US Army Corps of Engineers
St. Louis District

APPENDIX C

RISK SCREENING OF LIME/CLASS C FLY ASH SLURRY INJECTION FOR LEVEE STABILIZATION

ENVIRONMENTAL ASSESSMENT

Alton to Gale Organized Levee Districts
Illinois and Missouri

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1.0 INTRODUCTION

This Appendix C to the Environmental Assessment (EA) was prepared to present a screening of the potential environmental risks associated with the efforts of the U.S. Army Corps of Engineers (USACE), St. Louis District to correct a design deficiency associated with numerous levee reaches in the Alton-to-Gale Levee Districts. The design deficiency, which has resulted in numerous slides in the levee embankments, will be corrected by injecting a lime/Class C fly ash slurry into the levee soils improving their geotechnical characteristics and reducing the risk of future slides on the levee embankments. The risk screening evaluates potential human health, ecological and agrarian risks associated with the use of the lime/Class C fly ash slurry by comparing estimated exposure concentrations to risk screening criteria.

1.1. Description of Design Deficiency

The Alton to Gale Levee System is made up of seventeen small levees grouped together into a combined 200+ mile system on the Middle Mississippi River in the states of Illinois and Missouri. The levees are all located along the Mississippi River, extending from Alton, Illinois, (Mississippi River Mile 203) to Gale, Illinois, (Mississippi River Mile 46). All levee sections requiring repair are located in Illinois except for those of the Bois Brule Drainage and Levee District (D&LD) which are located in Perry County, Missouri.

During the construction of the levees, locally available soils were used, which included highly plastic clays. Those plastic clays have low residual long-term shear strengths and are subject to extreme volume changes. Those volume changes lead to the formation of cracks during dry periods that subsequently fill with water during precipitation events. These conditions in the clay levee soils reduce their shear strength and lead to embankment movements (slides) that can compromise levee integrity. The St. Louis District has an ongoing program in place since 1961 to inspect the levees and document the existence of levee slides. The majority of the

documented levee slides have occurred within the levee district reaches constructed using highly plastic clays.

Several alternative actions for repairing the deficient levee reaches were considered. A "No Action" alternative was considered unacceptable due to the increased risk of significant levee failure during significant rainfall events. The consequences of levee failure relative to health, safety, environmental, and economic viability for the protected cities, towns, villages, industry, transportation, and commercial enterprises were deemed unacceptable. Therefore, it was concluded that the high plasticity soils must be replaced or chemically modified to lower the risk of failure and meet USACE criteria for flood control projects.

Four action alternatives were considered including the replacement of unsuitable soils with soils capable of stabilizing existing soils by excavating, stabilizing and replacing the soils or by in-`place stabilization to improve the soil conditions without earthmoving. The alternatives were evaluated for efficacy, environmental impact and cost. The in-place stabilization alternative utilizing lime/Class C fly ash slurry injection into the levee soils was chosen as the recommended alternative. This type of injection will achieve the same level of repair integrity as any of the other alternatives with lower construction costs and fewer adverse environmental impacts associated with this implementation of the remedy.

1.2. Description of Selected Alternative

The lime/Class C fly ash slurry injection alternative involves injecting a mixture of hydrated lime and Class C fly ash at regular intervals into the levee slopes using injector rods. This material would be proportioned at the ratio of 1 part lime to 3 parts Class C fly ash and would be mixed in the range of 6 to 8 pounds lime/Class C fly ash per gallon of water. The typical injection depth will be 10 feet but could be revised in reaches where the slide failure planes have been found to extend to greater depths. The injector rods have tips capable of dispersing the slurry in a 360-degree pattern. The typical injection rate is 1.5 lbs of lime/Class C fly ash slurry per cubic foot

of soil to be stabilized. When slurry is injected into clay soils, it fills the cracks that form as a result of shrinking and swelling of the highly plastic clays. A chemical reaction takes place between the calcium hydroxide (lime) and the silica and alumina naturally occurring in the clay. The materials combine to form calcium silica hydrates and calcium silica aluminates. These are stabilizing compounds that result in increased shear strength in the weakness planes and chemically treat the clays to reduce plasticity resulting in a reduced potential for shrink-swell. This method has been used for several years in other Corps Districts and has proven highly effective in stabilizing levees of the type present in the project area.

Beneficial use of fly ash and other CCPs (coal combustion products) is encouraged on federally funded projects by its classification as a "recovered" product under the Resource Conservation and Recovery Act (RCRA). Fly ash has been used for over 20 years by USACE for improving levee stabilization and for highway subgrade improvement applications. Amending high plasticity clay with Class C fly ash has been proven to result in improved soil properties, including increases in stiffness, strength, and freeze-thaw durability as well as reductions in permeability, plasticity, and swelling. Levees amended using this method have not needed repairs thereafter.

1.3. Approach to the Risk Screening

This risk screening was performed to evaluate the long-term potential risks associated with the use of lime/Class C fly ash slurry to stabilize the levee embankments. Potential worker safety risks during the construction phase of the project were not addressed by the screening in this document, but will be addressed by work practices specified by USACE and by worker health and safety plans.

The conceptual framework for the risk screening is as follows:

- Develop a set of chemical characteristics for the lime/Class C fly ash slurry and unamended levee soils for use in risk screening (Section 2.0).
- Develop a conceptual site model to represent the levee system and potential receptors, including identification of release mechanisms, secondary sources, and exposure pathways (Section 3.0).
- Estimate exposure point concentrations based on the chemical characteristics developed in Section 2.0 for the receptors identified in Section 3.0 (Section 4.0).
- Evaluate potential risks to the receptors identified in Section 3.0 by comparing the exposure point concentrations developed in Section 4.0 to published criteria and standards (Section 5.0).

2.0 CHEMICAL CHARACTERISTICS OF LIME/CLASS C FLY ASH SLURRY AND UNAMENDED LEVEE SOILS

The chemical characteristics of both the lime/Class C fly ash slurry and the levee soils into which the slurry will be injected need to be estimated to support the screening of potential human health and ecological risks. The results of the sampling and analysis of injected lime/Class C fly ash slurry and unamended levee soils, data provided by Midwest U.S. Class C fly ash generators, and published fly ash chemistry and soil chemistry references were used to select the chemical characteristics of the lime/Class C fly ash slurry and unamended levee soils used in the environmental risk screening.

2.1 Stabilized Levee Sampling

On August 17, 2010, representatives of the USACE St. Louis District obtained unamended levee soil and samples from a levee that had been stabilized using lime/Class C fly ash slurry injection. The levee sampled was located approximately 10 miles south of Cape Girardeau along the Castor River Diversion Channel. The inland side of the levee had been stabilized in previous USACE levee projects with slurry consisting of Class C fly ash and quick lime in 1995. The side of the levee adjacent to the river was not amended. A small shovel sampling location was excavated on the inland side of the levee to a depth of approximately 6 inches where a light gray material was observed mixed in with the darker colored brown silty clay levee soil. It was concluded that the light gray material contained some of the slurry mixture that was injected. Efforts were taken to sample primarily the light gray material for chemical analysis. Additionally, a shovel sampling location was excavated on the river side of the levee to obtain a sample of unamended soil for chemical analysis. Both samples were analyzed for total metals, Toxicity Characteristic Leaching Procedure (TCLP) metals using USEPA Method SW846 1311, and leachable metals, pH, and wet chemistry parameters using a neutral pH water extraction consistent with ASTM D3987.

The results of the chemical analysis of the unamended levee soil and the soil amended with lime/Class C fly ash slurry samples are presented on Table 1. In general, the results of the total metals and leachable metal analyses for the unamended levee soil and the amended soil containing some lime/Class C fly ash mix were very similar. Those results suggest that the amended soil sample was likely a combination of levee soils and slurry. The sample result for the amended soil sample has metal concentrations that are typical of the type of results that would be anticipated using a slurry injection rate of 1.5 dry pounds of slurry per cubic foot of soil.

2.2 Fly Ash Analyses from Generators and Published References

The slurry to be injected into the levees will be three parts Class C fly ash and one part lime. As a result, the chemical characteristics of the slurry will be dominated by the chemical characteristics of the Class C fly ash. Class C fly ash data was collected from two generators in the vicinity of the project area to provide information to estimate the chemical characteristics of the lime/Class C fly ash mixture. The generators provided analyses for their Class C fly ashes included total metals, leachable metals by TCLP (USEPA Method SW846 1311) and by Synthetic Precipitation Leaching Procedure (SPLP) using USEPA Method SW 846 1312, and by a neutral pH leaching procedure (ASTM D3987) and pH. Additionally, chemical data from four Midwest fly ash generators was obtained from a published reference (Pflughoeft-Hassett, 1993). Samples of fly ash from the four sources was analyzed for total metals and TCLP metals using USEPA Method SW846 1311. The results of the chemical analyses from the generators and the published reference are summarized on Tables 2, 3 and 4.

2.3 Published Background Soil Information

Published information was researched to obtain data on the likely chemical characteristics of the soils that comprise the levees and into which the slurry will be injected. This data will be used to supplement the unamended levee soil data discussed in Section 2.1. The USEPA Mean Background Concentrations data for both Illinois and Missouri were identified for use in

establishing background concentrations (USEPA 2005a, Table 2-3). Additionally, background concentrations have been established for Illinois in the Illinois Tiered Approach to Corrective Action (TACO) program. The concentrations from both references are included on Table 5. Table 6 provides a comparison of the unamended levee soil to the background concentrations obtained from the references. In general, soils can be concluded to be similar unless metal concentrations vary by more than an order of magnitude for several parameters. As shown on Table 6, the background soil concentrations obtained from the USEPA reference and the Illinois TACO standards are generally similar to the concentrations obtained from the analysis of the unamended levee soil sample presented on Table 1.

2.4 Chemical Characteristics for Risk Screening

2.4.1 Lime/Class C Fly Ash Slurry

It was concluded, based on a comparison between the sampling and analysis results for the unamended and amended levee soil samples collected near Cape Girardeau, that the amended soil sample is a mixture of slurry and levee soils. As a result, the Cape Girardeau sample results cannot be used to establish the chemistry of the lime/Class C fly ash slurry for the risk screening.

Secondly, it was concluded that the fly ash data obtained from the two regional generators and the published reference would provide the best information for estimating the chemical characteristics of the lime/Class C fly ash slurry. To that end, the data from the two Midwest generators and the four samples from the published reference were used to develop a set of concentrations for use in risk evaluations. The data set developed and presented on Table 7 uses the maximum values from the total metal and leachable data results for these sample data. The use of the maximum concentrations results in a conservative estimate.

2.4.2 Unamended Levee Soil

The background soil concentrations identified by the published background soil data and the levee sampling data were used to establish the metal concentrations that likely are representative of the unamended levee soils into which the lime/Class C fly ash slurry will be injected. As discussed in Section 2.3, the total metal concentrations from both the unamended levee soil and the USEPA reference are very similar. The data for both total and leachable metals for the background soils that will be used for the risk screening are presented on Table 7. As with the Class C fly ash analyses, the maximum values were selected for the screening to provide a conservative estimate.

3.0 EXPOSURE ASSESSMENT

Development of a conceptual site model to support the evaluation of risks involves identifying the potential sources, release mechanisms, transport media, exposure pathway, and potential receptors. The conceptual model developed for the stabilized levees is described in the following subsections.

3.1 Exposure Setting

The exposure setting consists of a typical physical setting of the levees and the human and ecological populations near the levees. Figure 1 shows the location of the anticipated levee sites. In general, the area is mixed use, with large to small residential and commercial land use dominating along the Mississippi and its tributaries. Based on the 2009 Census Bureau, the St. Louis Metropolitan Area (MA) has a population of 2.8 M people. Small towns like East St. Louis with populations of 25,000 and rural towns like Wood River with populations of 437 are typically located along the levees. Levee environs become more heavily industrialized along the northern portions of the alignment near larger cities like St. Louis and lesser industrialized in small towns. Small human populations exist in agrarian areas which make up larger percentage of the levee alignment with the exception of the St. Louis MA. Given the types of human uses (including larger industrialized and agrarians uses) expected, the potential for long-term exposure to Site-related contaminants is considered low. There are no long-term onsite workers populations or occupied structures on the levees. Short term construction worker populations are not evaluated in this risk assessment and will be managed through site- specific safety requirements and best management practices.

3.2 Conceptual Site Model

The conceptual site model shown in Figure 2 was developed to represent a typical, idealized section of a lime/Class C fly ash slurry stabilized levee and is not intended to be site specific. The site conceptual model begins with the identification of the source of potential impacts. As shown on Figure 2, the primary source for this model is the lime/Class C fly ash slurry stabilized levee. The release mechanisms considered in this model for the lime/Class C fly ash slurry in the stabilized levee embankment are physical disturbance or erosion, or the leaching of metal constituents into groundwater or surface water. The total metals in the eroded or disturbed soils are evaluated for potential exposures by direct contact with those materials. The leachable metals from the stabilized levee soils are examined in terms of exposures by way of impacted groundwater or surface water. The potential receptors to those materials include human, ecological, and agrarian receptors.

3.3 Exposure Endpoints

The conceptual site model identified the following exposure endpoints:

Human Health

- Ingestion or direct contact with stabilized levee soils or sediments originating from those soils.
- Ingestion or dermal contact with impacted groundwater or surface water.
- Ingestion of crops grown on impacted lands.
- Ingestion of aquatic wildlife from impacted waters or sediments.

Ecological Risk

- Direct contact and ingestion of impacted soils and sediments originating from those soils.
- Direct contact with impacted groundwater or surface water.
- Ingestion of vegetation grown on impacted lands.

Agrarian

- Phytotoxicity to vegetation growing on lands impacted by stabilized levee soils.
- Phototoxicity to vegetation from contact or irrigation with impacted groundwater.

4.0 EXPOSURE POINT CONCENTRATIONS

4.1 Impacted Soils and Sediments

As indicated in Section 3.0, human, ecological and agrarian receptors were considered for exposure to soils into which the lime/Class C fly ash slurry has been injected for stabilization. Based on discussions with a contractor who has performed the stabilization of levees using the lime/Class C fly ash slurry injection method, slurry takes (i.e., the amount of slurry successfully injected) generally are approximately 1.5 pounds of lime/Class C fly ash slurry per cubic foot of soil to be stabilized. A typical cubic foot of compacted clay fill is about 105 to 115 pounds per cubic foot, dry weight. The 1.5 pounds of lime/Class C fly ash slurry per cubic foot of clay levee soil corresponds to about 1.3 to 1.4 percent by weight of lime/Class C fly ash slurry per cubic foot of levee soil. As a result, a ratio of 1.5% lime/Class C fly ash slurry per cubic foot of levee soil will be used to calculate exposure point concentrations. The resulting chemical characteristics of that soil mass will be based on 98.5% of unamended levee soil chemistry and on 1.5% of lime/Class C fly ash slurry chemistry.

Using a mass balance of 98.5% unamended levee soil to 1.5% lime/Class C fly ash slurry, the exposure point metal concentrations were calculated and are presented on Table 8. For values with non-detect values at their detection limits, the detection limit was used to calculate the exposure point concentration rather than the typical one-half detection limit to provide a conservative basis for risk screening. This represents the estimated concentration of those metals in the in-place soil matrix of a lime/Class C fly ash slurry stabilized levee.

If those soils were to erode into adjacent lands/farmlands, or into wetlands or water bodies to form sediments, the concentrations would be further reduced as the eroded material mixes with native sediments and soils or other transported sediments. By using the estimated in-place stabilized matrix concentration values on Table 8 to represent eroded soils or sediments, a very conservative evaluation of risks has been developed.

4.2 Impacted Groundwater and Surface Water

As indicated in Section 3.0, human, ecological and agrarian receptors have been identified in the conceptual site model for the potential for exposure to groundwater or surface water impacted by the lime/Class C fly ash slurry. As with the total metal concentrations described in Section 4.1, the leachable metal concentrations for the stabilized levee have been estimated by mass balance. The leachable mass balance, which estimates the concentration of metals in the leachate as it is developed in the levees, was calculated using 98.5% of the soil leachate concentrations and 1.5% of the lime/Class C fly ash slurry leachate concentrations.

When evaluating the potential impacts associated with chemicals leached from a source, USEPA and state regulatory agencies have recognized that it would be highly unlikely that receptors would be exposed to the leachate itself. The agencies recognized that as the resultant mass balance leachate chemical concentrations move through soil and groundwater, they are reduced in concentration by adsorption onto soil and aquifer particles, chemical transformations (e.g. precipitation) and dilution due to mixing of leachate with ambient ground water. The reduction in concentration due to the combination of these processes is expressed as a Dilution Attenuation Factor (DAF). The DAF is the ratio of the leachate concentration to the concentration at the exposure point. The use of DAFs has been considered by USEPA with respect to the transport of leachable metals and organics beginning with the development of EP Toxicity Testing limits and TCLP testing limits for characteristically hazardous waste. In the discussion of the support of those limits, in the May 19, 1980 and March 29, 1990 Federal Registers, USEPA considered a DAF of 100 to be appropriate for a landfill which is a large, continuous source of chemicals. The practice used by several Midwest states to evaluate the potential environmental risks associated with the beneficial use of non-hazardous waste materials on land is to apply a DAF of 25 to 30. In developing the National 1996 Soil Screening Guidance (SSL) impact to groundwater criteria, the USEPA developed and used a default DAF of 20. This DAF included only the aquifer dilution and mixing effects on leachate concentration reduction; the reduction effects of chemical transformation and adsorption were not considered. Considering the small

volume of lime/Class C fly ash slurry used in levee stabilization, the linear alignment of stabilized levees, and the parallel application of the USEPA SSL-developed DAF in impact to groundwater screening, the USEPA DAF of 20 was used in this analysis. Table 9 presents the mass balance leachate concentration and exposure point concentrations using the DAF of 20. Those values were used for the risk screening presented in Section 5.0.

As groundwater impacted by the lime/Class C fly ash slurry discharges to surface water, it will be diluted by water within the receiving body. However, in this screening evaluation, estimated groundwater metal concentrations were used without further dilution to conservatively represent surface water exposure concentrations.

5.0 RISK SCREENING

5.1 Hazardous Waste Evaluation

The maximum results of the TCLP results for the Class C fly ash produced by the two Midwest generators and obtained from the published reference were compared to the limits established in RCRA Part 261 to evaluate whether the Class C fly ash could be classified as characteristically hazardous waste. The results of that comparison are presented on Table 10 and demonstrate that none of the materials are characteristically hazardous wastes.

5.2 pH Impacts

The pH of the lime/Class C fly ash slurry can be estimated from the chemical data identified in Section 2.0. The pH of the fly ash produced by one of the two Midwest generators was estimated during both the total metals and SPLP metals analyses. The pH from those analyses ranged 12 to 12.6. This is consistent with the results of the pH analysis results presented for the four reference samples included in the published reference (Pflughoeft-Hassett, 1993). The neutral leaching fluid pH results for the four samples analyzed ranged from 11.7 to 12.3. The pH of the unamended levee soil and the lime/Class C fly ash slurry amended soil samples were estimated as part of the neutral fluid leaching analysis of the samples obtained during the sampling in August 2010. The pH of the unamended soil was 7 while the pH of the lime/Class C fly ash slurry amended soil was 8.6.

The potential impact on the pH of the environment as a result of the lime/Class C fly ash slurry injection into the levee soils was estimated by using the pH analysis results and a mass balance based on the ratio of levee soil volume to the lime/Class C fly ash slurry volume. Using a ratio of 98.5% soil and 1.5% slurry, and a pH of 7 for the soil and pH of 12.6 for the soil amended by lime/Class C fly ash soil, the resultant pH would be about 7.02. As a result, it is concluded that the impact on pH due to the lime/Class C fly ash slurry injection would be negligible.

5.3 Screening of Potential Human Health Risks

5.3.1 Soil and Sediment Screening

Human health screening was performed for soils (total metals) using both the Illinois Tiered Approach to Corrective Action Objectives (TACO) Tier I Residential standards and USEPA Regional Residential Screening Levels. These soil criteria were also used as surrogates for human exposure to sediment. The results of the soil and sediment screening using the exposure point concentrations included on Table 8 are presented on Table 11.

The screening shown on Table 11 indicates that both the unamended levee (background) soils and the lime/Class C fly ash slurry stabilized soils represented by the exposure point concentrations exceed the Illinois TACO Background Levels. All total metal exposure point concentrations, with the exception of the arsenic and thallium were below the health screening levels. Although the total arsenic exposure point and unamended levee soil concentrations exceed the Illinois TACO Tier 1 Objectives, the concentrations did not exceed the USEPA Regional Screening Levels. Additionally, the concentration of arsenic in the unamended levee soils also exceeds the TACO limit and, as shown on Table 11, the addition of lime/Class C fly ash slurry causes a negligible increase in the soils' arsenic concentration. As a result, the arsenic in the lime/Class C fly ash slurry is concluded to not add any potential health concern.

The thallium concentrations shown on the table represent the detection limits of the analyses performed. The thallium detection limit (60.7 mg/kg) in the unamended levee soil analysis was elevated above the Illinois TACO Tier I Residential criteria making evaluation of whether the unamended soil exceeds the criteria uncertain. The thallium concentration in the lime/Class C fly ash slurry (non-detect at 4 mg/kg) was below the Illinois TACO Tier I Residential criteria (6.2 mg/kg). As a result, thallium in the lime/Class C fly ash slurry is concluded not to add any potential health concern.

Based on the human health screening performed for the lime/Class C fly ash slurry stabilized levee soils, those soils and the sediments derived from erosion of those soils should also not present a human health concern.

5.3.2 Groundwater and Surface Water Screening

Human health exposure as a result of ingesting leachate-affected groundwater was screened using the USEPA Safe Drinking Water Act Maximum Concentration Limits (MCLs) and Secondary MCLs (SMCLs) and the Illinois TACO Class I Groundwater Standards. Those criteria were also used as a surrogate for the ingestion of surface water. The results of the groundwater ingestion screening using the groundwater exposure point concentrations from Table 9 are presented on Table 12.

As shown on the table, aluminum exceeds its SMCLs, which was established to address odor and taste concerns. The aluminum concentration does not represent a potential health concern. No other criteria were exceeded. Based on the screening performed for ingested water, the lime/Class C fly ash slurry stabilized levee soils should not present a human health concern.

5.3.3 Human Health Risk Screening Conclusion

The results of the human health screening did not identify potential health risks associated with the stabilization of the levees with lime/Class C fly ash slurry.

5.4 Screening of Potential Ecological Risks

5.4.1 Soil Screening

The ecological risk screening was performed for soils using the background concentrations and exposure point concentrations from Table 8. The results of the screening are presented on Table

13. The ecological soil screening levels (Eco-SSLs) used for this evaluation were obtained from the individual parameter documents prepared by USEPA for the most sensitive receptor (i.e., plant, soil invertebrate, avian, mammalian). If a soil screening value could not be found in the USEPA Eco-SSL documents for a parameter, the USEPA Region 5 (USEPA 2003a) screening level was used, if available.

The total metals in soils comparison in Table 13 indicates that the ecological risk screening levels for the majority of the metals, except for mercury and silver, are exceeded by the unamended levee soil background concentrations. The lime/Class C fly ash slurry stabilized soils exposure concentrations also exceed the ecological risk screening levels for the same metals as the unamended levee soils. Because the increase in the metal concentrations that result from the injection of the lime/Class C fly ash slurry into the levee soils does not result in any additional exceedances of ecological screening criteria beyond those of the unamended levee soils, the increase to the ecological risk impact from the injection operation is negligible in comparison to background conditions.

The exceedance of the ecological screening criteria by the metal concentrations in the soils used to construct the levees could be interpreted to suggest those soils may lead to ecological risks. That conclusion is not supported by risk assessment standards of practice that use background concentrations as the starting point for risk evaluations when published criteria are lower than background concentrations. Because the ecological screening criteria are very conservative and are lower than background concentrations, it is concluded that neither the levee soils themselves, or the small increase in metal concentrations that results from the injection of lime/Class C fly ash slurry will have more than negligible ecological impacts.

5.4.2 Sediment Screening

The ecological sediment screening levels used for this evaluation were the consensus-based threshold effect concentrations (TECs) for freshwater ecosystems presented in MacDonald et al. (2000) and the USEPA Region 5 (2003a) sediment screening levels. Because MacDonald et al.

and the Region 5 sediment screening levels report the same concentrations for the same metals, and the Region 5 screening levels address two additional metals, only the Region 5 sediment screening levels are presented on Table 14. The results of the screening of potential ecological risks for sediments are presented in Table 14.

The total metals in sediments comparison in Table 14 indicates that the ecological risk screening levels for five of the metals are exceeded by the unamended levee soil background concentrations. The lime/Class C fly ash slurry stabilized soil exposure concentrations also exceed the ecological risk screening levels for the same metals. The increased ecological risk impact from the injection operation is negligible in comparison to background conditions because:

- The increase in the metal concentrations that result from the injection of the lime/Class C fly ash slurry into the levee soils does not result in any additional exceedances of ecological screening criteria beyond those of the unamended levee soils.
- The lime/Class C fly ash slurry contribution by itself does not result in any exceedances of ecological screening criteria.

The exceedance of the ecological screening criteria by the metals concentrations in the sediments that would be produced from the soils used to construct the levees could be interpreted to suggest those soils/sediments may lead to ecological risks. That conclusion is not supported by risk assessment standards of practice that use background concentrations as the starting point for risk evaluations when published criteria are lower than background concentrations. Because the ecological screening criteria are very conservative and are lower than background concentrations, it is concluded that neither the sediments from the levee soils themselves, or the small increase in metal concentrations that results from the injection of lime/Class C fly ash slurry into the levee soils will have more than negligible ecological impacts.

5.4.3 Groundwater and Surface Water

For water, the groundwater/surface water exposure point concentrations were compared to USEPA National Recommended Freshwater Chronic Water Quality Criteria (USEPA, 2009). If a National Recommended Freshwater Chronic criterion was not established, the USEPA Region 5 Ecological Screening Levels were used, if available. The derivation of the concentration for certain dissolved metals requires a hardness concentration. For this evaluation we assumed that hardness was 100 mg/L. The results of the screening for potential ecological risks for groundwater/surface water metals are presented in Table 15.

The screening on Table 15 indicates that the ecological screening limits are only exceeded for vanadium. The leachable vanadium concentration used for the fly ash in the screening was the maximum of the six concentrations presented on Table 4, and is considered to be an outlier from the data set because the concentration is two to three orders of magnitude greater than the other concentrations. If the next highest vanadium concentration presented on Table 4 is used in the analysis, it is below the screening criteria presented on Table 15. Based on the consideration of the entire set of leachable vanadium concentrations, it is concluded that vanadium should not lead to ecological risk concerns. As a result, the lime/Class C fly ash slurry stabilization of the levee soils should not have an adverse impact on groundwater and surface water receptors.

5.4.4 Ecological Risk Screening Summary

In summary, the ecological risk screening did not identify potential significant risks associated with the use of lime/Class C fly ash slurry to stabilize the levee soils. Although potential impacts from the use of the background soils for levees was identified, further more detailed assessments would be needed to assess those potential risks.

5.5 Screening of Potential Agrarian Risks

The evaluation of potential agrarian risks was performed by screening the total metal exposure point concentrations developed in Section 4.1 to the standards established for the application of biosolids (sewage sludge) on land. Those limits were established by USEPA in 40 CFR 503. The limits for metals were established by evaluation of 15 exposure pathways, including 5 that directly involve agrarian consideration. Those five agrarian pathways include:

(1) Plant toxicity due to uptake when grown on biosolid amended soils.

(2) Human lifetime ingestion of plants grown on biosolid amended soils.

(3) Human gardeners' lifetime ingestion of plants grown on biosolid amended soils.

(4) Human lifetime ingestion of animal products from animals raised on forage grown on biosolid amended soils.

(5) Animal lifetime ingestion of plants grown on biosolid amended soils.

Those five agrarian pathways along with nine other exposure pathways were evaluated, with the most restrictive pathway for each parameter used to establish the allowable limits (USEPA 1993).

Table 16 presents a comparison of the biosolid standards to the exposure point concentration for soils and the unamended levee soils. That comparison indicates the lime/Class C fly ash slurry stabilized levee soils should not have adverse agrarian impacts.

The potential for impacts from the use of groundwater or surface water for irrigation water has been typically based on the human health limits established for groundwater ingestion. As indicated in Section 5.3, the exposure point concentrations for groundwater/surface water ingestion were below applicable standards and criteria. As a result, it is concluded the use of groundwater or surface water affected by the lime/Class C fly ash slurry should not adversely impact vegetation or crops.

5.6 Uncertainty Evaluation

The total metals analyses and leachable metals used in screening risks were obtained from a variety of published sources but was not an exhaustive literature search. Additional sources of analytical data may show the concentrations to differ from those selected for evaluation in this study. To the extent the concentrations used here are not representative of the levee soils and lime/Class C fly ash slurry, risk screening outcomes may differ.

The maximum concentration of each constituent was used as the representative concentration for risk screening. This value was chosen with the intent that the largest concentration would reflect a reasonable worst case exposure concentration. Whether use of the largest concentration in the data set results in use of an extreme value, a high-representative value, or an unrepresentative value, cannot be ascertained in the present data set.

Analytical data obtained from a variety of sources are likely to use differing analytical methods and have differing analytical quality control procedures applied during analysis. Analyses can be performed using a variety of extraction or analytical techniques that produce differing sensitivities and resultant analytical detection limits. In this analytical data set, some analytical detection limits were above human health or ecological screening criteria, making evaluation of whether these criteria had or had not been exceeded tenuous.

Contaminant transport and transfer was performed using simple deterministic calculations that while uniformly comparative may not reflect the variability that occurs due to media or chemical characteristics. To the extent that site-specific conditions vary from the conditions modeled, exposure point concentrations may vary resulting in differing risk screening outcomes.

6.0 CONCLUSIONS

The risk screening performed for the use of the lime/Class C fly ash slurry to stabilize levee soils developed the following conclusions.

1. The lime/Class C fly ash slurry used to stabilize the levees is not a listed or characteristically hazardous waste.
2. The use of lime/Class C fly ash slurry to stabilize levee soils would not adversely impact the pH of the levee soils or runoff (surface water).
3. The use of lime/Class C fly ash slurry to stabilize levee soils would not lead to human health impacts.
4. The use of lime/Class C fly ash slurry to stabilize levee soils would not lead to ecological impacts.
5. The use of lime/Class C fly ash slurry to stabilize levee soils would not lead to adverse agrarian impacts.

These conclusions reflect the volume of lime/Class C fly ash slurry typically injected to stabilize levee soils. Using the typical slurry injection rate of 1.5 dry pounds of slurry per cubic foot of soil to be stabilized, the contribution of the slurry to the entire soil mass is only about 1.5% by weight. The chemistry of the slurry would need to be significantly different than the chemistry of the soils for such a low injection rate to have large impacts. Because the overall chemistry of the lime/Class C fly ash is similar to the chemistry of the soils, the results of the screening are understandable.

7.0 REFERENCES

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39: 20-31.

Pfughoeft-Harrsett, D.F., Hassett, D.J., Lillemoen, C.M., Comparative Leaching of Midwestern Coal Fly Ash and Cements, Proceedings of the 10th Coal Ash Use Symposium, January 1993.

United States Environmental Protection Agency (USEPA). 2003a. Ecological screening levels. Region 5, RCRA. August 22

United States Environmental Protection Agency (USEPA). 2005a. Guidance for developing ecological soil screening levels. OSWER Directive 9285.7-55. November 2003. Revised February 2005.

United States Environmental Protection Agency (USEPA). 2005b. Ecological soil screening levels for antimony. Interim Final. OSWER Directive 9285.7-61. February 2005.

United States Environmental Protection Agency (USEPA). 2005c. Ecological soil screening levels for arsenic. Interim Final. OSWER Directive 9285.7-62. March 2005.

United States Environmental Protection Agency (USEPA). 2005d. Ecological soil screening levels for barium. Interim Final. OSWER Directive 9285.7-63. February 2005.

United States Environmental Protection Agency (USEPA). 2005e. Ecological soil screening levels for beryllium. Interim Final. OSWER Directive 9285.7-64. February 2005.

United States Environmental Protection Agency (USEPA). 2005f. Ecological soil screening levels for cadmium. Interim Final. OSWER Directive 9285.7-65. March 2005.

United States Environmental Protection Agency (USEPA). 2008. Ecological soil screening levels for chromium. Interim Final. OSWER Directive 9285.7-66. April 2008.

United States Environmental Protection Agency (USEPA). 2005g. Ecological soil screening levels for cobalt. Interim Final. OSWER Directive 9285.7-67. March 2005g.

United States Environmental Protection Agency (USEPA). 2007a. Ecological soil screening levels for copper. Interim Final. OSWER Directive 9285.7-68. February 2007.

United States Environmental Protection Agency (USEPA). 2003b. Ecological soil screening levels for iron. Interim Final. OSWER Directive 9285.7-69. November 2003.

United States Environmental Protection Agency (USEPA). 2005h. Ecological soil screening levels for lead. Interim Final. OSWER Directive 9285.7-70. March 2005.

United States Environmental Protection Agency (USEPA). 2007b. Ecological soil screening levels for manganese. Interim Final. OSWER Directive 9285.7-71. April 2007.

United States Environmental Protection Agency (USEPA). 2007c. Ecological soil screening levels for nickel. Interim Final. OSWER Directive 9285.7-76. March 2007.

United States Environmental Protection Agency (USEPA). 2007d. Ecological soil screening levels for selenium. Interim Final. OSWER Directive 9285.7-72. March 2007.

United States Environmental Protection Agency (USEPA). 2006. Ecological soil screening levels for silver. Interim Final. OSWER Directive 9285.7-77. September 2006.

United States Environmental Protection Agency (USEPA). 2005i. Ecological soil screening levels for vanadium. Interim Final. OSWER Directive 9285.7-75. April 2005.

United States Environmental Protection Agency (USEPA). 2007e. Ecological soil screening levels for zinc. Interim Final. OSWER Directive 9285.7-73. June 2007.

United States Environmental Protection Agency (USEPA). 2009. National recommended water quality criteria. Office of Water. http://www.epa.gov/ost/criteria/wqctable.

ADDITIONAL REFERENCES

Atlantic Division Naval Facilities Engineering Command. 2003. Record of Decision for Operable Unit 15, Marine Corps Air Station Cherry Point, North Carolina. Retrieved from: http://www.epa.gov/superfund/sites/rods/fulltext/r0403023.pdf

Beck, M.A, Daniels, L.W., and Eick, M. 2007. Leachate chemistry of mixtures of fly ash and alkaline coal refuse. *Proceedings of the 2007 World of Coal Ash (WOCA)*, Kentucky. Retrieved from: http://www.p2pays.org/ref/45/44881.pdf

Bin-Shafique, S., Benson, C.H., Edil, T. B., and Hwang, K. 2006. Leachate concentrations from water leach and column leach tests on fly ash-stabilized soils. *Environmental Engineering Science*, 23 (1), 53-67, doi:10.1089/ees.2006.23.53.

Bonetti, J.E., Brendel, G. F., and GAI Consultants. Assessing the water quality impacts of fly ash structural fill projects. *Proceedings of the Coal Combustion By-Products Associated with Coal Mining-Interactive Forum*, Carbondale, IL. Retrieved from: http://www.techtransfer.osmre.gov/nttmainsite/Library/proceed/ccb1996/session4.pdf

CalStar Products Inc. http://www.eco-intel.com/pub/Fly-Ash-Brick

Centre for Environment Education-Northern Regional Cell. 2007. Health impact assessment and remediation strategies of fly ash on the affected population in Kanpur, India. *Prepared for Panki*

Thermal Power Plant, Kanpur. Retrieved from: http://www.pollutedplaces.org/files/FileUpload/files/PCRs/Flyash-%20culmination%20report.pdf

Daniels, J. L. and Das, G.P. 2006, Leaching behavior of lime/fly ash mixtures. *Environmental Engineering Science*, 23 (1), 42-52. doi:10.1089/ees.2006.23.42.

Deshpande, P. S. 2003. The determination of appropriate phosphogypsum: class c fly ash: Portland type II cement compositions for use in marine applications. (Master Thesis, Louisiana State University). Retrieved from: http://etd.lsu.edu/docs/available/etd-0709103-205226/unrestricted/Deshpande_thesis.pdf

Fly Ash Resource Center. 2010. *Fly ash quality control*. Retrieved from: http://www.rmajko.com/qualitycontrol.htm

ISG Resources Inc. 2010. *U.S. Patent No. 2001066486- Control of ammonia emission from ammonia-laden fly ash in concrete*. SureChem Inc. Retrieved from: http://www.surechem.org/index.php?Action=document&docId=309526&db=WOPCT&tab=clms&lang=&db_query=0%3A%3A0%3A%3A0%3A&markupType=all

Luther, L. (2010). Managing coal combustion waste (CCW): Issues with disposal and use. Congressional Research Service. Retrieved from: http://www.fas.org/sgp/crs/misc/R40544.pdf

Polic, P.S., Ilic, M. R., and Popovic, A.R. 2005. Environmental impact assessment of lignite fly ash and its utilization products as recycled hazardous wastes on surface and ground water quality. *The Handbook of Environmental Chemistry*, 5F, 61–110, doi: 10.1007/b11733.

Savant, G. 2010. Adaptive hydraulics-comprehensive aquatic systems model (ADH-CASM). System-Wide Water Resources Depot. US Army Corps of Engineers. Retrieved from: https://swwrp.usace.army.mil

Schoof, R.A. 2003. Final guide for incorporating bioavailability adjustments into human health and ecological risk assessments at department of defense facilities. Part 2: Technical background document for assessing metals bioavailability *Prepared for Tri-Service Ecological Risk Assessment Workgroup*, Ohio. Retrieved from: http://web.ead.anl.gov/ecorisk/related/documents/Bioavail_Part_2-final.pdf

Tennessee Valley Authority. 2009. Emergency dredging for the Kingston fossil plant ash dike failure, Roane County, Tennessee. Retrieved from: http://www.tva.gov/environment/reports/kingston_dredge/environmental_assessment.pdf

Tennessee Valley Authority. 2009. Kingston Fly Ash Recovery Project Non-Time Critical Action Scope and EE/CA Work Plan for Public Review, Roane County, Tennessee. Retrieved from: http://www.tva.gov/kingston/admin_record/pdf/NTC/NTC2.pdf

US Army Corps of Engineers. *Adaptive Hydraulics Modeling*. ADH: Main Page. Retrieved from: https://adh.usace.army.mil/

FIGURES

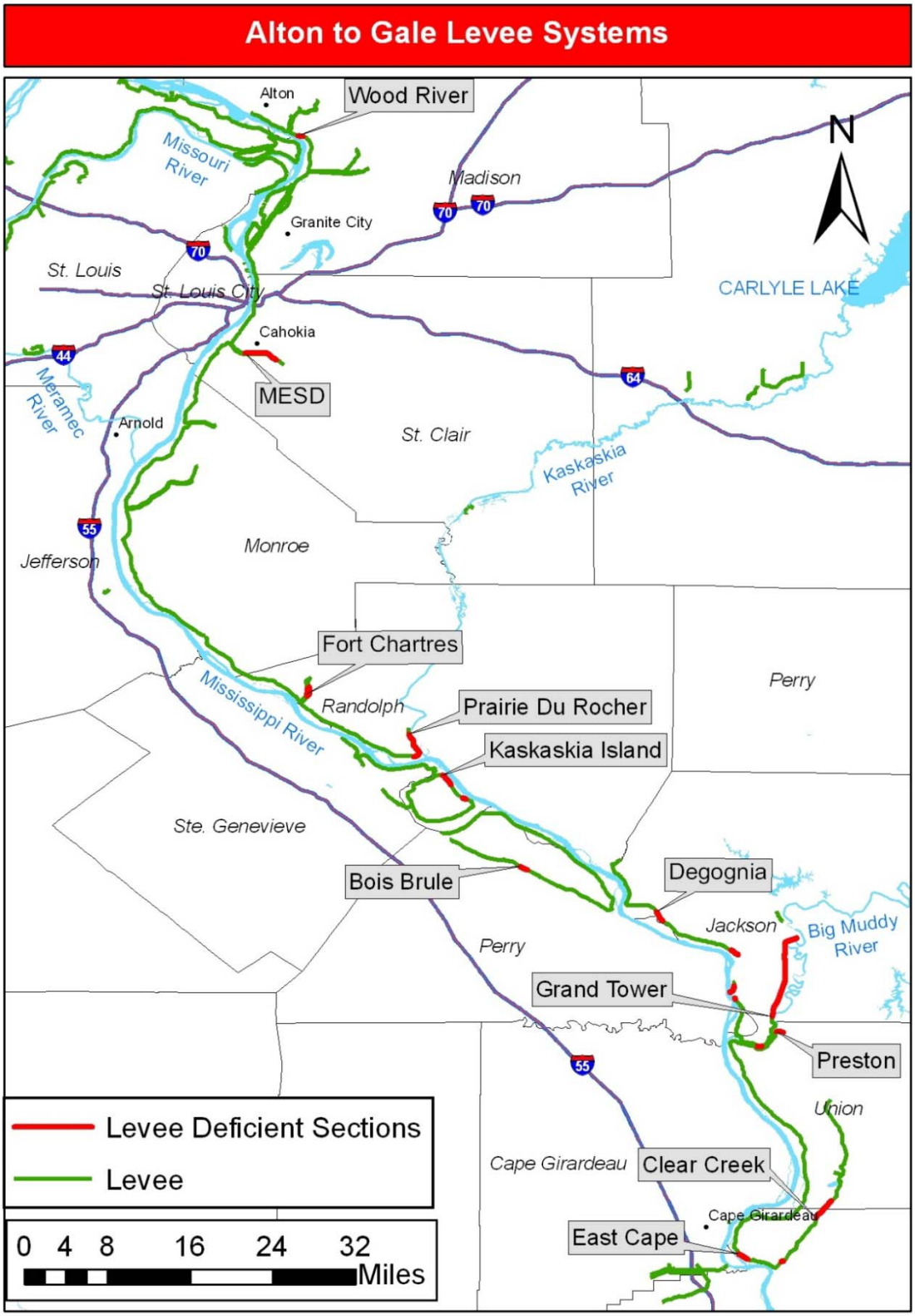

Figure -1 – Alton to Gale Organized Levee Districts with Design Deficiency Slides

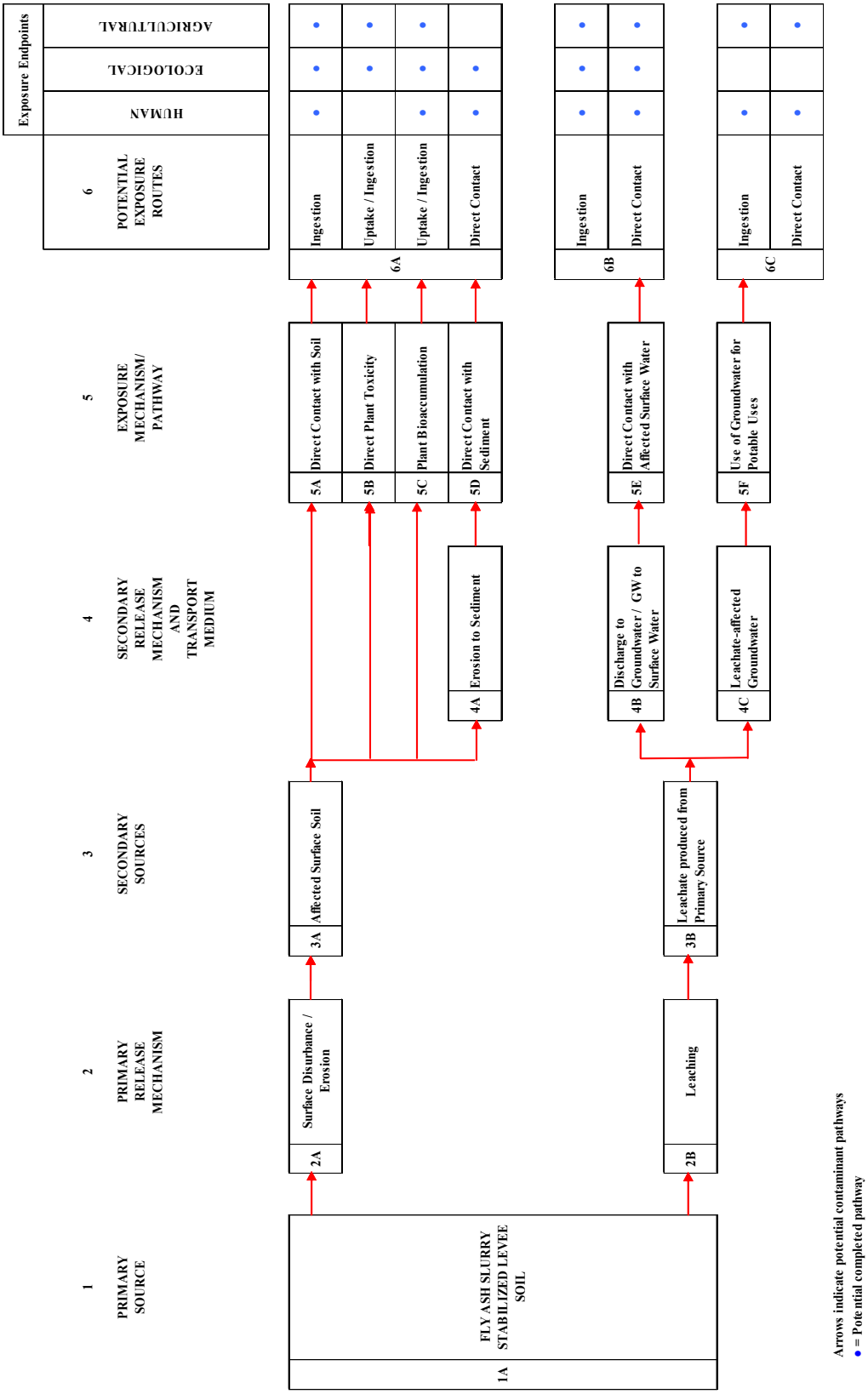

Figure -2 – Generalized Site Conceptual Model

TABLES

TABLE 1
RESULTS OF LEVEE SAMPLING
AUGUST 17, 2010

Parameter	Total Metal Results		TCLP Results [1]		DI Leachable Metal Results [2]	
	Unamended Levee Soil (mg/kg)	Fly Ash Slurry (mg/kg)	Unamended Levee Soil (mg/L)	Fly Ash Slurry (mg/L)	Unamended Levee Soil (mg/L)	Fly Ash Slurry (mg/L)
Aluminum	16,000	18,600	--	--	0.396	0.168 F
Antimony	7.1	9.4	0.35 U	0.35 U	0.005 U	0.005 U
Arsenic	25.4	25.5	0.5 U	0.05 U	0.0652 F	0.10 U
Barium	302 J	554 J	0.789	0.801	0.296	0.262
Beryllium	1.5	1.4	0.0125 U	0.0125 U	0.005 U	0.005 U
Boron	24.3 UJ	24.4 UJ	1.62	0.674	0.540	0.720
Cadmium	0.89 F	1.4 F	0.03 U	0.03 U	0.00039 F	0.00058 F
Calcium	7,110 J	20,400 J	--	--	92	156
Chromium	19	21	0.025 U	0.025 U	0.1 U	0.15 U
Cobalt	11.1 F	11.3 F	0.125 U	0.125 U	0.02 U	0.02 U
Copper	21.1	27.6	0.0625 U	0.0625 U	0.0058 F F	0.0057 F
Iron	23,900	25,000	--	--	0.257 F	0.5 U
Lead	19.8	17.3	0.25 U	0.25 U	0.002 F	0.0017 F
Magnesium	4,310	5,860	--	--	24.6	29.6-
Manganese	783 J	994 J	0.0375 U	0.0379	0.0291	0.0453-
Mercury	0.046 F	0.051	0.0015 U	0.0015 U	0.0002 U	0.0002 U
Molybdenum	--	--	--	--	0.0002 U	0.0002 U
Nickel	25.4	28	0.1 U	0.1 U	0.0096 F	0.0071 F
Potassium	2,510 F	1,710 F	--	--	3.77	1.5
Selenium	3.6 U	3.7 U	0.8 U	0.8 U	0.05 U	0.05 U
Silicon	--	--	--	--	--	--
Silver	0.77 F	1.2 F	0.04 U	0.04 U	0.002 U	0.002 U
Sodium	364 U	252 F	--	--	1210	1060
Thallium	60.7 U	61.1 U	0.5 U	0.5 U	0.002 U	0.002 U
Tin	24.3 U	24.4 U	0.25 U	0.25 U	0.003 U	0.0011 F
Vanadium	30.7	39.5	0.125 U	0.125 U	0.1 U	0.1 U
Zinc	99.3	96.6	0.0971	0.0728	0.100 U	0.107
pH [3]	--	--	--	--	7.0	8.6

Notes:
(1) TCLP: USEPA Method SW846 1311
(2) ASTM D3987 neutral pH extraction
(3) pH measured in standard units
--Parameter not analyzed
J-Estimated concentration
F-Estimated level detected below the laboratory's reporting limit (RL, but above the method detection limit (MDL)
U-Analyte not detected above the specified reporting limit.
UJ-Estimated reporting limit. Possibility of false negative due to associated high presence of iron.

mg/kg - milligrams/kilogram
mg/L - milligrams/liter

TABLE 2
CLASS C FLY ASH FROM MIDWEST GENERATORS
TOTAL METAL RESULTS

Metal	Generator No. 1 Fly Ash Sample 1 (1) (mg/kg)	Generator No. 2 Fly Ash Sample 1 (mg/kg)	Reference Fly Ash 1(2) (mg/kg)	Reference Fly Ash 2 (2) (mg/kg)	Reference Fly Ash 3 (2) (mg/kg)	Reference Fly Ash 4 (2) (mg/kg)
Aluminum	47,000	66,700	--	--	--	--
Antimony	0.57 F	73	--	--	--	--
Arsenic	12	13	12	37	68	100
Barium	4,800	3,810	6,400	5,000	10,000	6,500
Beryllium	2.6	3	1 U	1 U	1 U	1 U
Boron	450	--	610	1,200	770	1,100
Cadmium	1.0	4	--	--	--	--
Calcium	160,000	105,600	--	--	--	--
Chromium	35	75	51	74	54	69
Cobalt	17	11	39	51	39	24
Copper	120	--	175	280	210	65
Iron	25,000	30,700	--	--	--	--
Lead	17	40	23	20	9.8	19
Magnesium	18,000	13,600	--	--	--	--
Manganese	110	199	120	380	360	780
Mercury	0.24	5	0.23	0.61	0.32	0.10
Molybdenum	4.7	14	10 U	67	19	13
Nickel	27	52	31	960	28	34
Potassium	2,500	5,930	--	--	--	--
Selenium	5.6	1	0.4 U	20	17	9.8
Silicon	240	--	--	--	--	--
Silver	0.12 F	--	0.2 U	0.2 U	0.2 U	0.2 U
Sodium	7,100	8,260	--	--	--	--
Thallium	2.2	4	--	--	--	--
Tin	3.0	--	--	--	--	--
Vanadium	140	45	180	1,800	210	120
Zinc	43	159	43	290	100	75
pH (3)	12.0 to 12.6	--	--	--	--	--

Notes:
(1) Maximum concentration from four discreet samples
(2) Reference: Comparative Leaching of Midwestern Coal Fly Ash and Cement, Pflughoeft-Hassett, 1993
(3) pH measured in standard units
--Parameter not analyzed
F-Estimated level detected below the laboratory's reporting limit (RL), but above the method detection limit (MDL)
U-Analyte not detected above the specified reporting limit.
mg/kg - milligrams/kilogram

TABLE 3
CLASS C FLY ASH FROM MIDWEST GENERATORS AND PUBLISHED REFERENCE
TCLP RESULTS

Metal	Generator No. 1 Fly Ash(1) (mg/L)	Generator No. 2 Fly Ash (mg/L)	Reference Fly Ash 1(2) (mg/L)	Reference Fly Ash 2(2) (mg/L)	Reference Fly Ash 3(2) (mg/L)	Reference Fly Ash 4(2) (mg/L)
Arsenic	0.014 F	0.1 U	0.089	0.31	0.01 U	0.14
Barium	0.84	1 U	0.74	0.24	0.17	0.8
Cadmium	0.005 U	0.05 U	0.005 U	0.005 U	0.005 U	0.005 U
Chromium	0.092	0.1 U to 0.11	0.39	0.01 U	0.01 U	0.43
Lead	0.0075 U	0.1 U	0.01 U	0.01 U	0.01 U	0.01 U
Mercury	0.002 U	0.05 U	0.00025 U	0.00025 U	0.00025 U	0.00025 U
Selenium	0.094	0.05 U	0.26	0.39	0.28	0.12
Silver	0.025 U	0.1 U	0.001 U	0.001 U	0.001 U	0.001 U

Notes:
(1) Maximum concentration from four discreet samples
(2) Comparative Leaching of Midwestern Coal Fly Ash and Cements, Pfughoeft-Hassett, 1993

TCLP: USEPA Method SW846 1311
U – Analyte not detected above specified reporting limit
F – Estimated level detected below laboratory's reporting limit (RL), but above the method detection limit (MDL)

mg/L - milligrams/liter

TABLE 4
CLASS C FLY ASH FROM MIDWEST GENERATORS AND PUBLISHED REFERENCE
LEACHABLE METALS RESULTS

Metal	Generator No. 1 Fly Ash by DI Leach(1) (2) (mg/L)	Generator No. 2 Fly Ash by DI Leach(3) (mg/L)	Reference Fly Ash 1(4) (5) (mg/L)	Reference Fly Ash 2 (4) (5) (mg/L)	Reference Fly Ash 3 (4) (5) (mg/L)	Reference Fly Ash 4(4) (5) (mg/L)
Aluminum	81	35	0.5 U	1.6	0.52	0.5 U
Antimony	0.006 U	0.01 U	--	--	--	--
Arsenic	0.010 U	0.01 U	0.089	0.31	0.01U	0.14
Barium	26	0.36	0.74	0.24	0.17	0.8
Beryllium	0.004 U	0.01 U	--	--	--	--
Boron	2.5	1.62	6.5	19	7.9	25
Cadmium	0.005 U	0.01 U	0.005 U	0.005 U	0.005 U	0.005 U
Calcium	380	105	1,900	1,700	840	1,900
Chromium	0.19	0.22	0.39	0.01 U	0.01 U	0.43
Cobalt	0.025 U	0.01 U	0.05 U	0.11	0.05 U	0.05 U
Copper	0.043 J	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Iron	0.19	0.01 U	0.2 U	0.2 U	0.2 U	0.2 U
Lead	0.0075 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Magnesium	0.230 F	0.1	190	--	--	190
Manganese	0.025 U	0.01 U	0.05 U	1.0	0.41	0.2
Mercury	0.002 U	0.001 U	0.00025 U	0.00025 U	0.00025 U	0.00025 U
Molybdenum	0.050 U	0.16	0.1	1.6	0.53	0.33
Nickel	0.025 U	0.01 U	0.1 U	3.6	0.1 U	0.1 U
Potassium	0.580 F	1.6	--	--	--	--
Selenium	0.050 U	0.02	0.26	0.39	0.28	0.12
Silicon	--	--	53	140	50 U	58
Silver	0.025 U	0.1 U	0.001 U	0.001 U	0.001 U	0.001 U
Sodium	--	40.4	--	--	--	--
Thallium	0.002 U	0.01 U	--	--	--	--
Tin	0.050 U	--	--	--	--	--
Vanadium	0.010 U	0.01 U	0.050	16	0.07	0.26
Zinc	0.020 F	0.01 U	0.050	0.07	0.050	0.050
pH (6)	12.0 to 12.3	--	12.3	11.7	12.2	12.1

Notes:
(1) SPLP: USEPA Method SW 846 1312
(2) Maximum concentrations obtained from four discreet samples
(3) ASTM D3987 neutral pH extraction
(4) Comparative Leaching of Midwestern Coal Fly Ash and Cement, Pflughoeft-Hassett, 1993
(5) TCLP: USEPA Method SW846 1311
(6) pH measured in standard units
mg/L - milligrams/liter
--Parameter not analyzed
J-Estimated concentration
F-Estimated level detected below the laboratory's reporting limit (RL) but above the method detection limit (MDL)
U-Analyte not detected above the specified reporting limit

TABLE 5
BACKGROUND SOIL CONCENTRATIONS FROM EPA AND ILLINOIS REFERENCES
TOTAL METALS

Metal	U.S. EPA Mean Background Concentration Illinois[1] (mg/kg)	U.S. EPA Mean Background Concentration Missouri[1] (mg/kg)	IL TACO Background Levels [2] (mg/kg)
Aluminum	48,714	42,094	9,200
Antimony	1.1	1.0	3.3
Arsenic	7.1	10.1	11.3
Barium	551	499	122
Beryllium	0.70	1.0	0.56
Boron	NE	NE	NE
Cadmium	NE	NE	0.50
Calcium	NE	9,227	5,525
Chromium	48.4	50	13.0
Cobalt	9.8	11.8	8.9
Copper	24.0	19.1	12.0
Iron	19,159	24,733	15,000
Lead	39.0	22.5	20.9
Magnesium	NE	NE	2,700
Manganese	646	940	630
Mercury	NE	NE	0.05
Molybdenum	NE	NE	NE
Nickel	19.0	20.0	13.0
Potassium	NE	NE	1,100
Selenium	0.50	0.50	0.37
Silicon	NE	NE	NE
Silver	NE	NE	0.50
Sodium	NE	NE	130
Thallium	NE	NE	0.42
Tin	NE	NE	NE
Vanadium	62.0	72.4	25.0
Zinc	67.0	52.9	60.2

Notes:
(1) USEPA, 2003a
(2) 35IAC Part 742 Tiered Approach to Corrective Action Objectives, Appendix A, Table G
NE-No background concentration in reference or standard
mg/kg - milligrams/kilogram

TABLE 6
COMPARISON OF UNAMENDED LEVEE SOIL SAMPLING AND PUBLISHED BACKGROUND SOIL CONCENTRATIONS
TOTAL METALS

Metal	Unamended Levee Soils(1) (mg/kg)	U.S. EPA Mean Background Concentration Illinois (2) (mg/kg)	U.S. EPA Mean Background Concentration Missouri(2) (mg/kg)	IL TACO Background Levels(3) (mg/kg)
Aluminum	16,000	48,714	42,094	9,200
Antimony	7.1	1.1	1.0	3.3
Arsenic	25.4	7.1	10.1	11.3
Barium	302 J	551	499	122
Beryllium	1.5	0.70	1.0	0.56
Boron	24.3 UJ	NE	NE	NE
Cadmium	0.89 F	NE	NE	0.50
Calcium	7,110 J	NE	9,227	5,525
Chromium	19	48.4	50	13.0
Cobalt	11.1 F	9.8	11.8	8.9
Copper	21.1	24.0	19.1	12.0
Iron	23,900	19,159	24,733	15,000
Lead	19.8	39.0	22.5	20.9
Magnesium	4,310	NE	NE	2,700
Manganese	783 J	646	940	630
Mercury	0.046 F	NE	NE	0.05
Molybdenum	NE	NE	NE	NE
Nickel	25.4	19.0	20.0	13.0
Potassium	2,510 F	NE	NE	1,100
Selenium	3.6 U*	0.50	0.50	0.37
Silicon	NE	NE	NE	NE
Silver	0.77 F	NE	NE	0.50
Sodium	364 U*	NE	NE	130
Thallium	60.7 U*	NE	NE	0.42
Tin	24.3 U	NE	NE	NE
Vanadium	30.7	62.0	72.4	25.0
Zinc	99.3	67.0	52.9	60.2

Notes:
(1) Table 1, Unamended Levee Soil
(2) USEPA, 2003a
(3) 35 IAC Part 742 Tiered Approach to Corrective Action Objectives, Appendix A, Table G

mg/kg - milligrams/kilogram
NE - No background concentration in reference
*Comparison is not meaningful due to detection limits of analysis

J-Estimated concentration
F-Estimated level detected below the laboratory's reporting limit (RL), but above the method detection limit (MDL)
U-Analyte not detected above the specified reporting limit.
UJ-Estimated reporting limit. Possibility of false negative due to associated high presence of iron.

Unstabilized levee soil concentration is less than or within range of background soil conc.
Unstabilized levee soil concentration between 1X to 3X of minimum background soil conc.
Unstabilized levee soil concentration between 3X to 7X of minimum background soil conc.

TABLE 7
CHEMICAL CHARACTERISTICS FOR RISK SCREENING

Metal	Total Metals		Leachable Metals	
	Unamended Levee Soil[1] (mg/kg)	Fly Ash Slurry[2] (mg/kg)	Unamended Levee[3] Soil (mg/L)	Fly Ash Slurry[4] (mg/L)
Aluminum	48,714	66,700	0.396	81
Antimony	7.1	73	0.005	0.01
Arsenic	25.4	100	0.0652	0.31
Barium	551	10,000	0.296	26
Beryllium	1.5	2.6	0.005	0.1
Boron	24.3	1,200	0.540	25
Cadmium	0.89	4	0.00039	0.01
Calcium	7,110	160,000	92	1,900
Chromium	50	74	0.1	0.43
Cobalt	11.8	51	0.02	0.11
Copper	24	280	0.0058	0.0432
Iron	24,733	30,700	0.257	0.190
Lead	39	40	0.002	0.01
Magnesium	4,310	18,000	24.6	190
Manganese	940	780	0.0291	1
Mercury	0.046	0.61	0.0002	0.002
Molybdenum	--	67	0.0002	1.6
Nickel	25.4	960	0.0096	3.6
Potassium	2,510	5,930	3.77	1.6
Selenium	3.6	20	0.05	0.39
Silicon	--	240	--	140
Silver	0.77	0.1	0.002	0.025
Sodium	364	8,260	1210	40.4
Thallium	60.7	4	0.002	0.01
Tin	24.3	3	0.003	0.050
Vanadium	72.4	1,800	0.1	16
Zinc	99.3	290	0.100	0.07

Notes:
(1) Maximum of soil data from Tables 1 and 5
(2) Maximum of fly ash data from Table 2
(3) Data from Table 1, DI Leachable Metal Results, unamended levee soil
(4) Maximum of data from Table 4

--Parameter not analyzed
mg/kg - milligrams/kilogram
mg/L - milligrams/liter

TABLE 8
CALCULATION OF TOTAL METAL EXPOSURE POINT CONCENTRATIONS FOR LIME/CLASS C FLY ASH SLURRY STABILIZED LEVEE SOIL

Metal	Unamended Levee Soil [1] (mg/kg)	Fly Ash Slurry (mg/kg) [2]	Soil/Sediment Exposure Point Concentration [3] (mg/kg)
Aluminum	48,714	66,700	48,984
Antimony	7.1	73	8.1
Arsenic	25.4	100	26.5
Barium	551	10,000	693
Beryllium	1.5	2.6	1.54
Boron	24.3	1,200	41.9
Cadmium	0.89	4	0.94
Calcium	7,110	160,000	9,403
Chromium	50	74	50.1
Cobalt	11.8	51	12.4
Copper	24	280	27.8
Iron	24,733	30,700	24,823
Lead	39	40	39
Magnesium	4,310	18,000	4,515
Manganese	940	780	938
Mercury	0.046	0.61	0.054
Molybdenum	--	67	67
Nickel	25.4	960	39.4
Potassium	2,510	5,930	2,561
Selenium	3.6	20	3.8
Silicon	--	240	240
Silver	0.77	0.12	0.76
Sodium	364	8,260	483
Thallium	60.7	4	59.9
Tin	24.3	3	24.0
Vanadium	72.4	1,800	98.3
Zinc	99.3	290	102.2

Notes:
(1) Table 7, unamended levee soil
(2) Table 7, Fly Ash Slurry
(3) Exposure point concentration calculated using 98.5% unamended levee soil concentration and 1.5% Fly Ash Slurry concentration

--Parameter not analyzed
mg/kg - milligrams/kilogram

TABLE 9
CALCULATION OF LEACHABLE METALS EXPOSURE POINT CONCENTRATION FOR LIME/CLASS C FLY ASH SLURRY STABILIZED LEVEE SOIL

Metal	Unamended Levee Soil [1] (mg/L)	Fly Ash Slurry[2] (mg/L)	Mass Balance Leachate Concentration for Fly Ash Slurry Stabilized Levee[3] (mg/L)	Groundwater/Surface Water Exposure Point Concentration for Fly Ash Slurry Stabilized Levee [4] (mg/L)
Aluminum	0.396	81	1.61	0.081
Antimony	0.005	0.01	0.005	0.0003
Arsenic	0.0652	0.31	0.0690	0.0035
Barium	0.296	26	0.682	0.0341
Beryllium	0.005	0.1	0.006	0.0003
Boron	0.540	25	0.907	0.0454
Cadmium	0.00039	0.01	0.0005	0.00003
Calcium	92	1,900	119.1	5.96
Chromium	0.1	0.43	0.105	0.0053
Cobalt	0.02	0.11	0.021	0.0011
Copper	0.0058	0.0432	0.0064	0.0003
Iron	0.257	0.190	0.2560	0.0128
Lead	0.002	0.01	0.002	0.0001
Magnesium	24.6	190	27.1	1.36
Manganese	0.0291	1	0.0437	0.0022
Mercury	0.0002	0.002	0.0002	0.00001
Molybdenum	0.0002	1.6	0.0242	0.0012
Nickel	0.0096	3.6	0.0635	0.0032
Potassium	3.77	1.6	3.74	0.187
Selenium	0.05	0.39	0.055	0.0028
Silicon	--	140	140	7.0
Silver	0.002	0.025	0.002	0.0001
Sodium	1210	40.4	1192	59.6
Thallium	0.002	0.01	0.002	0.0001
Tin	0.003	0.050	0.004	0.0002
Vanadium	0.1	16	0.34	0.017
Zinc	0.100	0.07	0.100	0.005

Notes:
(1) Table 7, unamended levee soil
(2) Table 7, Fly Ash Slurry
(3) Concentration calculated by mass balance using 98.5% unamended levee soil concentration and 1.5% Fly Ash Slurry concentration
(4) Exposure point concentration calculated using a dilution/attenuation factor (DAF) of 20

--Parameter not analyzed
mg/L - milligrams/liter

TABLE 10
COMPARISON OF MAXIMUM TCLP CONCENTRATIONS IN FLY ASH TO CHARACTERISTIC HAZARDOUS WASTE LIMITS

Metal	Characteristic Hazardous Waste Limits (1) (mg/L)	Maximum TCLP Concentrations from Table 3 (2) (mg/L)
Arsenic	5	0.31
Barium	100	0.84
Cadmium	1	0.05 U
Chromium	5	0.39
Lead	5	0.1 U
Mercury	0.2	0.05 U
Selenium	1	0.39
Silver	5	0.1 U

Notes:
(1) Limits established in 40 CFR 261
(2) TCLP: USEPA Method SW846 1311

U – Analyte not detected above the specified reporting limit
mg/L - milligrams/liter

TABLE 11
HUMAN RECEPTOR RISK SCREENING - SOILS AND SEDIMENT

Metal	Unamended Levee Soil Background Concentration (mg/kg) (1)	Fly Ash Slurry Exposure Point Concentration Relative Contributions and Total			IL TACO Background Levels (mg/kg) (5)	IL TACO Tier 1 Residential Soil Remediation Objectives (mg/kg) (6)	EPA Regional Residential Soils Screening Levels (mg/kg) (7)
		Relative Contribution of Unamended Levee Soil (mg/kg) (2)	Relative Contribution of Fly Ash Slurry (mg/kg) (3)	Exposure Point Concentration (mg/kg) (4)			
Aluminum	48,714	47,983	1,001	48,984	9,200	NE	77,000
Antimony	7.1	7.0	1.1	8.1	3.3	31	31
Arsenic	25.4	25.0	1.5	26.5	11.3	11.3	0.39
Barium	551	543	150	693	122	5,500	15,000
Beryllium	1.5	1.5	0.04	1.54	0.56	160	160
Boron	24.3	23.9	18.0	41.9	NE	16,000	16,000
Cadmium	0.89	0.88	0.06	0.94	0.50	78	70
Calcium	7,110	7,003	2,400	9,403	5,525	NE	NE
Chromium	50	49	1.1	50.1	13.0	230	12,000
Cobalt	11.8	11.6	0.8	12.4	8.9	4,700	23
Copper	24	23.6	4.2	27.8	12.0	2,900	3,100
Iron	24,733	24,362	461	24,823	15,000	NE	55,000
Lead	39	38	0.6	39	20.9	400	400
Magnesium	4,310	4,245	270	4,515	2,700	325,000	NE
Manganese	940	926	12	938	630	1,600	1,800
Mercury	0.046	0.045	0.009	0.054	0.05	10	23
Molybdenum	--	--	67	67	NE	NE	390
Nickel	25.4	25.0	14.4	39.4	13.0	1,600	1,500
Potassium	2,510	2,472	89	2,561	1,100	NE	NE
Selenium	3.6	3.5	0.3	3.8	0.37	390	390
Silicon	--	--	240	240	NE	NE	NE
Silver	0.77	0.76	0.002	0.76	0.50	390	390
Sodium	364	359	124	483	130	NE	NE
Thallium	60.7*	59.8	0.1**	59.9	0.42	6.3	NE
Tin	24.3	23.9	0.045	24.0	NE	NE	47,000
Vanadium	72.4	71.3	27.0	98.3	25.0	550	390
Zinc	99.3	97.8	4.4	102.2	60.2	23,000	23,000

Notes:
(1) Table 7, unamended levee soil
(2) 98.5% of concentrations from Table 7, unamended levee soil
(3) 1.5% of concentrations from Table 7, Fly Ash Slurry
(4) Table 8, Exposure Point Concentration
(5) 35 IAC Part 742 Tiered Approach to Corrective Action Objectives, Appendix A, Table G
(6) 35IAC Part 742 Tiered Approach to Corrective Action Objectives, Appendix B, Table A
(7) USEPA Regional Screening Levels, May 2010

mg/kg - milligrams/kilogram
--Parameter not analyzed
NE – no standard established

*Thallium was not detected in unamended levee soil sample at a detection limit of 60.7 mg/kg
**Thallium was not detected in fly ash samples at a detection limit of 4 mg/kg

Concentration exceeds standard and standard exceeded

TABLE 12
HUMAN RECEPTOR RISK SCREENING
GROUNDWATER AND SURFACE WATER INGESTION

Metal	Unamended Levee Soil Leachable Metals, DAF of 20 (1) (mg/L)	Exposure Point Concentration (2) (mg/L)	Drinking Water MCLs (3) (mg/L)	IL Class I Groundwater Standards (4) (mg/L)
Aluminum	0.0198	0.081	0.050-0.200 (5)	NE
Antimony	0.0003	0.0003	0.006	0.006
Arsenic	0.0033	0.0035	0.010	0.050
Barium	0.0148	0.0341	2.000	2.000
Beryllium	0.0003	0.0003	0.004	0.004
Boron	0.027	0.0454	NE	2.000
Cadmium	0.00002	0.00003	0.005	0.005
Calcium	4.6	5.96	NE	NE
Chromium	0.005	0.0053	0.100	0.100
Cobalt	0.001	0.0011	NE	1.000
Copper	0.0003	0.0003	1.000 (5)	0.650
Iron	0.0129	0.0128	0.300 (5)	5.000
Lead	0.0001	0.0001	0.015	0.0075
Magnesium	1.23	1.36	NE	NE
Manganese	0.0015	0.0022	0.050 (5)	0.150
Mercury	0.00001	0.00001	0.002	0.002
Molybdenum	0.00001	0.0012	NE	NE
Nickel	0.0005	0.0032	NE	0.100
Potassium	0.189	0.187	NE	NE
Selenium	0.0025	0.0028	0.050	0.050
Silicon	--	7.0	NE	NE
Silver	0.0001	0.0001	0.100 (5)	0.050
Sodium	60.5	59.6	NE	NE
Thallium	0.0001	0.0001	0.002	0.002
Tin	0.0002	0.0002	NE	NE
Vanadium	0.005	0.017	NE	0.049
Zinc	0.005	0.005	5.000 (5)	5.000

Notes:
(1) Table 9, unamended levee soil leachate reduced by dilution/attenuation factor (DAF) of 20
(2) Table 9, Exposure Point Concentrations
(3) USEPA Maximum Contaminant Levels (MCLs), National Primary Drinking Water Regulations
(4) 35 IAC Part 742, Tiered Approach to Corrective Action Objectives, Appendix B, Table E
(5) USEPA, Secondary Maximum Contaminant Levels, National Secondary Drinking Water Regulations (non-enforceable guidelines)

NE-No standard established
mg/L - milligrams/liter

Concentration exceeds standard and standard exceeded

TABLE 13
ECOLOGICAL RECEPTOR RISK SCREENING OF SOILS

Metal	Unamended Levee Soil Background Concentration (mg/kg) (1)	Fly Ash Slurry Exposure Point Concentration Relative Contributions and Total			USEPA Ecological Screening Level (Eco SSL) (5) (mg/kg)	USEPA Region 5 Ecological Screening Level(6) (mg/kg)
		Relative Contribution of Unamended Levee Soil(2) (mg/kg)	Relative Contribution of Fly Ash Slurry(3) (mg/kg)	Exposure Point Concentration (4) (mg/kg)		
Aluminum	48,714	47,983	1,001	48,984	NE	NE
Antimony	7.1	7.0	1.1	8.1	0.27	ESL
Arsenic	25.4	25.0	1.5	26.5	18	ESL
Barium	551	543	150	693	330	ESL
Beryllium	1.5	1.5	0.04	1.54	21	ESL
Boron	24.3	23.9	18.0	41.9	NE	NE
Cadmium	0.89	0.88	0.06	0.94	0.36	ESL
Calcium	7,110	7,003	2,400	9,403	NE	NE
Chromium	50	49	1.1	50.1	26 (+3), 130 (+6)	ESL
Cobalt	11.8	11.6	0.8	12.4	13	ESL
Copper	24	23.6	4.2	27.8	28	ESL
Iron	24,733	24,362	461	24,823	NE	NE
Lead	39	38	0.6	39	11	ESL
Magnesium	4,310	4,245	270	4,515	NE	NE
Manganese	940	926	12	938	220	NE
Mercury	0.046	0.045	0.009	0.054	NE	0.1
Molybdenum	--	--	67	67	NE	NE
Nickel	25.4	25.0	14.4	39.4	38	ESL
Potassium	2,510	2,472	89	2,561	NE	NE
Selenium	3.6	3.5	0.3	3.8	0.52	ESL
Silicon	--	--	240	240	NE	NE
Silver	0.77	0.76	0	0.76	4.2	ESL
Sodium	364	359	124	483	NE	NE
Thallium	60.7	59.8	0.1	59.9	NE	0.0569
Tin	24.3	23.9	0.1	24.0	NE	7.62
Vanadium	72.4	71.3	27.0	98.3	7.8	ESL
Zinc	99.3	97.8	4.4	102.2	46	ESL

Notes:
(1) Table 7, unamended levee soil
(2) 98.5% of concentrations from Table 7, unamended levee soil
(3) 1.5% of concentrations from Table 7, Fly Ash Slurry
(4) Table 8, Exposure Point Concentration
(5) USEPA Ecological Soil Screening Levels (EcoSSL) Interin Final OSWER Directive 9285.7, (2005-2008
(6) USEPA Region 5, RCRA Eco SSL, August 22, 2003
mg/kg - milligrams/kilogram
--Parameter not analyzed
NE – no standard established
ESL – USEPA Ecological Screening Levels supercedes

Concentration exceeds standard and standard exceeded

TABLE 14
ECOLOGICAL RECEPTOR RISK SCREENING OF SEDIMENTS

Metal	Unamended Levee Soil Background Concentration[1] (mg/kg)	Fly Ash Slurry Exposure Point Concentration Relative Contributions and Total			USEPA Region 5, Ecological Screening Level[5] (mg/kg)
		Relative Contribution of Unamended Levee Soil [2] (mg/kg)	Relative Contribution of Fly Ash Slurry [3] (mg/kg)	Exposure Point Concentration[4] (mg/kg)	
Aluminum	48,714	47,983	1,001	48,984	NE
Antimony	7.1	7.0	1.1	8.1	NE
Arsenic	25.4	25.0	1.5	26.5	9.79
Barium	551	543	150	693	NE
Beryllium	1.5	1.5	0.04	1.54	NE
Boron	24.3	23.9	18.0	41.9	NE
Cadmium	0.89	0.88	0.06	0.94	0.99
Calcium	7,110	7,003	2,400	9,403	NE
Chromium	50	49	1.1	50.1	43.4
Cobalt	11.8	11.6	0.8	12.4	50.0
Copper	24	23.6	4.2	27.8	31.6
Iron	24,733	24,362	461	24,823	NE
Lead	39	38	0.6	39	35.8
Magnesium	4,310	4,245	270	4,515	NE
Manganese	940	926	12	938	NE
Mercury	0.046	0.045	0.009	0.054	0.174
Molybdenum	--	--	67	67	NE
Nickel	25.4	25.0	14.4	39.4	22.7
Potassium	2,510	2,472	89	2,561	NE
Selenium	3.6	3.5	0.3	3.8	NE
Silicon	--	--	240	240	NE
Silver	0.77	0.76	0.0018	0.76	0.5
Sodium	364	359	124	483	NE
Thallium	60.7	59.8	0.1	59.9	NE
Tin	24.3	23.9	0.045	24.0	NE
Vanadium	72.4	71.3	27.0	98.3	NE
Zinc	99.3	97.8	4.4	102.2	121

Notes:
(1) Table 7, unamended levee soil
(2) 98.5% of concentrations from Table 7, unamended levee soil
(3) 1.5% of concentrations from Table 7, Fly Ash Slurry
(4) Table 8, Exposure Point Concentration
(5) USEPA Region 5, RCRA Ecological Screening Levels, August 22, 2003

mg/kg - milligrams/kilogram
--Parameter not analyzed
NE – no standard established

Concentration exceeds standard and standard exceeded

TABLE 15
ECOLOGICAL RECEPTOR RISK SCREENING
GROUNDWATER AND SURFACE WATER

Metal	Unamended Levee Soil Leachable Metals, DAF of 20 (1) (mg/L)	Exposure Point Concentration(2) (mg/L)	USEPA National Freshwater Chronic Criteria(3) (mg/L)	USEPA Region 5 Ecological Screening Level (4) (mg/L)
Aluminum	0.0198	0.081	0.087	NE
Antimony	0.0003	0.0003	NE	0.080
Arsenic	0.0033	0.0035	1.50	FCS
Barium	0.0148	0.0341	NE	0.220
Beryllium	0.0003	0.0003	NE	0.0036
Boron	0.027	0.0454	NE	NE
Cadmium	0.00002	0.00003	0.00025	FCS
Calcium	4.6	5.96	NE	NE
Chromium	0.005	0.0053	0.011(+6), 0.074(+3)	FCS
Cobalt	0.001	0.0011	NE	0.024
Copper	0.0003	0.0003	0.0114	FCS
Iron	0.0129	0.0128	1.0	NE
Lead	0.0001	0.0001	0.0025	FCS
Magnesium	1/23	1.36	NE	NE
Manganese	0.0015	0.0022	NE	NE
Mercury	0.00001	0.00001	0.00077	FCS
Molybdenum	0.00001	0.0012	NE	NE
Nickel	0.0005	0.0032	0.052	FCS
Potassium	0.189	0.187	NE	NE
Selenium	0.0025	0.0028	0.005	FCS
Silicon	--	7.0	NE	NE
Silver	0.0001	0.0001	NE	0.00012
Sodium	60.5	59.6	NE	NE
Thallium	0.0001	0.0001	NE	0.010
Tin	0.0002	0.0002	NE	0.180
Vanadium	0.005	0.017	NE	0.012
Zinc	0.005	0.005	0.120	FCS

Notes:
(1) Table 9, unamended levee soil leachate reduced by dilution/attenuation factor (DAF) of 20
(2) Table 9, Exposure Point Concentration
(3) USEPA National Recommended Water Quality Criteria, Freshwater Chronic Criteria, USEPA 2009
(4) USEPA Region 5, Ecological Screening Levels, USEPA 2009

mg/L - milligrams/liter
NE – No standard established
FCS – USEPA National Freshwater Chronic Criteria supercedes

Concentration exceeds standard and standard exceeded

TABLE 16
AGRARIAN RISK SCREENING
SOILS AND SEDIMENT

Parameters	Unamended Levee Soil Background Concentration[1] (mg/kg)	Soil/Sediment Exposure Point Concentration[2] (mg/kg)	503 Limits[3] (mg/kg)
Arsenic	25.4	26.5	41
Cadmium	0.89	0.94	39
Chromium	50	50.1	2,400
Copper	24	27.8	1,500
Lead	39	39.0	300
Mercury	0.046	0.054	17
Molybdenum	--	67	75
Nickel	25.4	38.4	420
Selenium	3.6	3.8	36
Sodium	364	48.	3,500
Zinc	99.3	102.2	2,800

Notes:
(1) Table 7, unamended levee soil
(2) Table 8, Exposure Point Concentration
(3) 40 CFR 503, Table 3, Pollutant Concentration Limits except molybdenum which is from Table 1, Ceiling Concentration Limit

mg/kg - milligrams/kilogram
-- Parameter not analyzed