ENVIRONEERING, INC.

PHASE 4 – CORRECTIVE MEASURES ALTERNATIVES
and
PHASE 5 – JUSTIFICATION AND RECOMMENDATION OF THE SELECTED CORRECTIVE MEASURE ALTERNATIVE

for the

CORRECTIVE MEASURES STUDY
BADIN WORKS FACILITY
BADIN, NORTH CAROLINA

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TABLE OF CONTENTS

1.0 INTRODUCTION....1
1.1 Purpose....1
1.2 Basis for Analysis....1
1.3 Threshold Criteria....2
1.4 Balancing Criteria....2
1.5 Report Organization....3
2.0 SITE CONDITIONS....4
2.1 Site History....4
2.2 Site Conceptual Model....4
2.3 Constituents of Interest ("*COIs*")....4
2.3.1 Alcoa/Badin Landfill ("*SWMU No. 2*")....4
2.3.2 Old Brick Landfill ("*SWMU No. 3*")....5
2.3.3 Main Plant Groundwater....5
3.0 DEVELOPMENT OF CORRECTIVE ACTION OBJECTIVES....6
3.1 Applicable Media Cleanup Standards....6
3.2 Corrective Action Objectives ("*CAOs*")....6
4.0 IDENTIFICATION OF POTENTIAL TECHNOLOGIES....7
4.1 Identified Potential Treatment Technologies....7
4.2 Risk-based Assessment....7
5.0 DETAILED ANALYSIS OF ALTERNATIVES....8
5.1 Groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*")....8
5.1.1 No Action....8
5.1.2 Monitoring with Institutional Controls....10
5.2 Groundwater at the Old Brick Landfill ("*SWMU No. 3*")....11
5.2.1 No Action....12
5.2.2 Monitoring with Institutional Controls....13
5.3 Groundwater at the Main Plant....15
5.3.1 No Action....15
5.3.2 Monitored Natural Attenuation with Institutional Controls....16
5.3.3 In Situ Treatment via Permeable Reactive Barriers with Institutional Controls....18
5.3.4 Ex Situ Treatment via Groundwater Pumping and Treatment with Institutional Controls....20
5.3.5 Risk-Based Assessment....22
6.0 RECOMMENDATION OF CORRECTIVE ACTION ALTERNATIVES....25
6.1 Address Groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*")....25
6.2 Address Groundwater at the Old Brick Landfill ("*SWMU No. 3*")....25
6.3 Address Groundwater at the Main Plant....25
7.0 REFERENCES....27

LIST OF APPENDICES

Appendix A Alternative Costing Details

1.0 INTRODUCTION

On behalf of Alcoa Remediation, ENVIRONEERING, INC. has prepared this Phase 4 and Phase 5 Corrective Measures Study ("*CMS*") Report for the Alcoa Badin Works Facility Site located in Badin, Stanly County, North Carolina.

The development of the CMS was conducted in five phases that included:

- Phase 1: Update of Site Geological and Hydrological Model and Establishment of Corrective Action Objectives, submitted to the NCDENR as the *Corrective Measures Study - Phase 1 Report* in August 2009,
- Phase 2: Identification and Development of the Corrective Measures Alternatives, submitted to the NCDENR as the *Phase 2 Identification of Potential Treatment Technologies Report* on October 21, 2009,
- Phase 3: Engineering Data Collection, submitted to the NCDENR as the *Phase 3 Engineering Data Collection for the Corrective Measures Study Report* on October 31, 2012,
- Phase 4: Refine Corrective Measures Alternatives, and
- Phase 5: Justification and Recommendation of the Selected Corrective Measure Alternative.

This Phase 4 and Phase 5 CMS Report utilizes the results from Phase 3 to analyze corrective measures alternatives identified in Phase 2 against evaluation criteria outlined in Phase 1.

1.1 Purpose

The purpose of the Phase 4 and Phase 5 CMS assessments are to evaluate current information to support an informed management decision regarding corrective action alternatives at the Site that sufficiently accomplish the defined corrective action objectives.

1.2 Basis for Analysis

This Phase 4 and Phase 5 CMS Report follows the Corrective Measures Study Plan Outline in Appendix C of the Badin RCRA Part B permit, dated March 4, 2006. In addition, guidance detailed in the RCRA Corrective Action Plan (Final) (OSWER Directive 9902.3-2A, Office of Waste Programs Enforcement, Office of Solid Waste, May 1994) was utilized. To assist in the evaluation of corrective measure alternatives developed for this site, nine evaluation criteria were used to assess, weigh, and rank the proposed alternatives. The criteria are separated into two groups - threshold criteria and balancing criteria, as summarized below:

- Threshold Criteria
    1. Protect Human Health and the Environment,
    2. Attain Media Cleanup Standards,
    3. Control the Source of Releases, and
    4. Comply with Applicable Standards for Waste Management.

- Balancing Criteria
    1. Long Term Reliability and Effectiveness,
    2. Reduction of Toxicity, Mobility, or Volume of Wastes,
    3. Short Term Effectiveness,
    4. Implementability, and
    5. Cost.

1.3 Threshold Criteria

The four threshold criteria are described below:

1. Protect Human Health and the Environment: Alternatives are evaluated to determine if implementation will provide and maintain adequate protection of human health and the environment by eliminating, reducing, or controlling site exposures to acceptable risk levels established in the corrective action objectives.
2. Attain Media Cleanup Standards: Alternatives are evaluated to determine if their implementation would result in the attainment of media cleanup standards derived from existing state or federal regulations. In addition, the time frame necessary for the alternative to meet the standards is included.
3. Control the Source of Releases: Alternatives are evaluated to determine if their implementation would stop further environmental degradation at the site by controlling or eliminating current and future releases of contamination, to the extent possible, that may pose a threat to human health and the environment.
4. Comply with Applicable Standards for Waste Management: Alternatives are evaluated to determine if waste management activities associated with the implementation of each alternative would be conducted in compliance with all applicable state or federal regulations.

The four threshold criteria were used to initially screen corrective measure alternatives. Results were detailed in the *Phase 2 Identification of Potential Treatment Technologies Report*.

1.4 Balancing Criteria

The five balancing criteria are described below:

1. Long Term Reliability and Effectiveness: Alternatives are evaluated with respect to their demonstrated and expected reliability and permanence based on the degree of certainty that the alternative would prove to be successful in establishing controls to eliminate or manage the risk posed by treatment residuals or untreated wastes. Each alternative is also evaluated in terms of its projected useful life (i.e., the length of time the level of effectiveness can be maintained).
2. Reduction of Toxicity, Mobility, or Volume of Wastes: Alternatives are evaluated to determine the degree to which their implementation would reduce or eliminate the toxicity, mobility, or volume of waste at the site. This evaluation focuses on specific factors, including the amount of hazardous materials that will be destroyed or treated, the expected reduction of the toxicity, mobility, and

volume, the degree to which the treatment will be irreversible, and the type and quantity of treatment residuals.

3. Short Term Effectiveness: Alternatives are evaluated with respect to the short-term risks that might be posed to the community, workers, and the environment during the implementation of the alternative. Each alternative is also evaluated in terms of the time that site conditions are protective of human health and the environment.
4. Implementability: Alternatives are evaluated in terms of the ease or difficulty of their implementation considering the technical and administrative feasibility. Technical feasibility includes difficulties and unknowns associated with time for implementation, time for beneficial results, and availability of technologies, as well as the availability of technical services and materials. Administrative feasibility includes permits, rights of way, and off-site approvals and the length of time necessary to obtain any approvals.
5. Cost: Alternatives are evaluated in terms of the net present value of capital costs and the present worth of the annual operation and maintenance costs. Capital costs consist of direct costs and indirect costs. Direct costs include labor, equipment, and materials expenditures necessary to install the corrective measure. Indirect costs include engineering, financial, and other service fees apart from installation activities. Cost analyses for the corrective action alternatives are derived from a number of sources, including vendor estimates, estimates from similar projects, actual experience at other sites, and standard costing guidance references.

The five balancing criteria were used to evaluate corrective measure alternatives identified in the *Phase 2 Identification of Potential Treatment Technologies Report*, and are the subject of this report.

1.5 Report Organization

This Phase 4 and Phase 5 CMS Report is organized as follows:

- Section 1 – Introduction: This section describes the purpose and objectives of the report and outlines the organization of the report.
- Section 2 – Site Conditions: This section provides a historical perspective of the Site along with Site-specific conditions.
- Section 3 – Development of Corrective Action Objectives: This section describes the Corrective Action Objectives and Applicable Media Cleanup Standards.
- Section 4 – Identification of Potential Technologies: This section provides a summary of the alternatives that are to undergo further evaluation.
- Section 5 – Detailed Analysis of Alternatives: This section describes the detailed evaluation of corrective action alternatives that passed the initial screening process. The detailed analysis evaluates alternatives against seven evaluation criteria.
- Section 6 – Recommendation of a Corrective Action Alternatives: This section presents the recommended alternatives for the Site.

2.0 SITE CONDITIONS

This section describes the conditions at the site, including the Site history, Site conceptual model, and constituents of interest.

2.1 Site History

In March 1990, Alcoa filed a RCRA Part B permit application with USEPA to store spent potlining ("*SPL*") waste (K088) on-site in an enclosed storage building for greater than 90 days. In response to the permit application, USEPA Region IV performed a RCRA Facility Assessment ("*RFA*") of the Alcoa Badin Works and associated off-site locations. The RFA identified at total of 34 SWMUs and 2 Areas of Concern ("*AOCs*"). Twelve additional SWMUs were added after the initial RFA was completed. The North Carolina Department of Environment, Health, and Natural Resources Division of Solid Waste Management (now the NCDENR Division of Waste Management), in cooperation with USEPA Region IV, issued the final RCRA Part-B Permit to Alcoa on March 30, 1992.

Part VII of Alcoa's RCRA permit outlined the corrective action activities to be conducted. The initial step in the process required that confirmatory sampling be conducted at seven SWMUs. Based on the results of the RFA and the confirmatory sampling a RCRA Facility Investigation ("*RFI*") was conducted at 16 SWMUs and AOCs. The RFI Report was submitted to the NCDENR in March 2001. Since the commencement of corrective action activities, twenty-two of the facility's SWMUs have received "No Further Actions" status by the NCDENR. In addition, Interim Measures activities have been conducted at a number of the Badin SWMUs.

The RFI report identified groundwater in three areas of the facility as needing further actions. These areas were: groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*"); groundwater at the Old Brick Landfill ("*SWMU No. 3*"); and groundwater at the Main Plant.

2.2 Site Conceptual Model

An understanding of the Site geology, hydrogeology, and Site Conceptual Model is presented in the Corrective Measures Study - Phase 1 Report, submitted to the NCDENR in August 2009. The understanding was updated in the Phase 3 Engineering Data Collection for the Corrective Measures Study Report, submitted to the NCDENR on October 31, 2012.

2.3 Constituents of Interest ("*COIs*")

2.3.1 Alcoa/Badin Landfill ("*SWMU No. 2*")

The RFI showed there were no Constituents of Interest ("*COIs*") present in soil adjacent to the Alcoa/Badin Landfill at concentrations exceeding the conservative risk-based screening values. The Alcoa/Badin Landfill has a cover drainage system consisting of clean compacted fill overlying the unit. As a result, soils surrounding SWMU No. 2 do not pose unacceptable risk to potential current or reasonably anticipated future receptors. The RFI showed only total cyanide exceeding the screening

values, in a single well downgradient of the landfill. The screening level risk assessment for Little Mountain Creek showed no COIs present at concentrations exceeding applicable human health screening values. The RFI concluded that total cyanide exceeded the screening value in a single well downgradient of the landfill.

Phase 3 groundwater sampling results demonstrate the beneficial effects of landfill cover system upgrades. In results from all the recent sampling events, available cyanide and fluoride were not reported in any well at concentrations that exceed the NC 2L Standard.

2.3.2 Old Brick Landfill ("*SWMU No. 3*")

The RFI showed there were no COIs present in soils adjacent to the Old Brick Landfill at concentrations exceeding the conservative risk-based screening values. The Old Brick Landfill has a cover drainage system consisting of clean compacted fill overlying the unit. As a result, soils do not present a risk to potential current or reasonably anticipated future receptors. The RFI concluded that groundwater showed only cyanide exceeding the screening values. Groundwater beneath the landfill is not used for any purpose. Residential wells identified in the survey are on the other side of Badin Lake and hydraulically isolated from SWMU No. 3.

Phase 3 groundwater sampling results demonstrate the beneficial effects of the cover system upgrades. Available Cyanide was reported above the NC 2L Standard in one well during one of the sampling events. In the subsequent sampling events the compound was not detected at concentrations above the 2L standard in any of the wells. In results from all the recent sampling events, fluoride was not reported in any well at concentrations that exceed the NC 2L Standard.

2.3.3 Main Plant Groundwater

For the evaluation of corrective measure alternatives below, the entire main plant area groundwater has been evaluated collectively. Within the Main Plant, the primary COIs identified by the RFI in soils were addressed in the interim measures work and soil removal activities. No further action is required to address direct contact pathways for soils at the SWMUs and AOCs in the plant area. The RFI identified cyanide, fluoride, arsenic, trichloroethene and trichloromethane (chloroform) as the only COIs in the plant groundwater. Arsenic was detected at an estimated concentration in one well, however arsenic is known to occur naturally in groundwater in Stanly County and other areas within the Carolina Slate Belt. The RFI concluded, and the NCDENR agreed, that because of this fact arsenic was eliminated as a COI from the Site.

Phase 3 groundwater sampling results identified available cyanide, fluoride, and trichloroethene at concentrations above the 2L Standard. Trichloromethane was not detected at a concentration above the 2L standard during the Phase 3 investigation in any well sampled.

3.0 DEVELOPMENT OF CORRECTIVE ACTION OBJECTIVES

The identification and screening of appropriate corrective action alternatives requires that corrective action goals and requirements be established as the basis for remediation. In this section, applicable media cleanup standards were identified and Corrective Action Objectives ("*CAOs*") were established. With these identified, alternatives with the potential to meet them can be developed.

3.1 Applicable Media Cleanup Standards

Chemical and remedy specific media cleanup standards were evaluated as part of this CMS for the Site. The major media cleanup standards considered include:

- State and Federal Maximum Contaminant Levels ("*MCLs"*) for drinking water;
- State and Federal Air Emission limits;
- National Pollution Discharge Elimination System ("*NPDES*");
- State Pollution Discharge Elimination System ("*SPDES*");
- RCRA Hazardous Waste generator, transporter, treatment and disposal requirements; and
- State Corrective Action Program Groundwater Cleanup Objectives (15A NCAC 2L).

Applicable media cleanup standards were used in the development of CAOs.

3.2 Corrective Action Objectives ("*CAOs*")

As part of the Corrective Measures Study - Phase 1 Report, appropriate CAOs were identified that would protect human health and the environment in a cost-effective manner. The regulatory driver for this process is the North Carolina Administrative Code Title 15A, Subchapter 2L "Classification and Water Quality Standards Applicable to the Groundwaters of North Carolina." These rules are commonly referred to as the 2L Standards.

Three target areas have been identified at the facility as needing further action to meet the CAOs. These areas were:

1. Groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*"),
2. Groundwater at the Old Brick Landfill ("*SWMU No. 3*"), and
3. Groundwater at the Main Plant.

The objective of the CMS is to address the three target areas through the identification and screening of corrective action technologies.

4.0 IDENTIFICATION OF POTENTIAL TECHNOLOGIES

The implementation of the CMS Phase 2 "*Identification of Potential Treatment Technologies*" involved the recognition of alternatives to be examined for the removal, containment, treatment, and/or other remediation of the impacted media based on the specified groundwater cleanup objectives. Numerous alternatives were screened and the process identified 4 potential corrective measures that should proceed for further evaluation.

4.1 Identified Potential Treatment Technologies

The potential corrective measures technologies that were carried forward from the Phase 2 "*Identification of Potential Treatment Technologies Report*" were:

Alternative No. 1 – No Action (to be included as a baseline for comparison purposes)
Alternative No. 2 – Monitoring/Monitored Natural Attenuation
Alternative No. 3 – In Situ Treatment via Permeable Reactive Barriers
Alternative No. 4 – Ex Situ Treatment via Groundwater Pumping and Treatment

With the exception of Alternative 1, No Action, each alternative will be coupled with Institutional Controls, where needed.

4.2 Risk-based Assessment

In addition to the previously identified potential technologies, a risk-based assessment is being added as a technology for evaluation at the Badin site. During the previous phases of the CMS process, NCDENR did not have regulatory statues to support risk assessment as a potential corrective action option in the State of North Carolina. However, The North Carolina General Assembly in 2011 passed House Bill 45 which allows the use of a risk-based remediation to accelerate the cleanup of industrial sites. Therefore, at this time this potential corrective action will be added.

Alternative No. 5 – Risk-based Assessment

5.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of each corrective action alternative identified in Section 4.0. The detailed analysis will present relevant information that will aid in the selection of an alternative that satisfies the CAOs, specifically, that ground water impacts be remediated to the 15A NCAC 2L.0202 standards.

The detailed analysis consists of a description of each alternative followed by an evaluation of each alternative against the Threshold Criteria identified in Section 1.3 and the Balancing Criteria identified in Section 1.4.

5.1 Groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*")

Recent groundwater sampling results demonstrate the beneficial effects of the cover system upgrades and the utilization of a toe drain collection system at the Alcoa/Badin Landfill. In results from all the recent sampling events, COIs were not reported in any well at concentrations that exceed the CAOs.

Two corrective action alternatives were retained for detailed analysis to address COIs historically present in groundwater.

- No Action (to be included as a baseline for comparison purposes)
- Monitoring with Institutional Controls

The detailed analysis of the corrective action alternatives is presented in the following sections.

5.1.1 No Action

The following sections present a detailed analysis of conducting No Action to COIs historically present in the groundwater. This alternative was retained to provide a baseline for comparison to all other alternatives

Threshold: Protection of Human Health and the Environment

Although COIs were not reported in any well at concentrations that exceed the CAOs, the No Action alternative cannot reduce existing concentrations in the landfill. It would not incorporate implementing activities that would present exposure risks to the community, workers, or the environment.

Threshold: Attain Media Cleanup Standards

Results from the groundwater sampling events report that COIs were not reported in any well at concentrations that exceed 2L standards.

Threshold: Control the Source of Releases

Interim measures have been completed at the Alcoa/Badin Landfill consisting of re-grading and cover improvements of two additional feet of low permeability clay and six inches of topsoil to establish a vegetative cover. In addition, the installation of a toe drain collection system that transports collected water to a POTW has eliminated the surface discharge under the facility's NPDES permit. The objectives of the interim measures were to prevent surface run-on, promote surface run-off, reduce infiltration into the landfill and collect and transport toe drain water to a POTW. The cap is impeding infiltration and the toe drain collection system is functioning therefore, control of the source of release will be achieved.

Threshold: Comply with Applicable Standards for Waste Management

Since no actions will be performed under this alternative, no wastes will be generated. The requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

No Corrective Action is associated with this alternative therefore, no long-term effectiveness will be achieved.

Balancing: Reduction of Mobility, Toxicity, or Volume

Interim measures undertaken at the unit offers opportunity for reduction of toxicity, mobility, and volume through these actions.

Balancing: Short-Term Effectiveness

The No Action alternative does not include any implementation activities, and thus, poses no risks to the community, workers or the environment.

Balancing: Implementability

Since no corrective actions are associated with this alternative, this alternative would be technically and administratively feasible and not cause a disruption. No difficulties are foreseen in regards to the availability of services and materials.

Balancing: Cost

The capital and O&M costs associated with this alternative are $0 since there are no corrective actions associated with this alternative. The total costs for this alternative are estimated to be approximately $0 in 2013 dollars.

5.1.2 Monitoring with Institutional Controls

Conduct annual monitoring events for five years to confirm stability and effectiveness of the interim measures taken. In addition, a re-evaluation of the success of the alternative after the five year monitoring period will be conducted.

Threshold: Protection of Human Health and the Environment

Although COIs were not reported in any well at concentrations that exceed the 2L standards, the Monitoring with Institutional Controls alternative cannot reduce existing concentrations in groundwater. Monitoring would provide an increase in protection to human health and the environment allowing for the demonstration of conformance with the regulations. With periodic monitoring, COI concentrations in groundwater will be observed and compared to the 2L standards. Additionally, it would not incorporate implementing activities that would present exposure risks to the community, workers, or the environment.

Institutional Controls provide an increased level of protection thereby reducing the potential for exposure. Physical access is currently restricted at the Site through fencing. The exposure of authorized visitors (i.e., the maintenance workers and other adult nonresidents) would be reduced to acceptable levels through controls such as PPE requirements, dig permits, or other restrictions that would be outlined in an environmental use agreement. Implemented legal barriers may include restrictive covenants and deed notices.

Threshold: Attain Media Cleanup Standards

In results from all the recent sampling events, COIs were not reported in any well at concentrations that exceed 2L standards.

Threshold: Control the Source of Releases

Interim measures have been completed at the Alcoa/Badin Landfill. The interim measures are working therefore, control of the source of release will be achieved.

Threshold: Comply with Applicable Standards for Waste Management

Some investigation derived wastes ("*IDW*") will be generated as part of the Monitoring with Institutional Controls process. After completion of each round of sampling, the IDW will be sampled and analyzed for characterization. The waste handling activities will be performed in accordance with state and federal regulations and the requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

The magnitude of residual risk may diminish over time. However, this will be dependent on the natural degradation processes. The groundwater sampling data collected over the next five years of this

alternative would be used to confirm the effectiveness of the interim measures. Therefore, the Monitoring with Institutional Controls alternative would meet the long-term reliability balancing criterion.

Balancing: Reduction of Mobility, Toxicity, or Volume

Interim measures undertaken at the unit offers opportunity for reduction of toxicity, mobility, and volume through these actions.

Balancing: Short-Term Effectiveness

The short-term effectiveness of interim measures at the SWMU has been demonstrated through the collection of groundwater data during the Phase 3 engineering study. Current concentrations of all COIs are below the 2L standards. Monitoring of the groundwater at the unit will insure compliance over the next 5 years.

Balancing: Implementability

Implementation of this alternative is technically feasible, as the technology to collect groundwater samples is well established. The materials and services to necessary for the collection and analysis of groundwater samples are readily available. The sampling activities are not expected to impact the facility.

Balancing: Cost

The Capital cost associated with this alternative is zero because no capital infrastructure are associated with this alternative. Access is currently restricted at the Site. O&M costs include groundwater monitoring. Total annual O&M costs are estimated to be $24,300. The total present value life cycle costs of this alternative using a discount rate of 7 percent is $110,000. A cost analysis is included in Appendix A.

5.2 Groundwater at the Old Brick Landfill ("*SWMU No. 3*")

Recent groundwater sampling results demonstrate the beneficial effects of the cover system upgrades. One COI was reported above the NC 2L Standard in one well during one of the sampling events. In the subsequent sampling events the COI was not detected at concentrations above the CAO in any of the wells. In results from all the recent sampling events, all other COIs were not reported in any well at concentrations that exceed the CAOs.

Two corrective action alternatives were retained for detailed analysis to address COIs historically present in groundwater. The detailed analysis of the corrective action alternatives is presented in the following sections.

- No Action (to be included as a baseline for comparison purposes)
- Monitoring with Institutional Controls

In addition, a re-evaluation of the success of the alternative after the five year monitoring period will be conducted.

5.2.1 No Action

The following sections present a detailed analysis of conducting No Action to COIs historically present in the groundwater. This alternative was retained to provide a baseline for comparison to all other alternatives

Threshold: Protection of Human Health and the Environment

Although COIs were not reported in any well at concentrations that exceed the 2L standards in the latest results from the CMS Phase 3 sampling events, the No Action alternative cannot reduce existing concentrations in groundwater. This alternative would not incorporate implementing activities that would present exposure risks to the community, workers, or the environment.

Threshold: Attain Media Cleanup Standards

In the latest results from the CMS Phase 3 sampling events, COIs were not reported in any well at concentrations that exceed the 2L standards. Should concentrations of COIs be present, this alternative would not comply with media cleanup standards because it would not address concentrations in groundwater.

Threshold: Control the Source of Releases

Significant cover system upgrades were performed at the Old Brick Landfill since the commencement of the RFI process. These upgrades consisted of cover system reconfiguration to mitigate surface water infiltration, control storm water flow, and manage storm water run-off through infiltration. Due to the cover system upgrades, control of the source of release will be achieved.

Threshold: Comply with Applicable Standards for Waste Management

Since no actions will be performed under this alternative, no wastes will be generated. The requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

No Corrective Action is associated with this alternative.

Balancing: Reduction of Mobility, Toxicity, or Volume

Cover system upgrades undertaken at the unit offers opportunity for reduction of toxicity, mobility, and volume through these actions.

Balancing: Short-Term Effectiveness

The No Action alternative does not include any implementation activities, and thus, poses no risks to the community, workers or the environment.

Balancing: Implementability

Since no corrective actions are associated with this alternative, this alternative would be technically and administratively feasible and not cause a disruption. No difficulties are foreseen in regards to the availability of services and materials.

Balancing: Cost

The capital and O&M costs associated with this alternative are $0 since there are no corrective actions associated with this alternative. The total costs for this alternative are estimated to be approximately $0 in 2013 dollars.

5.2.2 Monitoring with Institutional Controls

Conduct annual monitoring events for five years to confirm effectiveness of the cover system upgrades upon groundwater quality. In addition, a re-evaluation of the success of the alternative after the five year monitoring period will be conducted.

Threshold: Protection of Human Health and the Environment

Although COIs were not reported in any well at concentrations that exceed the 2L standards, the Monitoring with Institutional Controls alternative cannot reduce existing concentrations in groundwater. Monitoring would provide an increase in protection to human health and the environment allowing for the demonstration of conformance with the regulations. With periodic monitoring, COI concentrations in groundwater will be observed and compared to the 2L standards. Additionally, it would not incorporate implementing activities that would present exposure risks to the community, workers, or the environment.

Institutional Controls provide an increased level of protection thereby reducing the potential for exposure. Physical access is currently restricted at the Site through fencing. The exposure of authorized visitors (i.e., the maintenance workers and other adult nonresidents) would be reduced to acceptable levels through controls such as PPE requirements, dig permits, or other restrictions that would be outlined in an environmental use agreement. Implemented legal barriers may include restrictive covenants and deed notices.

Threshold: Attain Media Cleanup Standards

In the latest results from the CMS Phase 3 sampling events, COIs were not reported in any well at concentrations that exceed the 2L standards.

Threshold: Control the Source of Releases

Significant cover system upgrades were performed at the Old Brick Landfill since the commencement of the RFI process. These upgrades consisted of cover system reconfiguration to mitigate surface water infiltration, control storm water flow, and manage storm water run-off through infiltration. Due to the cover system upgrades, control of the source of release will be achieved.

Threshold: Comply with Applicable Standards for Waste Management

Some IDW will be generated as part of the Monitoring with Institutional Controls process. After completion of each round of sampling, the IDW will be sampled and analyzed for characterization. The waste handling activities will be performed in accordance with state and federal regulations and the requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

The magnitude of residual risk may diminish over time. However, this will be dependent on the natural degradation processes. The groundwater sampling data collected over the next five years of this alternative would be used to confirm the effectiveness of the cover system upgrades. Therefore, the Monitoring with Institutional Controls alternative would meet the long-term reliability balancing criterion.

Balancing: Reduction of Mobility, Toxicity, or Volume

Cover system upgrades undertaken at the unit offers opportunity for reduction of toxicity, mobility, and volume through these actions.

Balancing: Short-Term Effectiveness

The Short-term effectiveness of interim measures at the SWMU has been demonstrated through the collection of groundwater data during the Phase 3 engineering study. Current concentrations of all COIs are below the 2L standards. Monitoring of the groundwater at the unit will insure compliance over the next 5 years.

Balancing: Implementability

Implementation of this alternative is technically feasible, as the technology to collect groundwater samples is well established. The materials and services to necessary for the collection and analysis of groundwater samples are readily available. The sampling activities are not expected to impact the facility.

Balancing: Cost

The Capital cost associated with this alternative is zero because no capital infrastructure are associated with this alternative. Access is currently restricted at the Site. O&M costs include groundwater

monitoring. Total annual O&M costs are estimated to be $23,050. The total present value life cycle costs of this alternative using a discount rate of 7 percent is $90,000. A cost analysis is included in Appendix A.

5.3 Groundwater at the Main Plant

Five corrective action alternatives were retained for detailed analysis to address groundwater at the Main Plant. The detailed analysis of the corrective action alternatives is presented in the following sections.

- No Action (to be included as a baseline for comparison purposes)
- Monitored Natural Attenuation with Institutional Controls
- In Situ Treatment via Permeable Reactive Barriers with Institutional Controls
- Ex Situ Treatment via Groundwater Pumping and Treatment with Institutional Controls
- Risk-based Assessment

5.3.1 No Action

The following sections present a detailed analysis of conducting No Action to COIs historically present in the groundwater. This alternative was retained to provide a baseline for comparison to all other alternatives

Threshold: Protection of Human Health and the Environment

The No Action alternative cannot reduce existing concentrations in groundwater. However, it would not incorporate implementing activities that would present increased exposure risks to the community, workers, or the environment.

Threshold: Attain Media Cleanup Standards

This alternative would not comply with media cleanup standards because it would not address concentrations in groundwater above the 2L standard.

Threshold: Control the Source of Releases

While several interim measures and corrective actions have been implemented at various areas at the Site, there is no control of COIs in the groundwater.

Threshold: Comply with Applicable Standards for Waste Management

Since no actions will be performed under this alternative, no wastes will be generated. The requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

No Corrective Action is associated with this alternative therefore, no long-term effectiveness will be achieved.

Balancing: Reduction of Mobility, Toxicity, or Volume

This action offers no opportunity for reduction of toxicity, mobility, or volume through treatment.

Balancing: Short-Term Effectiveness

The No Action alternative does not include any implementation activities, and thus, poses no increase risks to the community, workers or the environment.

Balancing: Implementability

Since no corrective actions are associated with this alternative, this alternative would be technically and administratively feasible and not cause a disruption. No difficulties are foreseen in regards to the availability of services and materials.

Balancing: Cost

The capital and O&M costs associated with this alternative are $0 since there are no corrective actions associated with this alternative. The total costs for this alternative are estimated to be approximately $0 in 2013 dollars. A cost analysis is included in Appendix A.

5.3.2 Monitored Natural Attenuation with Institutional Controls

Conduct annual monitoring events for five years to confirm monitor effectiveness of the Monitored Natural Attenuation with Institutional Controls. Institutional Controls such as restricted access fencing, restrictive covenants, and excavation permits would reduce the potential for exposure. In addition, a re-evaluation of the success of the alternative after the five year monitoring period will be conducted.

Threshold: Protection of Human Health and the Environment

Although the Monitored Natural Attenuation with Institutional Controls alternative may reduce trichloroethene below CAOs, the Monitored Natural Attenuation with Institutional Controls alternative will not likely reduce existing concentrations of all COIs in groundwater. Monitored Natural Attenuation would provide an increase in protection to human health and the environment. With periodic monitoring, selected COI concentrations in groundwater can be observed and compared to CAOs. Additionally, it would not incorporate implementing activities that would present exposure risks to the community, workers, or the environment.

Institutional Controls provide an increased level of protection thereby reducing the potential for exposure. Currently, physical access is partially restricted at the Site. The exposure of authorized visitors (i.e., the maintenance workers and other adult nonresidents) would be reduced to acceptable levels through controls such as PPE requirements, dig permits, or other restrictions that would be outlined in an environmental use agreement. Implemented legal barriers may include restrictive covenants and deed notices.

Threshold: Attain Media Cleanup Standards

This alternative would not comply with media cleanup standards because it would not address all concentrations of COIs in groundwater.

Threshold: Control the Source of Releases

While several interim measures and corrective actions have been implemented at various areas at the Site there is no control of COIs in the groundwater.

Threshold: Comply with Applicable Standards for Waste Management

Some IDW will be generated as part of the Monitored Natural Attenuation with Institutional Controls process. After completion of each round of sampling, the IDW will be sampled and analyzed for characterization. The waste handling activities will be performed in accordance with state and federal regulations and the requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

The magnitude of residual risk for selected COIs may diminish to acceptable levels over time. However, this will be dependent on the natural attenuation processes. Under the right environmental conditions, the biological degradation of trichloroethene may occur over time. Fluoride and cyanide attenuation occurs through different processes and occurs at a dissimilar rate. The additional groundwater sampling data collected during the implementation of this alternative would be used to confirm the effectiveness of the interim measures. Therefore, it is unclear if this alternative would meet the long-term reliability balancing criterion.

Balancing: Reduction of Mobility, Toxicity, or Volume

Although the Monitored Natural Attenuation with Institutional Controls alternative may reduce selected COIs below CAOs, this action offers no opportunity for reduction of toxicity, mobility, or volume of the remaining COIs through treatment.

Balancing: Short-Term Effectiveness

Implementation of this alternative coupled with Institutional Controls would result in minimal increased exposure risk to the community, workers, and the environment. Waste generated during the collection of groundwater samples would be managed using approved methods.

Balancing: Implementability

Implementation of this alternative is technically feasible, as the ability to implement Institutional Controls and collect groundwater samples is well established. The materials and services to necessary for the collection and analysis of groundwater samples are readily available. The activities are not expected to impact the facility.

Balancing: Cost

Capital costs include design and installation of institutional controls. Total capital costs are estimated to be approximately $116,000 for this alternative. O&M costs include groundwater monitoring. Total annual O&M costs are estimated to be $75,000. The total present value life cycle costs of this alternative using a discount rate of 7 percent is $410,000. A cost analysis is included in Appendix A.

5.3.3 In Situ Treatment via Permeable Reactive Barriers with Institutional Controls

Install a permeable reactive barrier ("*PRB*") across the flow path of the COI plume. For the purposes of the analysis, a calcite ($CaCO_3$) permeable reactive barrier (via hydraulic fracturing) was evaluated. For a typical treatment zone, multiple boreholes would be installed in multiple rows in the targeted area. Within each borehole, fractures will be created and filled with a proppant and treatment media. The hydraulic fracturing process generates a minimal amount of aquifer material requiring disposal, but some residual material used in the injection mixing tanks may require off-site disposal.

Four new monitoring wells will be installed to monitor the treatment. Performance monitoring would be conducted to monitor COIs. Institutional Controls such as restricted access fencing, restrictive covenants, and excavation permits would reduce the potential for exposure.

Threshold: Protection of Human Health and the Environment

Although the PRB with Institutional Controls alternative may reduce selected COIs (fluoride) below CAOs, this alternative cannot reduce existing concentrations of all COIs in groundwater. Potential exposure of non-reduced COIs may still exist. This alternative does incorporate implementing activities (hydraulic fracturing) that may present exposure risks to the community, workers, or the environment.

Institutional Controls provide an increased level of protection thereby reducing the potential for exposure. Currently, physical access is partially restricted at the Site. The exposure of authorized visitors (i.e., the maintenance workers and other adult nonresidents) would be reduced to acceptable levels through controls such as PPE requirements, dig permits, or other restrictions that would be outlined in an

environmental use agreement. Implemented legal barriers may include restrictive covenants and deed notices.

Threshold: Attain Media Cleanup Standards

This alternative would not comply with media cleanup standards because it would not address all concentrations of COIs in groundwater.

Threshold: Control the Source of Releases

Although the PRB with Institutional Controls alternative can control the release of fluoride from the site, this alternative cannot control all COIs in groundwater. Additionally, difficulty in distribution of the PRB as well as the limited longevity of the PRB would constrain its ability to effectively control the source.

Threshold: Comply with Applicable Standards for Waste Management

Some IDW will be generated as part of the PRB installation, well installation, and performance monitoring processes. After completion of each, the IDW will be sampled and analyzed for characterization. The waste handling activities will be performed in accordance with state and federal regulations and the requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

The PRB would operate as a passive treatment method that relies on groundwater flowing through the barrier for treatment. Implementation would control the release of fluoride from the site, this alternative cannot control all COIs in groundwater nor would it treat upgradient COIs in groundwater.

Additionally, with the implementation of PRBs as a passive treatment method, it is estimated, for purposes of this analysis, it would take 30 years for this alternative to achieve CAOs. The actual duration for this alternative may be longer than the standard 30-year horizon evaluated herein. The anticipated effectiveness of the reactive material within the PRB is 20 years, and replacement of the PRB at 20-year intervals will be required to maintain effective treatment of groundwater. This alternative would not meet the balancing criterion, as long-term effectiveness and permanence would not be achieved.

Balancing: Reduction of Mobility, Toxicity, or Volume

Although the PRB with Institutional Controls alternative can reduce selected COIs (fluoride) in the treatment zone below CAOs, this action offers no opportunity for reduction of toxicity, mobility, or volume of the remaining COIs through treatment nor does it address COIs in groundwater outside the treatment zone.

Balancing: Short-Term Effectiveness

Installation of the calcite PRB alternative can effectively reduce local concentrations of selected COIs (fluoride) in the short-term. However, a calcite PRB will not affect the remaining COIs. Implementation of this alternative could result in minimal exposure risk to the community, workers, and the environment. Wasted generated during the installation of the PRB would be managed using approved methods.

Balancing: Implementability

Treating fluoride in the groundwater by installing a calcite-based PRB would be technically feasible and would have minimal impact to the facility and community. No administrative implementation obstacles are expected. The materials and services necessary for the installation of PRB are readily available.

The effectiveness of the PRB will be controlled by the ability to distribute the proppant/treatment media in the subsurface. However, through a sequenced injection of sufficient proppant and treatment media volumes at appropriate spacing throughout the treatment area, distribution in the subsurface may be achieved at the Site.

Balancing: Cost

Capital costs include design, installation of institutional controls, installation of PRB, and waste disposal. Total capital costs are estimated to be approximately $2,400,000 for the PRB alternative. Additional costs may include multiple rounds of PRB treatment zone installation and groundwater monitoring. Total additional costs are estimated to $1,880,000. The total present value life cycle costs of this alternative using a discount rate of 7 percent is $4,280,000. A cost analysis is included in Appendix A.

5.3.4 Ex Situ Treatment via Groundwater Pumping and Treatment with Institutional Controls

Install an active groundwater pumping and treatment system to remove COI impacted groundwater and contains of impacted groundwater to prevent migration. Well design, pumping system, and treatment are dependent on the site geology and hydrogeology, and COIs. Extraction of impacted groundwater for treatment would reduce the dissolved-phase COIs, and establish hydraulic control to minimize plume migration toward surface water bodies.

Actual treatment of extracted groundwater would include a multi-phased process flow system tailored to remove specific COIs. Initial treatment would require air stripping to remove VOCs, a flocculation process to remove fluoride, then a cyanide treatment train. The treated groundwater would then be discharged through a NPDES permitted outfall.

Performance monitoring would be conducted to monitor COIs. Institutional Controls such as restricted access fencing, restrictive covenants, and excavation permits would reduce the potential for exposure.

Threshold: Protection of Human Health and the Environment

The implementation of this alternative may control the flow of impacted groundwater to potential receptors. However, the effectiveness of the treatment of a major COI, cyanide, is likely not to be effective. Cyanide discharge limits under the NPDES program are likely not to be achievable with standard wastewater treatment technologies. Therefore, this alternative may not provide protection of human health and the environment.

Institutional Controls provide an increased level of protection thereby reducing the potential for exposure. Currently, physical access is partially restricted at the Site. The exposure of authorized visitors (i.e., the maintenance workers and other adult nonresidents) would be reduced to acceptable levels through controls such as PPE requirements, dig permits, or other restrictions that would be outlined in an environmental use agreement. Implemented legal barriers may include restrictive covenants and deed notices.

Threshold: Attain Media Cleanup Standards

The groundwater pumping and treatment system alternative would attain media cleanup standards in groundwater through the extraction and separation of COIs and by preventing the completion of an exposure pathway for groundwater.

Threshold: Control the Source of Releases

The implementation of a groundwater collection system would likely control the flow of impacted groundwater.

Threshold: Comply with Applicable Standards for Waste Management

Some IDW will be generated as part of the groundwater pumping and treatment system installation, well installation, and performance monitoring processes. After completion of each, the IDW will be sampled and analyzed for characterization. The waste handling activities will be performed in accordance with state and federal regulations and the requirements of this threshold criterion would be met.

Groundwater pumping and treatment systems produce an effluent consisting of treated groundwater. Current groundwater pumping and treatment technology will not likely treat cyanide to levels below regulatory effluent discharge limits. As a result, treated groundwater would require additional management as a waste, therefore, this threshold criterion would not be met.

Balancing: Long-Term Effectiveness and Permanence

The groundwater pumping and treatment system alternative would prevent potential receptor exposure through hydraulic containment, thereby controlling further COI migration. With the implementation of groundwater pumping and treatment system as an active treatment method, this alternative would decrease the overall timeframe required to achieve remedial goals. Long-term O&M of the groundwater

pump and treat system would be required. For the purposes of this analysis it is assumed that it will take a minimum of 30 years for this alternative to achieve remedial goals. The actual remediation duration for this alternative may be longer than the standard 30-year horizon evaluated herein.

Balancing: Reduction of Mobility, Toxicity, or Volume

The groundwater pumping and treatment system alternative would further reduce the mobility, toxicity, and volume of COIs in groundwater. Further COI migration would be controlled and groundwater remediation time would be accelerated through groundwater extraction and treatment.

Balancing: Short-Term Effectiveness

Implementation of this alternative may result in additional exposure risk to the community, workers, and the environment through the discharge of treatment effluent potentially above regulatory levels.

Balancing: Implementability

Treating selected COIs by installing a groundwater pumping and treatment system would be technically feasible and would have minimal impact to the facility and community. The potential non-compliance of NPDES permit limits presents an administrative obstacle to be expected. The materials and services necessary for the installation of groundwater pumping and treatment system are readily available.

Balancing: Cost

Capital costs include design, installation of institutional controls, installation of groundwater pumping and treatment system, and waste disposal. Cost estimates were based on the installation of vertical extraction wells. Variability in local geological conditions would result higher capital costs for a horizontal extraction well or collection trench system. Total capital costs are estimated to be approximately $2,500,000 for the groundwater pumping and treatment system alternative. Total annual O&M costs are estimated to be approximately $210,000 each year for 30 years. The total present value life cycle costs of this alternative using a discount rate of 7 percent is $5,310,000. A cost analysis is included in Appendix A.

5.3.5 Risk-Based Assessment

This alternative involves the implementation of a site-specific risk-based assessment to examine current CAOs which are solely defined on existing regulatory policy. A risk-based corrective action process provides a framework for remediation decisions at impacted sites. It protects human health and the environment while allowing constructive current and future site use.

Using a risk-based process, CAOs are based on site-specific human health and environmental risk from exposure to COIs. Safe levels of COIs are based on land use (residential or non-residential) and the analysis of exposure pathways such as direct exposure to surface soil, groundwater use, vapor intrusion

into buildings, and others. The necessity of Institutional Controls will be evaluated as part of the risk assessment process.

Threshold: Protection of Human Health and the Environment

The implementation of a site-specific risk-based assessment can result in the protect human health and the environment.

Threshold: Attain Media Cleanup Standards

The current CAOs were developed based on existing regulatory policy. Revised CAOs would be developed based on site use and the analysis of exposure pathways. The use of a risk-based assessment would likely demonstrate compliance with this criterion

Threshold: Control the Source of Releases

There is no control of releases from the source(s).

Threshold: Comply with Applicable Standards for Waste Management

No wastes will likely be generated by this alternative. Therefore, the requirements of this threshold criterion would be met.

Balancing: Long-Term Effectiveness and Permanence

The implementation of a site-specific risk-based assessment will likely demonstrate compliance with this criterion.

Balancing: Reduction of Mobility, Toxicity, or Volume

A site-specific risk-based assessment will not result in the reduction components of this criterion.

Balancing: Short-Term Effectiveness

The implementation of a site-specific risk-based assessment will likely demonstrate compliance with this criterion.

Balancing: Implementability

This alternative would be technically and administratively feasible and not cause a disruption to the facility or surrounding area. No difficulties are foreseen in regards to the availability of services and materials to perform this alternative.

Balancing: Cost

The total capital costs associated with this alternative, which includes Engineering costs for the Risk Assessment, estimated to be approximately $88,000. Total periodic O&M costs, which includes Site restoration, are estimated to be approximately $68,000. The total present value life cycle costs of this alternative using a discount rate of 7 percent is $130,000. A cost analysis is included in Appendix A.

6.0 RECOMMENDATION OF CORRECTIVE ACTION ALTERNATIVES

This section provides the recommendation of the corrective action alternative to address the RAOs. Following the recommendation is justification for the alternatives selection. The corrective action alternatives recommended for the Site are:

- To address groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*") – Monitoring with Institutional Controls
- To address groundwater at the Old Brick Landfill ("*SWMU No. 3*") – Monitoring with Institutional Controls
- To address groundwater at the Main Plant – Risk-based Assessment

6.1 Address Groundwater at the Alcoa/Badin Landfill ("*SWMU No. 2*")

Based on the conclusions of the detailed analysis from Section 5.1, Monitoring with Institutional Controls is recommended as the corrective action alternative for the Alcoa/Badin Landfill. The Monitoring with Institutional Controls alternative provides the most protection for human health and the environment and attains media cleanup standards. Control of the source has been achieved. Furthermore, the Monitoring with Institutional Controls alternative better fits the long-term reliability balancing criterion.

By implementing the Monitoring with Institutional Controls alternative, annual monitoring will be conducted for a period five years to confirm stability and effectiveness of the interim measures. In addition, a re-evaluation of the success of the alternative after the five year monitoring period will be conducted.

6.2 Address Groundwater at the Old Brick Landfill ("*SWMU No. 3*")

Based on the conclusions of the detailed analysis from Section 5.2, Monitoring with Institutional Controls is recommended as the corrective action alternative for the Alcoa/Badin Landfill. The Monitoring with Institutional Controls alternative provides the most protection for human health and the environment and attains media cleanup standards. Control of the source has been achieved. Furthermore, the Monitoring with Institutional Controls alternative better fits the long-term reliability balancing criterion.

By implementing the Monitoring with Institutional Controls alternative, annual monitoring will be conducted for a period five years to confirm stability and effectiveness of the cover system upgrades. In addition, a re-evaluation of the success of the alternative after the five year monitoring period will be conducted.

6.3 Address Groundwater at the Main Plant

Based on the conclusions of the detailed analysis from Section 5.3, the Risk-based assessment alternative is recommended as the corrective action alternative for the Main Plant. The Risk-based assessment alternative provides a framework for remediation decisions at impacted sites. It protects human health and the environment while allowing constructive current and future site use.

By implementing the Risk-based Assessment alternative, a site-specific risk-based assessment will be executed to examine current action levels which are solely defined on existing regulatory policy. Risk-based action levels will be developed, and will be based on site-specific human health and environmental risk from exposure to COIs. Safe levels of COIs will be based on land use (residential or non-residential) and the analysis of exposure pathways such as direct exposure to surface soil, groundwater use, vapor intrusion into buildings, and others. The necessity of Institutional Controls will be evaluated as part of the risk assessment process.

7.0 REFERENCES

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APPENDIX A

ALTERNATIVE COSTING DETAILS

Monitoring with Institutional Controls Alternative Cost Estimate Summary
Alcoa/Badin Landfill - Badin, North Carolina

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1.	General Conditions (NOT APPLICABLE)				**$ -**
2.	Construction Costs (NOT APPLICABLE)				**$ -**
3.	Transportation & Disposal (T&D) (NOT APPLICABLE)				$ -
4.	Treatment (NOT APPLICABLE)				$ -
	SUBTOTAL CAPITAL COST				**$ -**
5.	Pre-construction Sampling/Delineation				$ -
6.	Design Engineering (5% capital cost)				$ -
7.	General Contractor Overhead and Profit (20% GC & Construction, 10% T&D)				$ -
8.	Resident Engineering (2.5% capital cost)				$ -
	TOTAL CAPITAL COST				**$ -**
OPERATION & MAINTENANCE (O&M) COSTS					
Annual O&M Costs					
9.	Annual Monitoring (Year 1-5)	1	$ 24,300	YEAR	**$ 24,300**
Periodic Costs					
10.	Site Restoration (at the end 5th year)	1	$ 25,438	LS	**$ 25,438**
11.	Year 5 Monitoring Evaluation Report	1	$ 16,950	LS	**$ 16,950**
	TOTAL O&M COST				**$ 112,531**
PRESENT VALUE					
	TOTAL PRESENT VALUE (7% DISCOUNT RATE)				**$ 112,531**
				SAY	**$ 110,000**

Monitoring with Institutional Controls Alternative Cost Estimate Summary
Old Brick Landfill - Badin, North Carolina

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1.	General Conditions (NOT APPLICABLE)				**$ -**
2.	Construction Costs (NOT APPLICABLE)				**$ -**
3.	Transportation & Disposal (T&D) (NOT APPLICABLE)				$ -
4.	Treatment (NOT APPLICABLE)				$ -
	SUBTOTAL CAPITAL COST				**$ -**
5.	Pre-construction Sampling/Delineation				$ -
6.	Design Engineering (5% capital cost)				$ -
7.	General Contractor Overhead and Profit (20% GC & Construction, 10% T&D)				$ -
8.	Resident Engineering (2.5% capital cost)				$ -
	TOTAL CAPITAL COST				**$ -**
OPERATION & MAINTENANCE (O&M) COSTS					
Annual O&M Costs					
9.	Annual Monitoring (Year 1-5)	1	$ 23,050	YEAR	**$ 23,050**
Periodic Costs					
10.	Site Restoration (at the end 5th year)	1	$ 7,600	LS	**$ 7,600**
11.	Year 5 Monitoring Evaluation Report	1	$ 16,950	LS	**$ 16,950**
	TOTAL O&M COST				**$ 95,579**
PRESENT VALUE					
	TOTAL PRESENT VALUE (7% DISCOUNT RATE)				**$ 95,579**
				SAY	**$ 90,000**

MNA Alternative Cost Estimate Summary
Plant Groundwater - Badin, North Carolina

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1.	General Conditions (NOT APPLICABLE)				**$ -**
2.	Construction Costs				**$ -**
	Institutional Controls - Fencing	1	$ 108,000	LS	**$ 108,000**
3.	Transportation & Disposal (T&D) (NOT APPLICABLE)				$ -
4.	Treatment (NOT APPLICABLE)				$ -
	SUBTOTAL CAPITAL COST				**$ 108,000**
5.	Pre-construction Sampling/Delineation				$ -
6.	Design Engineering (5% capital cost)				$ 5,400
7.	General Contractor Overhead and Profit (20% GC & Construction, 10% T&D)				$ -
8.	Resident Engineering (2.5% capital cost)				$ 2,700
	TOTAL CAPITAL COST				**$ 116,100**
OPERATION & MAINTENANCE (O&M) COSTS					
Annual O&M Costs					
9.	Annual Monitoring (Year 1-5)	1	$ 74,865	YEAR	**$ 74,865**
Periodic Costs					
10.	Site Restoration (at the end 5th year)	1	$ 36,500	LS	**$ 36,500**
11.	Year 5 Monitoring Evaluation Report	1	$ 31,900	LS	**$ 31,900**
	TOTAL O&M COST				**$ 302,350**
PRESENT VALUE					
	TOTAL PRESENT VALUE (7% DISCOUNT RATE)				**$ 418,450**
				SAY	**$ 410,000**

PRB Summary (Fracing) Cost Estimate Summary
Plant Groundwater - Badin, North Carolina

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1.	General Conditions				**$ 40,000**
	General Administrative Conditions	1	$ 10,000	LS	$ 10,000
	Permitting	1	$ 10,000	LS	$ 10,000
	Survey	1	$ 20,000	LS	$ 20,000
2.	Construction Costs				**$ -**
	PRB Installation				**$ 1,847,885**
3.	Transportation & Disposal (T&D) (NOT APPLICABLE)				$ -
4.	Treatment (NOT APPLICABLE)				$ -
	SUBTOTAL CAPITAL COST				**$ 1,887,885**
5.	Pre-construction Sampling/Delineation (NOT APPLICABLE)				$ -
6.	Design Engineering (5% capital cost)				$ 94,394
7.	General Contractor Overhead and Profit (20% GC & Construction, 10% T&D)				$ 377,577
8.	Resident Engineering (2.5% capital cost)				$ 47,197
	TOTAL CAPITAL COST				**$ 2,407,053**
OPERATION & MAINTENANCE (O&M) COSTS					
Annual O&M Costs					
8.	Project Management (Year 1-30)	1	$ 30,000	YEAR	**$ 30,000**
9.	Annual Monitoring (Year 1-30)	1	$ 74,865	YEAR	**$ 74,865**
	SUBTOTAL O&M COST				**$ 104,865**
Periodic Costs					
10.	PRB Maintenance (Year 20)	1	$ 1,497,930	LS	**$ 1,497,930**
11.	Site Restoration (at the end 30th year)	1	$ 36,500	LS	**$ 36,500**
12.	Year 30 Monitoring Evaluation Report	1	$ 31,900	LS	**$ 31,900**
13.	OM&M Overhead and Profit (10%)				**$ 171,066**
	TOTAL O&M COST				**$ 1,881,726**
PRESENT VALUE					
	TOTAL PRESENT VALUE (7% DISCOUNT RATE)				**$ 4,288,780**
				SAY	**$ 4,280,000**

Groundwater P&T Summary (Extraction Wells) Cost Estimate Summary
Plant Groundwater - Badin, North Carolina

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1.	General Conditions				**$ 40,000**
	General Administrative Conditions	1	$ 10,000	LS	$ 10,000
	Permitting	1	$ 10,000	LS	$ 10,000
	Survey	1	$ 20,000	LS	$ 20,000
2.	Construction Costs				**$ -**
	System Installation				**$ 1,889,290**
3.	Transportation & Disposal (T&D) (NOT APPLICABLE)				$ -
4.	Treatment (NOT APPLICABLE)				$ -
	SUBTOTAL CAPITAL COST				**$ 1,929,290**
5.	Pre-construction Sampling/Delineation (NOT APPLICABLE)				$ -
6.	Design Engineering (5% capital cost)				$ 96,465
7.	General Contractor Overhead and Profit (20% GC & Construction, 10% T&D)				$ 385,858
8.	Resident Engineering (2.5% capital cost)				$ 48,232
	TOTAL CAPITAL COST				**$ 2,459,845**
OPERATION & MAINTENANCE (O&M) COSTS					
Annual O&M Costs					
8.	Project Management (Year 1-30)	1	$ 30,000	YEAR	**$ 30,000**
9.	Annual Monitoring (Year 1-30)	1	$ 66,115	YEAR	**$ 66,115**
10.	System Monitoring (Year 1-30)	1	$ 114,280	YEAR	**$ 114,280**
	SUBTOTAL O&M COST				**$ 210,395**
Periodic Costs					
11.	Site Restoration (at the end 30th year)	1	$ 36,500	LS	**$ 36,500**
12.	Year 30 Monitoring Evaluation Report	1	$ 31,900	LS	**$ 31,900**
13.	OM&M Overhead and Profit (10%)				**$ 259,215**
	TOTAL O&M COST				**$ 2,851,363**
PRESENT VALUE					
	TOTAL PRESENT VALUE (7% DISCOUNT RATE)				**$ 5,311,208**
				SAY	**$ 5,310,000**

Risk Assessment Alternative Cost Estimate Summary
Plant Groundwater - Badin, North Carolina

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1.	General Conditions (Risk Assessment Report)	1	$ 88,100	LS	**$ 88,100**
2.	Construction Costs (NOT APPLICABLE)				**$ -**
3.	Transportation & Disposal (T&D) (NOT APPLICABLE)				$ -
4.	Treatment (NOT APPLICABLE)				$ -
	SUBTOTAL CAPITAL COSTS				**$ 88,100**
5.	Pre-construction Sampling/Delineation (NOT APPLICABLE)				$ -
6.	Design Engineering (NOT APPLICABLE)				$ -
7.	General Contractor Overhead and Profit (NOT APPLICABLE)				$ -
8.	Resident Engineering (NOT APPLICABLE)				$ -
	TOTAL CAPITAL COST				**$ 88,100**
OPERATION & MAINTENANCE (O&M) COSTS					
Annual O&M Costs					
9.	Annual Monitoring (Year 1-5)	1	$ -	YEAR	**$ -**
PERIODIC COSTS					
10.	Site Restoration (at the end 5th year)	1	$ 36,500	LS	**$ 36,500**
11.	Final Evaluation Report	1	$ 31,900	LS	**$ 31,900**
	PRESENT WORTH OF TOTAL RISK ASSESSMENT O&M COST				**$ 68,400**
PRESENT VALUE					
	TOTAL PRESENT VALUE (7% DISCOUNT RATE)				**$ 136,869**
				SAY	**$ 130,000**