radiation at a target location is weakened when interceding matter shields the target from the source. The intensity is also weakened as the distance between the source and the target increases. The current CERCLA method of risk calculation, as embodied in EPA's "PRG Calculator,"[6] is capable of calculating risks to receptors from both surface and subsurface deposits of radionuclides. As any partial excavation remedy will, by definition, leave subsurface deposits of radionuclides in-place, the subsurface calculator option will be the preferred method of calculating risks from this type of geometry.

If the material is deeper than the EPA web calculator can accept, MicroShield ™ will be used as an alternative method to assess attenuation of gamma radiation and the reduction in associated risk. Site-specific input values will be used where possible, and commonly accepted default values will be used to quantify parameters for which site-specific information is lacking.

Concentrations of the radionuclides of concern that result in risks on the order of 10^{-4} will be calculated for different depths. A description of the conceptual model, tables of input values (and justification), and a copy of the two confirmatory RESRAD summary output files (dose and risk) documenting the concentrations of radionuclides in the mixture that produce 10^{-4} risk at various depth intervals (currently planned as the surface, 2 ft, 4 ft, and 8 ft depths, but these depths are subject to change) will be included in the FFS.

4.2.2 Partial Excavation RIM Identification and Volume Estimates

With respect to the partial excavation options, evaluations will need to be performed to identify the extent and volume of RIM that would be included under each alternative. Such evaluations cannot be conducted until all of the additional data being obtained as part of the Additional Characterization of Areas 1 and 2 and the additional work being performed by Cotter have been provided by the laboratory and subjected to data validation.

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[6] http://epa-prgs.ornl.gov/cgi -bin/radionuclides/rprg_search

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Specifically, once the final laboratory data are available, the downhole and core sample gamma measurements and laboratory data will need to be assembled and evaluated. An approximate correlation will need to be developed between the two types of data to identify the levels of gamma activity that are expected to reflect the specific remediation goals identified by EPA for each of the partial excavation alternatives. The approach to these evaluations is expected to be similar to the approach used previously in the SFS to identify the specific soil/waste occurrences and depth intervals to be included in the scope of the "complete rad removal" alternatives evaluated in the SFS (please see Appendix B-1 of the 2011 SFS report).

Once the criteria are established for identification of the specific gamma and radionuclide activity levels associated with the remediation goals for the various partial excavation alternatives, the results of these evaluations will tabulated to identify the locations and depth intervals that contain, or are likely to contain, radionuclide occurrences above the stated cleanup levels. The survey data for these locations and the depth intervals will be tabulated to identify the location and elevation of the intervals that contain, or are likely to contain radionuclides above the cleanup levels. These locations and depth intervals will then be correlated to identify general zones where radionuclides are expected to be present at activities greater than the cleanup levels.

Once the locations and intervals of RIM that exceed the alternative-specific remediation goals have been identified, the three-dimensional extent of the RIM above the remediation goals will be estimated. The procedures to be used to estimate the three-dimensional extent of RIM above remediation goals are currently anticipated to be the same engineering procedures previously used in the SFS to estimate the extent of RIM associated with the "complete rad removal" alternatives (please see Appendix B-2 of the 2011 SFS report). Geostatistical methods will also be used to estimate the three-dimensional extent of RIM above the remediation goals for each partial excavation option.

Once the three-dimensional extent of RIM has been estimated (regardless of the method used to develop the extent), the volumes of overburden (non-RIM) and RIM will be calculated for each partial excavation alternative. The methods to be used to calculate the overburden and RIM volumes are expected to be the same as those that were previously used to calculate the overburden and RIM volumes for the "complete rad removal" alternatives evaluated in the SFS (please see Appendix B-1 of the 2011 SFS report).

4.2.3 Full Excavation RIM Extent and Volume

The evaluation of the extent of RIM associated with the prior SFS "complete rad removal" alternatives will need to be redone to reflect the results of the additional investigations that have been performed since the SFS was completed. The procedures to be used to update the extent of RIM will be the same as those previously used in the SFS

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(please see Appendices B-1 and B-2 of the 2011 SFS report). Once the estimated extent of RIM has been updated, the volumes of overburden and RIM will be revised.

The revised extent of RIM in Area 1 will include RIM located within that portion of Area 1 that is overlain by the above-grade portion of the North Quarry portion of the Bridgeton Landfill. Therefore, the evaluation of the volume of overburden to be removed to allow for full excavation of RIM will also require evaluation of temporary removal, stockpiling and replacement of a large amount of the above-grade portion of the North Quarry portion of the Bridgeton Landfill, including temporary shut-down, removal and ultimate replacement of associated infrastructure [e.g., access roads, landfill gas extraction wells, landfill gas conveyance piping, leachate extraction points and leachate conveyance piping, soil and possibly EVOH cover components].

4.2.4 Revisions to ROD-Selected Remedy Scope

Previously, it was anticipated that the extent of the new landfill cover associated with the ROD-Selected Remedy would terminate near the base of the slope associated with the north side of the above-grade portion of the North Quarry portion of the Bridgeton Landfill. As discussed above, the revised extent of RIM in Area 1 will include RIM located within that portion of Area 1 that is overlain by the above-grade portion of the North Quarry portion of the Bridgeton Landfill. Therefore, evaluations will need to be performed in consultation with Bridgeton Landfill personnel as to how best to integrate the ROD-selected remedy landfill cover for Area 1 with the existing landfill cover requirements associated with the Bridgeton Landfill.

4.3 NCP Required Evaluations of Remedial Alternatives

All of the remedial alternatives will be evaluated using the threshold and primary balancing criteria provided in the NCP at 40 CFR § 300.430. A comparative analysis of the results of these evaluations of the alternatives against the No Action alternative will also be performed.

These evaluations will be performed consistent with the requirements set forth in the NCP and EPA's RI/FS guidance (EPA, 1988) using the same methodologies that were previously used and described in the SFS (EMSI, 2011).

Although not required by the SOW for the SFS (EPA, 2010b), the NCP requires remedial alternatives to be evaluated in terms of Modifying Criteria which include State and community acceptance. State acceptance will be evaluated by EPA based on comments and feedback provided by MDNR on the FFS and Proposed Plan. State and community acceptance will be evaluated by EPA as part of any decision process that may be undertaken by EPA after completion of the SFS.

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4.4 Comparative Analysis of "Complete Rad Removal" Alternatives

The relative performance of each of the alternatives will be evaluated against the performance of the other alternatives for each of the threshold and primary balancing criterion during the comparative analysis. This comparative analysis will identify the advantages and disadvantages of each alternative.

4.5 FFS Preparation

Upon completion of the engineering and NCP evaluations, a draft FFS Report will be prepared. The FFS report will integrate the prior 2006 FS report and the 2011 SFS report, and include updates to reflect the results of the additional investigations and evaluations performed since the ROD was prepared as well as those performed as part of the FFS evaluations described above.

A potential outline for the FFS Report is as follows:

1. Introduction, Purpose, and Scope
2. Site Conditions
3. Potential ARARs and Remedial Action Objectives
4. Technology Screening and Remedial Alternative Development
5. Detailed Analysis of Alternatives
6. Comparative Analysis of Alternatives
7. References

The FFS report is currently anticipated to include the following appendices (which are subject to change):

A. Existing Institutional Controls, City of St. Louis - Negative Easement and Restrictive Covenant on West Lake Landfill, and FAA ROD, MOU, and Advisories

B. Technical Memorandum: Evaluation of Potential "Hot-Spot" Occurrences and Removal for Radiologically-Impacted Soil

C. Identification and Quantification of the Volume of RIM above Remediation Goals

D. Off-site Disposal Facilities – Waste Acceptance Criteria

E. Derivation of an Industrial Use Risk-Based Criteria for a Partial Excavation Alternative

F. Required Cover Thicknesses Calculations

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G. Conceptual Environmental Monitoring Plan

H. Evaluation of Potential Risks Associated with the Proposed Remedial Alternatives

I. Estimated Greenhouse Gas Emissions Associated with the Alternatives

J. Estimated Project Schedules for the Remedial Alternatives

K. Estimated Costs for the Remedial Alternatives

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5 SCHEDULE TO COMPLETE RI ADDENDUM AND FFS

An anticipated schedule for the various activities to be conducted to complete the RI Addendum and Final FS is presented on Table 1. This schedule meets the requirement set forth in the Statement of Work for the RI Addendum and FFS; however, as previously discussed with EPA, the OU-1 Respondents have some concerns about the ability to realistically meet EPA's aggressive deadlines, but will make their best efforts to do so

The status of the work performed to complete the RI Addendum and FFS will be tracked and reported to EPA in monthly status reports, as required by the Administrative Order on Consent, as amended (EPA, 1993, 1997c and 2008b).

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6 REFERENCES

Arcadis, 2015, Memorandum in Support of Further Characterization of Extent of Radiologically Impacted material in Areas 1 and 2 – West Lake Landfill Operable Unit-1, Bridgeton, Missouri, May 18.

Auxier & Associates, Inc. (Auxier), 2015, West Lake Landfill Perimeter Air Monitoring Quarterly Report, December.

Auxier, 2014, Air Monitoring, Sampling and QA/QC Plan, West Lake Landfill Superfund Site Operable Unit 1, October.

Auxier, 2000, Baseline Risk Assessment, West Lake Landfill Operable Unit 1, April 24.

Bridgeton Landfill, LLC, 2013, Bridgeton Landfill North Quarry Contingency Plan – Part 1, June 27.

Engineering Management Support, Inc. (EMSI), 2015a, Phase 1D Investigation – Additional Characterization of Extent of Radiologically-Impacted Material in Area 1: Revised Addendum to Phase 1 Work Plans for Isolation Barrier Investigation, West Lake Landfill Operable Unit-1, Bridgeton, Missouri, May 1.

EMSI, 2015b, Work Plan for Additional Characterization of Extent of Radiologically-Impacted Material in Areas 1 and 2, West Lake Landfill Operable Unit-1, Bridgeton, Missouri, September 29.

EMSI, 2015c, Revised Work Plan Partial Excavation Alternative, West Lake Landfill Operable Unit-1, July 23.

EMSI, 2015d, Revised Work Plan Alternative Area 2 Excavation Depths and Volumes, West Lake Landfill Operable Unit-1, July 23.

EMSI, 2015e, Responses to EPA's and Other Agencies' Comments on the Isolation Barrier Alternatives Analysis, West Lake Landfill Superfund Site, Bridgeton, Missouri, October 6.

EMSI, 2014a, Groundwater Monitoring Report, October 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1, February 21.

EMSI, 2014b, Evaluation of Possible Impacts of a Potential Subsurface Smoldering Event on the Record of Decision – Selected Remedy for Operable Unit-1 at the West Lake Landfill, January 14.

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EMSI, 2014c, Isolation Barrier Alternatives Analysis, West Lake Landfill Superfund Site, October 10.

EMSI, 2013a, Groundwater Monitoring Report, July 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1, December 1.

EMSI, 2013b, Groundwater Monitoring Report, April 2013 Additional Groundwater Sampling Event, West Lake Landfill Operable Unit-1, July 8.

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Table

Table 1: Anticipated Schedule for RI Addendum and Final Feasibility Study

Field Work			
Activity	Start	Duration	Completion
AREA 1			
Drilling	11/9/2015		11/15/2015
Core log & scan	11/24/2015	6	11/30/2015
Lab Analyses	11/30/2015	45	1/14/2016
Data Validation	1/14/2016	21	2/4/2016
AREA 2			
Drilling	11/16/2015	22	12/8/2015
Core log & scan	12/21/2015	10	12/31/2015
Lab Analyses	12/21/2015	45	2/14/2016
Data Validation	2/4/2016	21	3/6/2016
Fate & Transport Testing and Evaluations			
Drilling	12/9/2015	5	12/14/2015
Core log & scan	12/14/2015	2	12/16/2015
Lab Analyses	12/14/2015	90	3/15/2016
Data Validation	1/28/2016	21	4/5/2016
F&T Evaluations	3/15/2016	105	6/28/2016
Cotter Borings			
Drilling	12/15/2015	5	12/20/2015
Core log & scan	1/2/2016	4	1/6/2016
Lab Analyses	1/2/2016	45	2/20/2016
Data Validation	2/16/2016	21	3/12/2016
RI/FS Work Plan			
Outline	12/9/2015	-5	12/4/2015
Draft Work Plan	12/9/2015	9	12/18/2015
EPA Review	12/18/2015	14	1/1/2016
Final Work Plan	1/1/2016	10	1/11/2016
EPA Approval	1/11/2016	14	1/25/2016

RI Addendum			
Activity	Start	Duration	Completion
Update non-soil sections	12/8/2015	60	2/6/2016
Data Tabulation	2/4/2016	7	3/19/2016
Data Plotting	3/19/2016	14	4/2/2016
Update soil sections	3/19/2016	7	3/26/2016
Update BRA Evaluations	3/19/2016	56	5/14/2016
Prepare BRA summary	5/14/2016	7	5/21/2016
Prepare draft RI Addendum	3/26/2016		6/4/2016
Client Review of Draft RI Add	6/4/2016	28	7/2/2016
Prepare Final Draft RI Add	7/2/2016	7	7/9/2016
EPA Review of Draft RI Addendum	7/9/2016	28	8/6/2016
Prepare Final RI Addendum	8/6/2016	21	8/27/2016
EPA Schedule 60 days after Area 2 data			*7/10/2016*
No. of Days after Reciept of Validated Data			*119*

Note: The above schedules are subject to revision based on the actual rate of progress of the drilling, logging and sample collection activities.

Table 1: Anticipated Schedule for RI Addendum and Final Feasibility Study

Update ROD-Selected Remedy Calculations				Complete Rad Removal Calculations			
Activity	Start	Duration	Completion	Activity	Start	Duration	Completion
ROD Remedy Grading Plans	1/25/2016	14	2/8/2016	**AREA 1**			
ROD Remedy Construct Cost Est.	2/8/2016	14	2/22/2016	RIM ID for CRR	2/4/2016	7	2/11/2016
ROD Remedy Construct Schedule	2/22/2016	14	3/7/2016	RIM Extent for CRR	2/11/2016	7	2/18/2016
ROD Remedy Risk Evaluations	3/7/2016	28	4/4/2016	CRR RIM Volume	2/18/2016	7	2/25/2016
				CRR Excavation Plans	2/25/2016	14	3/10/2016
				CRR Final Grading Plans	3/10/2016	14	3/24/2016
				CRR Construct Cost Est.	3/24/2016	7	3/31/2016
				CRR Construct Schedule	3/24/2016	7	3/31/2016
				CRR Risk Evaluations	3/31/2016	28	4/28/2016
				AREA 2			
				RIM ID for CRR	3/6/2016	7	3/13/2016
				RIM Extent for CRR	3/13/2016	7	3/20/2016
				CRR RIM Volume	3/20/2016	7	3/27/2016
				CRR Excavation Plans	3/27/2016	7	4/3/2016
				CRR Final Grading Plans	4/3/2016	14	4/17/2016
				CRR Construct Cost Est.	4/17/2016	7	4/24/2016
				CRR Construct Schedule	4/17/2016	7	4/24/2016
				CRR Risk Evaluations	4/24/2016	28	5/22/2016

Table 1: Anticipated Schedule for RI Addendum and Final Feasibility Study

Partial Excavation #1 52.9 pCi/g up to 16 ft depth Calculations				Partial Excavation #2 Industrial Use Criteria Calculations			
Activity	Start	Duration	Completion	Activity	Start	Duration	Completion
AREA 1				**AREA 1**			
RIM ID for PE Alt #1	2/11/2016	7	2/18/2016	RIM ID for PE Alt #2	2/18/2016	7	2/25/2016
RIM Extent for PE Alt #1	2/18/2016	7	2/25/2016	RIM Extent for PE Alt #2	2/25/2016	7	3/3/2016
PE Alt #1 RIM Volume	2/25/2016	7	3/3/2016	PE Alt #2 RIM Volume	3/3/2016	7	3/10/2016
PE Alt #1 Excavation Plans	3/3/2016	14	3/17/2016	PE Alt #2 Excavation Plans	3/10/2016	14	3/24/2016
PE Alt #1 Final Grading Plans	3/17/2016	14	3/31/2016	PE Alt #2 Final Grading Plans	3/24/2016	14	4/7/2016
PE # 1 Construct Cost Est.	3/31/2016	7	4/7/2016	PE # 2 Construct Cost Est.	4/7/2016	7	4/14/2016
PE #1 Construct Schedule	3/31/2016	7	4/7/2016	PE #2 Construct Schedule	4/7/2016	7	4/14/2016
PE #1 Risk Evaluations	4/7/2016	28	5/5/2016	PE #2 Risk Evaluations	4/14/2016	28	5/12/2016
AREA 2				**AREA 2**			
RIM ID for PE Alt #1	3/13/2016	7	3/20/2016	RIM ID for PE Alt #2	3/20/2016	7	3/27/2016
RIM Extent for PE Alt #1	3/20/2016	7	3/27/2016	RIM Extent for PE Alt #2	3/27/2016	7	4/3/2016
PE Alt #1 RIM Volume	3/27/2016	7	4/3/2016	PE Alt #2 RIM Volume	4/3/2016	7	4/10/2016
PE Alt #1 Excavation Plans	4/3/2016	7	4/10/2016	PE Alt #2 Excavation Plans	4/10/2016	7	4/17/2016
PE Alt #1 Final Grading Plans	4/10/2016	14	4/24/2016	PE Alt #2 Final Grading Plans	4/17/2016	14	5/1/2016
PE # 1 Construct Cost Est.	4/24/2016	7	5/1/2016	PE # 2 Construct Cost Est.	5/1/2016	7	5/8/2016
PE #1 Construct Schedule	4/24/2016	7	5/1/2016	PE #2 Construct Schedule	5/1/2016	7	5/8/2016
PE #1 Risk Evaluations	5/1/2016	28	5/29/2016	PE #2 Risk Evaluations	5/8/2016	28	6/5/2016

Table 1: Anticipated Schedule for RI Addendum and Final Feasibility Study

Partial Excavation #3 1,000 pCi/g Calculations				Final Feasibility Study			
Activity	Start	Duration	Completion	Activity	Start	Duration	Completion
AREA 1				Update non-remedy sections	1/25/2016	60	3/25/2016
RIM ID for PE Alt #3	2/25/2016	7	3/3/2016	Remedy Evaluations	4/4/2016		6/19/2016
RIM Extent for PE Alt #3	3/3/2016	7	3/10/2016	Prepare draft FFS Text	5/19/2016	14	7/3/2016
PE Alt #3 RIM Volume	3/10/2016	7	3/17/2016	Prepare Appendices	6/12/2016	21	7/3/2016
PE Alt #3 Excavation Plans	3/17/2016	14	3/31/2016	Compile FFS and QC Review	7/3/2016	14	7/17/2016
PE Alt #3 Final Grading Plans	3/31/2016	14	4/14/2016	Client Review of Draft FFS text	7/17/2016	28	8/14/2016
PE # 3 Construct Cost Est.	4/14/2016	7	4/21/2016	Prepare Revised Draft FFS	8/14/2016	14	8/28/2016
PE #3 Construct Schedule	4/14/2016	7	4/21/2016	EPA Review of Draft FFS	8/28/2016	28	9/25/2016
PE #3 Risk Evaluations	4/21/2016	28	5/19/2016	Prepare Final FFS	9/25/2016	28	10/23/2016
AREA 2				*EPA Schedule 175 days*			*8/28/2016*
RIM ID for PE Alt #3	3/27/2016	7	4/3/2016				
RIM Extent for PE Alt #3	4/3/2016	7	4/10/2016				
PE Alt #3 RIM Volume	4/10/2016	7	4/17/2016				
PE Alt #3 Excavation Plans	4/17/2016	7	4/24/2016	*No. of Days after Reciept of Validated Data*			*175*
PE Alt #3 Final Grading Plans	4/24/2016	14	5/8/2016				
PE # 3 Construct Cost Est.	5/8/2016	7	5/15/2016				
PE #3 Construct Schedule	5/8/2016	7	5/15/2016				
PE #3 Risk Evaluations	5/15/2016	28	6/12/2016				

Figures

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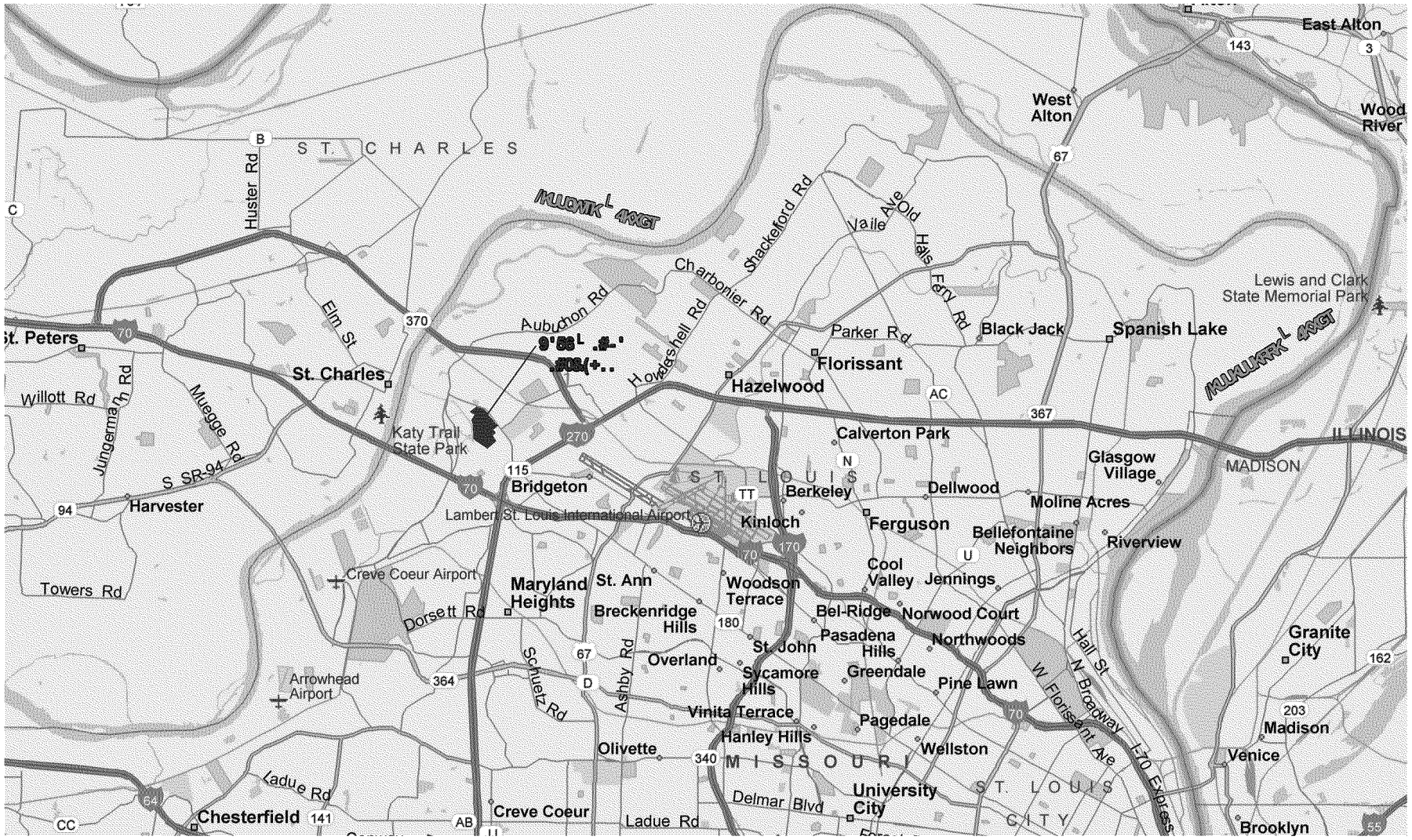

Figure 1

General Location Map

West Lake Landfill Superfund Site

EMSI Engineering Management Support, Inc.

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Figure 2

Facility Layout

West Lake Landfill Superfund Site

EMSI Engineering Management Support, Inc.