



OCT 28 2016

October 20, 2016

Mr. Tim Barr P.E.
Deputy Program Administrator
Division of Waste Management
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399

SUBJECT: Request for Amendment to Approval of Standing Beneficial Use of
Encapsulated Bottom Ash Generated by the Pasco County Resource
Recovery Facility

Dear Mr. Barr:

Pasco County has been working extensively on the recycling of bottom ash from the Pasco County Resource Recovery Facility. Over the past four years, we have been working with a team of scientists and engineers to develop the appropriate processes to implement our recycling objectives. Throughout this process we have gathered the necessary data to demonstrate that these activities can be conducted in a manner that is safe for human health and the environment. This is due in large part to significant laboratory testing, a pilot project, and groundwater monitoring effort conducted by the University of Florida. In December of 2014, Pasco County received departmental authorization for the standing use of waste to energy bottom ash in county wide projects for three roadway construction applications, subject to a series of prescribed conditions.

The departmental approval was based on the engineering efforts described above and consistent with the authority described in Section 403.7045(5) of the Florida Statutes. Section 403.7045(5) of the Florida Statutes authorizes the Department to allow beneficial reuse of ash residue when an applicant demonstrates that "no significant threat to public health will result and that applicable Department standards and criteria will not be violated." A technical report entitled "Pasco County Use Case Scenarios to Examine the Recycling of Waste to Energy Bottom Ash in Road Construction Applications" was prepared by the University of Florida on behalf of the county and was submitted with the initial request in 2014.

As our recycling initiative has progressed following the 2014 Department approval, our team has identified additional potential uses for the bottom ash that were not originally contemplated. At our request, Innovative Waste Consulting Services and JMG

COUNTY ADMINISTRATION

West Pasco Government Center 8731 Citizens Drive, Suite 340 New Port Richey, FL 34654
mbaker@pascocountyfl.net 727.847.8115

Engineering have prepared a technical memorandum entitled "Amendment Request to Approval of Specified Materials for Recycling and Reuse of Treated Bottom Ash Residue from the Pasco County Resource Recovery Facility". This document is attached here for your review along with an additional copy of the 2014 report. This technical memorandum presents the proposed amendments and supporting technical evaluation and justification for the two additional construction applications incorporating waste to energy bottom ash from the Pasco County facility.

By way of submittal of the attached document, Pasco County, Florida formally requests Departmental approval to utilize bottom ash in two additional beneficial use applications:

- A. As a partial coarse aggregate replacement in portland cement concrete slabs beneath structures. To ensure that the beneficially reused ash would provide sufficient structural support, designed for facilities where WTE bottom ash was incorporated in the slab and would be required to be signed and sealed by a licensed professional engineer.
- B. As a structural base course, underlying multi-use paths. Multi-use paths where WTE bottom ash is used as a structural base would be required to have a one inch minimum asphalt thickness. Ash utilized as a structural base would not extend more than six inches beyond the outside edge of the pavement. The maximum thickness of ash would be restricted to less than eight inches and maximum width to less than twelve feet.

The County is committed to adhering to the manners and techniques utilized in the construction of the demonstration road segments (as summarized in the attached report); adhering to construction, processing, and location constraints included in the initial approval and/or identified in the attached technical memorandum; and limiting use of the bottom ash to Pasco County projects (or those projects under the direct supervision of Pasco County). Thank you for your consideration of this request. We look forward to implementing this important project and continuing to work with the FDEP to identify ways of maximizing recycling in Pasco County.

Sincerely,



Michele Baker, MBA
County Administrator

MB/ck

Enclosure

cc: Flip Mellinger, Assistant County Administrator (Utilities Services)

Amendment Request to Approval of Specified
Materials for Recycling and Reuse of Treated
Bottom Ash Residue from the Pasco County
Resource Recovery Facility:

Supporting Technical Memorandum

Prepared for:

*Pasco County Utilities
7536 State St. Suite 213
New Port Richey, FL 34654*

Prepared by:

*Innovative Waste Consulting Services
Justin G. Roessler, Ph.D.
Timothy G. Townsend, Ph.D., P.E.*

Under Subcontract to:

*JMG Engineering
Jason M. Gorrie, P.E., BCEE*

1.0 Overview

Pasco County, Florida is requesting Florida Department of Environmental Protection authorization of two additional beneficial use applications for waste to energy (WTE) bottom ash. This report provides a discussion of these beneficial use options, proposed constraints, and supporting technical analysis. The County's ash reuse efforts have moved out of research and into an applied phase. The County is eager to pursue ash recycling under the current approval, and has identified several similar applications that do not specifically fall under the original approval, but which should offer comparable benefit and pose a similar level of risk as the first approval.

1.1 Background

In December of 2014, the Florida Department of Environmental Protection (FDEP) granted Pasco County Utilities approval for the recycling and reuse of processed WTE bottom ash from the Pasco County Resource Recovery Facility, under the provisions of Section 403.7045(5), Florida Statutes (F.S.). The data and ash reuse options presented in the 2014 approval were identified during a multi-year research and development effort led by Drs. Timothy Townsend and Justin Roessler, at the University of Florida. As a part of this effort, Pasco County Utilities constructed a series of roadway test sections at the West Pasco Landfill which incorporated WTE bottom ash under a FDEP Research, Development, and Demonstration permit. This pilot project gave the engineering team the opportunity to gather environmental data, produce ash amended asphalt and concrete using local vendors, and conduct a trial run employing Pasco County's construction equipment and personnel.

The environmental data gathered from the pilot study were coupled with contaminant fate and transport modeling to conduct a use case analysis, assessing whether the County's proposed ash recycling activities were protective of human and environmental health. The scenarios examined in the use case analysis mirrored those constructed in the pilot project. The results of this analysis were summarized in the technical report "Pasco County Use Case Scenarios to Examine the Recycling of Waste to Energy Bottom Ash in Road Construction Applications" authored by Drs. Townsend and Roessler. This report was provided to the Department upon submittal of the County's approval request in August of 2014.

Agency authorization for bottom ash reuse was granted for the specific set of roadway construction applications examined in the use case analysis. These applications are subject to a series of prescribed conditions outlined in the August 2014 report. The specific roadway construction applications authorized were: use of bottom ash as a structural base layer under a roadway, use of ash as a partial course aggregate replacement in hot mix asphalt (HMA), and use of ash as a partial coarse aggregate replacement in portland cement concrete (PCC) (referred to herein as

authorized uses one, two and three). The explicit departmental language for the approved uses is provided in Appendix A.

As previously discussed, the three approved standing uses are subject to a series of prescribed conditions to ensure that ash processing and roadway construction are conducted in such a way to be protective of human and environmental health. These conditions require aging of the ash to reduce its leachability, set placement limitations with respect to groundwater depth and proximity to sensitive water bodies, provide storage limits for ash in asphalt and concrete batch plants, stipulate departmental reporting and end of service requirements, and prescribe specific construction practices with respect to the thickness of the overlaying asphalt layer when ash is used as a structural base course. The explicit departmental language for the currently approved uses is provided in Appendix A.

1.2 County Objectives

Pasco County continues to work to identify avenues for the beneficial reuse of ash. The current departmental approval for ash reuse within the County is limited only to the three specific applications initially requested. Continued groundwater monitoring of wells surrounding the test roadway has demonstrated no impact. The County is committed to development of ash reuse projects for these applications, however, a number of similar applications are presently not authorized, as they were not taken into consideration by the County and its engineering team at time of the initial request. As these applications are comparable in nature to the currently approved uses, they will likely pose a similar level of environmental risk and offer a substantial benefit.

1.3 Scope of Report

While the level of risk for comparable applications should be similar, a technical evaluation to appropriately quantify the risk presented by the contemplated new uses is still necessary. The County has identified two additional reuse options that most closely match what has already been approved. The County wishes to amend the original approval to include these uses. The proposed applications are:

- A. Use of WTE bottom ash as a partial coarse aggregate replacement in a portland cement concrete slab
- B. Use of waste to energy bottom ash as a structural base layer under multi-use paths

This report provides an assessment of whether the proposed reuse options meet the same acceptable level of risk as those which were initially approved. While the scope of this report is limited to the two reuse options listed above, other applications could present a similar level of risk to those considered in the first

approval. However, a detailed technical investigation would first need to be conducted to appropriately assess this risk.

2.0 Proposed Applications

Section 2 provides a detailed review of the two proposed uses, with respect to their applications and reuse conditions; a technical analysis of the level of environmental risk present is provided in Section 3. The two proposed uses would be subject to all of the conditions listed in Appendix A, except where explicitly discussed in the text. In all instances, the proposed uses would provide institutional control through either encapsulation (concrete) or covering (structural base). For both of the proposed uses modifications are suggested to the list of reuse constraints to facilitate construction in practical and cost effective manner, while still ensuring adequate protection of human and environmental health.

2.1 Aggregate in a Concrete Slab For a Commercial/Industrial Facility

Proposed use A centers on the incorporation of aged and processed WTE bottom ash as a partial coarse aggregate replacement in PCC slabs. Use of ash-amended PCC would be restricted to commercial/industrial facilities located within Pasco County. Bottom ash would be aged and processed consistent with conditions outlined in Appendix A; the ash would be aged on a lined landfill cell and would be processed to remove the majority of the fine fraction ($< 3/8"$) of the material, in order to produce a gradation which would be representative of a coarse aggregate commonly used in PCC. The processed and aged ash would then be used in the same fashion as a conventional coarse aggregate in the batching of PCC by a third party vendor. Oversight of material delivery and storage to batch plants will be supervised by the County or their authorized agent.

Differences between proposed use A and authorized use three (PCC pavement) lie in the end use of the ash amended PCC. The ash amended PCC would be produced using the same material (ash) and process as the currently approved use, and subject to all of the same recycling and reuse conditions (outlined in Section 1.1); however, the PCC would be incorporated into a building slab in lieu of PCC pavement. One additional recycling and reuse conditions is recommended for proposed use one.

1. Design of the commercial/industrial facility foundation slab incorporating ash be signed and sealed by a licensed professional engineer

This recycling and reuse condition is recommended to ensure that when ash is beneficially used in the construction of a PCC slab, it will comply with the necessary structural design requirements. As a part of its research and development efforts, the County has compiled substantial testing data on the strength of ash amended PCC. This data and the County's construction experience with ash will allow for the

development of mixture designs which meet structural design requirements. Proposed condition one ensures that this will be verified by a licensed professional engineer.

2.2 Structural Base Under a Multi-Use Path

Proposed use B focuses on the use of processed and aged bottom ash as a structural base course under multi-use paths within the County. Multi-use paths with an overlaying asphalt layer are supported by a structural base course, and serve as an avenue for pedestrian traffic and other recreational activities (bike riding, rollerblading). Differences between proposed use two and authorized use one (road base) relate to the utility of the overlying asphalt layer, its thickness, and the volume of structural base course to be placed below the asphalt. Mixed use paths vary in width from eight to twelve feet and have an overlaying asphalt layer ranging in thickness from one to two inches. The underlying structural base course, where the processed ash would be utilized, ranges in thickness from six to eight inches.

Proposed use A would be subject to the recycling and reuse conditions (listed in Appendix A) which are applicable for ash utilized a roadway base. Minor amendments to recycling and reuse conditions four and six are proposed in order to allow for the practical and cost feasible construction of multi-use paths where processed WTE bottom ash is used as a structural base course. Condition four would be modified to reflect the extension of the ash base out four to six inches from the edge of the overlying pavement layer. This modification is needed to prevent structural failure to the edge of the overlying HMA surface. Condition six would be altered to allow for the reduced thickness of the overlying asphalt layer. Due to the reduced loading (in comparison to a roadway) multi-use paths employ both a thinner asphalt and structural base layer. In addition to the modifications listed above, one supplementary recycling and reuse condition is suggested for proposed use two. Suggested language modifications to conditions four and six and the additional recycling and reuse condition are described below:

Modified Recycling and Reuse Conditions

- Condition 4. Rev) When utilized as structural base for multi-use paths, the placement of the bottom ash shall not extend more than six inches beyond the outside edge of the pavement; the fraction of bottom ash extending beyond the edge of the pavement shall be completely covered by a compacted soil layer. Bottom ash remaining outside this distance after construction shall be removed and recycled in a manner consistent with this Order or placed in a permitted Class I lined landfill."
- Condition 6. Rev) "When bottom ash is utilized as a structural base layer under a multi-use path, only asphalt mixes shall be placed as the overlying pavement layer with a one-inch or greater as-built thickness."

Additional Recycling and Reuse Condition

1. When processed bottom ash is used as a structural base course beneath a multi-use path the maximum thickness of ash be restricted to no greater than eight inches and maximum width be restricted to no more than twelve feet.

3.0 Supporting Technical Evaluation

Section 3 provides a technical background for the proposed amendments to the ash recycling use approval. As the proposed uses employ bottom ash from the same facility, processed in the same manner as the current approval, the data and analysis from the 2014 report "Pasco County Use Case Scenarios to Examine the Recycling of Waste to Energy Bottom Ash in Road Construction Applications" are referenced for technical support. Standard procedure for assessing the potential environmental and human health impacts for beneficially used materials focus on examining two pathways, direct human exposure risk and leaching to water supplies. These pathways are discussed in the subsequent sections for the two proposed recycling applications.

3.1 Direct Human Exposure

In the context presented here, direct exposure refers to the direct contact of a person with a beneficially used material, through the pathways of ingestion, inhalation and dermal contact. Consistent with the previous approval, the County will recycle WTE bottom ash in a manner that eliminates the direct exposure pathway. The ash will be encapsulated in a PCC matrix, or in the case of structural base course, it will be completely covered by an asphalt pavement layer or compacted soil shoulder. In accordance with the current authorization, the potential for worker exposure during ash processing, transport, and recycling will be controlled through proper ash management techniques (e.g. on-site wetting to control dust). Thus consistent with the prior approval, with respect to Section 403.7045(5) F.S., the requirement to demonstrate that no significant threat to public health will result from beneficial use, the direct human exposure concerns are satisfactorily addressed through the method in which the ash is recycled. Detailed laboratory characterization data on the total elemental composition of the bottom ash from the Pasco County Facility was provided in the 2014 report, which is attached under separate cover.

3.2 Leaching to Groundwater

Leaching risk to groundwater is commonly assessed through a two step process. First a waste's potential to release chemicals into the surrounding environment are quantified through the use of a leaching test. Second the concentration of contaminants of potential concern (COPC) are estimated at a simulated compliance point, a fixed distance away from the edge of the material. This is done using a fate and transport model. This is conceptually illustrated for the beneficial use scenario of ash used as a base course under a roadway in Figure 3.2.1..

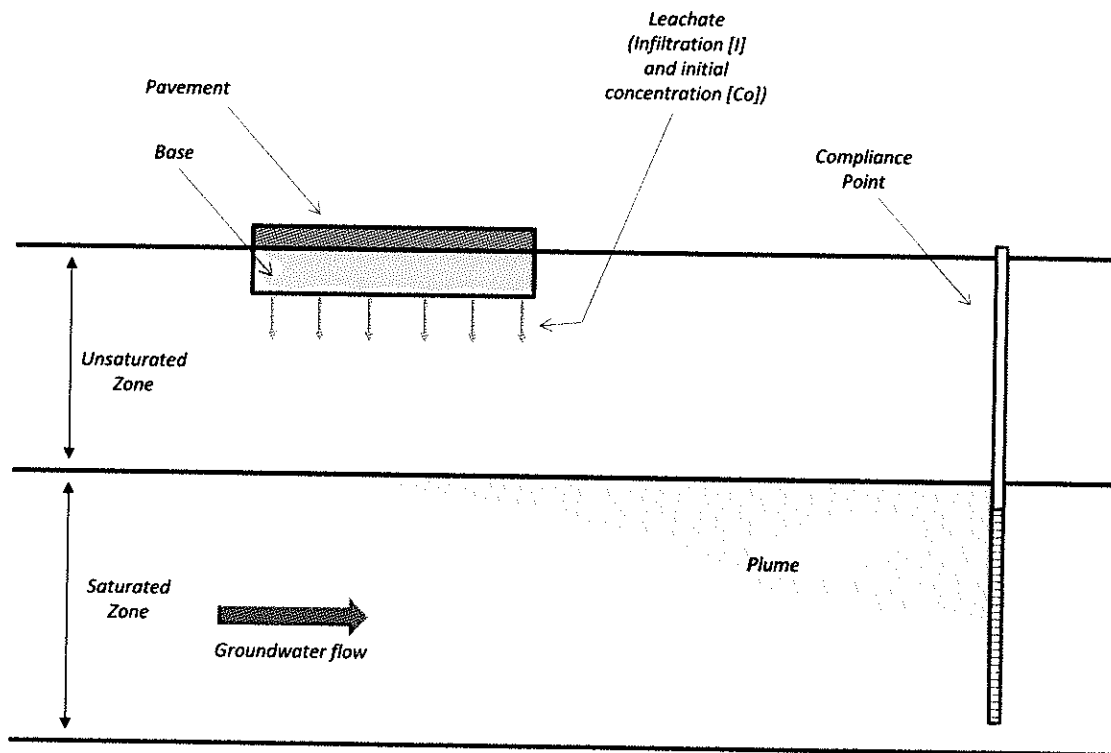


Figure 3.2.1 Conceptual Illustration of Fate and Transport Scenario for WTE Bottom Ash Reuse

In the previous report, a detailed fate and transport modeling analysis was done for the three reuse scenarios presented in Section 1.1 (HMA, PCC, road base). This analysis used results from leaching tests conducted at the University of Florida on the Pasco ash, and ash amended PCC and HMA. Hydrogeologic and climatic data tailored to be specific to the County was incorporated into the modeling assessment. The researcher's then used further modeling and laboratory testing in an attempt to estimate the rate of water infiltration through each of the waste materials. The modeling assessment conducted in the previous study evaluated uses similar to the two proposed amendments using data representative of the ash leachate quality and area hydrogeologic conditions. However, model runs with site

conditions and dimensions specific to the two proposed amendments (uses A and B) were not previously conducted.

While the results of the previous modeling analysis provide some support for the protection of groundwater, two additional modeling evaluations were conducted to provide further evidence that the proposed reuse applications would not be likely to substantially impact water quality. These were designed to account for the differing conditions present in the new scenarios. Technical background on the model employed, model development, and the results are presented in Sections 3.2.1 through 3.2.3

3.2.1 Industrial Waste Management Evaluation Model Technical Background

The Industrial Waste Management Evaluation Model (IWEM) is a pollutant fate and transport model developed by the United States Environmental Protection Agency (EPA) and designed as a screening level tool for fate and transport analysis. In the 2014 study, IMEM was one of the two models used. IWEM is a stochastic model, meaning that in each run it conducts simulations over a varying range of hydrogeologic conditions (e.g. thickness, hydraulic conductivity, pH, gradient). Each model run consists of 10,000 individual realizations in order to encompass a range of possible hydrogeologic conditions. The model output is reported as the 90th percentile of the 10,000 realization data set in order to provide a conservative estimate. All IWEM inputs were kept the same as the 2014 study, with the exception of those needing to be modified to account for a specific condition of the use. Each of the model runs were conducted using the previously authorized point of compliance (100 feet from the edge of the beneficial use application).

In addition to initial COPC concentrations, a fate and transport modeling evaluation relies on a description of the hydrology of the site in question to predict concentrations at a set receptor distance. The primary hydrologic input parameters for a fate and transport modeling evaluation are: the infiltration rate of water through the beneficially used waste material, aquifer recharge rate, distance to simulated point of compliance, and aquifer characteristics (thickness, hydraulic conductivity, and gradient). Once simulated, modeled results at the receptor are then typically compared to risk based concentration thresholds. In this and the 2014 study, the modeled results were compared to Florida Groundwater Cleanup Target Levels (62-777 F.A.C) with the exception of aluminum. The GCTL for aluminum is its federal secondary drinking water standard, which is a non-health based threshold reflective of aesthetic concerns such as taste and odor. A health based target level of 7 mg/L was calculated for aluminum in the 2014 study, using aluminum's health based dose assumptions incorporated in to the Florida Soil Cleanup Target Levels. This was used as the reference threshold in this study.

3.2.2. IWEM Model Development

In both the current and prior study, IWEM runs were only evaluated for COPC where the initial pore water concentration was elevated above the GCTL or the derived health risk threshold. The COPC's and input concentrations employed were taken from data gathered at the University of Florida during the 2014 study. The COPCs identified for the ash used as a structural base are: aluminum, antimony, and molybdenum; molybdenum is the only COPC for the ash amended PCC. Specific model design for the evaluation of proposed uses A and B are presented in sections 3.2.2.1 and 3.2.2.2 respectively.

3.2.2.1 IWEM Simulation One: Ash as a Partial Coarse Aggregate Replacement in Portland Cement Concrete Slabs – Proposed Use A

IWEM simulation one was conducted to evaluate the impact of the increase in the size (and subsequent mass) of the ash amended PCC being placed in a specific location. The area of the waste source was increased to 50,000 ft², which was set to be representative of the possible footprint of commercial/industrial facility where ash would be incorporated into the slab. The slab thickness was set at 8 inches. For the PCC slab model the waste infiltration rate was set to the maximum value (1 inch/year) used for concrete in the 2014 assessment. This value was determined through water balance modeling using the EPA's HELP model. This serves as a conservative estimation of the infiltration rate as a commercial/industrial facility where a slab would be placed would be roofed, limiting water infiltration through the majority of the slab in comparison to a roadway. Leaching test results from US EPA's Method 1312 – *The Synthetic Precipitation Leaching Procedure (SPLP)*, conducted on ash amended PCC, were used as the concentration inputs for IWEM simulation one (the same concentration inputs used for the PCC pavement scenario in the 2014 study).

3.2.2.2 IWEM Simulation Two: Ash as a Structural Base Under a Multi-Use Path - Proposed Use B

IWEM simulation two was done to evaluate the use of WTE bottom ash as a structural base under a multi-use path. This application is similar to the analysis previously conducted for the ash used as roadway base course. Differences in the applications relate to both the thickness and width of the ash used as base. Multi-use paths experience less loading and don't have to account for vehicle width. The volume of ash used as base in a multi-use path 12 feet in width with an 8 inch base course is less than 35% of what would typically be used to construct a two lane roadway. IWEM simulation two was modeled as the same scenario that was run for the roadway base with the exception that the roadway thickness was decreased (from 8 to 10 inches) to be representative of a typical path design. For the multi-use path scenario the waste infiltration rate was set equal to the aquifer recharge rate in the IWEM model (4.05 inches/year). (e.g., the volume of water that infiltrates

through the soil into the underlying groundwater). In other words, this method assumes that infiltration into the roadway is equal to the amount that is moving through the surrounding soil and into the groundwater. As asphalt surfaces are both sloped and semi-impervious, this is designed as a conservative assumption. Leaching test results from US EPA's Method 1314 - *Liquid-Solid Partitioning as a Function of Liquid-Solid Ratio for Constituents in Solid Materials Using An Up-Flow Percolation Column*, conducted on the aged Pasco WTE bottom ash, were used as the concentration inputs for IWEM simulation two (the same concentration inputs used for road base in the 2014 study).

3.2.3 IWEM Model Results

The results of the two IWEM simulations are presented in Table 3.3.1. For both of the scenarios examined, the model results did not produce concentrations in exceedance of the risk threshold employed. This is consistent with the results of the 2014 modeling evaluation. The detailed outputs of the IWEM runs conducted are provided in Appendix A.

Table 3.2.3.1 Modeled IWEM 90th Percentile Concentrations at Point of Compliance

COPC	Risk Threshold (mg/L)	Ash as Base in Multi-Use Path (mg/L)	Ash as Aggregate in PCC Slab (mg/L)
Sb	0.006 ¹	0.0031	n/a
Mo	0.035 ¹	0.0237	0.0261
Al*	7.0 ²	0.777	n/a

¹Florida groundwater clean-up target level (F.A.C. 62-777)

²Health derived risk threshold for aluminum from 2014 study

This analysis supports the conclusion that proposed uses A and B pose a similar level of risk to those applications which are presently authorized under the current approval. Similar to the 2014 evaluation, model results demonstrated that groundwater quality would not be significantly impacted at a 100 foot point of compliance. Results from groundwater monitoring of the pilot roadway, constructed in 2014, support the transport models results and methodology.

4.0 Summary

Pasco County proposes to amend its current standing beneficial use approval for WTE bottom ash to include two additional applications: use as a partial coarse aggregate replacement in PCC slabs, and use as a structural base layer under multi-use paths. These applications are similar to the existing suite of approved uses and would incorporate the same processing, aging, construction techniques that are currently required in the 2014 approval. In addition, the two proposed uses would be subject to the recycling and reuse conditions based on the recommendations from the "Pasco County Use Case Scenarios to Examine the Recycling of Waste to Energy Bottom Ash in Road Construction Applications" report, also outlined in the standing use approval. Certain reuse conditions are proposed for amendment to allow for practicability of construction for the beneficial use applications. Table 4.1 presents a summary of the proposed uses A and B, recommended recycling and reuse conditions, and differences from the presently authorized applications. Suggested language modifications for proposed use B are compared to the present approval language in Table 4.2

Table 4.1 Summary of Proposed Beneficial Use Applications

Reuse Application	Use as a Partial Coarse Aggregate Replacement in Portland Cement Concrete Slabs – Proposed Use A	Use as a Structural Base Course Under a Multi-Use Path – Proposed Use B
Similar Application Currently Authorized	Use as a partial coarse aggregate replacement in portland cement concrete pavement	Use as a structural base course underneath a paved roadway
Differences in Proposed Application	<ul style="list-style-type: none"> • larger area footprint • roofed application – limited infiltration • potential for increased loading on concrete 	<ul style="list-style-type: none"> • thickness of overlying asphalt layer reduced • width decreased from 24 ft (2-lane road) to 12 ft (multi-use path) • depth of base decreased from 10-12 inches (roadway) to <8 inches (multi-use path) • extension of base 6 inches from edge of pavement permitted if covered
Additional Recycling and Reuse Conditions	<ol style="list-style-type: none"> 1. Design of the commercial/industrial facility incorporating ash be signed and sealed by a licensed professional engineer 	<ol style="list-style-type: none"> 1. When processed bottom ash is used as a structural base course beneath a multi-use path the maximum thickness of ash be restricted to no greater than eight inches and maximum width be restricted to no more than twelve feet.

Table 4.2 Recommended Language Changes for Recycling and Reuse Conditions

Current Recycling and Reuse Condition Language	Suggested Language Changes for Multi-Use Path
Condition 4.) When utilized as road base, the placement of the bottom ash shall not extend beyond the outside edge of the pavement. Bottom ash remaining outside the edge of the pavement after construction shall be removed and recycled in a manner consistent with this Order or placed in a permitted Class I lined landfill.	Condition 4. Rev) When utilized as <u>structural base</u> for <u>multi-use paths</u> , the placement of the bottom ash shall not extend <u>more than six inches beyond the outside edge</u> of the pavement; <u>the fraction of bottom ash extending beyond the edge of the pavement shall be completely covered by a compacted soil layer.</u> Bottom ash remaining outside <u>this distance</u> after construction shall be removed and recycled in a manner consistent with this Order or placed in a permitted Class I lined landfill.
Condition 6.) When bottom ash is utilized as a road base course, only dense-graded asphalt mixes shall be placed as the overlying pavement layer with a 4-inch or greater as-built thickness.	Condition 6. Rev) When bottom ash is utilized as a structural base layer under a multi-use path, only dense-graded asphalt mixes shall be placed as the overlying pavement layer with a <u>one-inch</u> or greater as-built thickness.

A substantial fate and transport modeling evaluation was done as a component of the 2014 study to examine the potential for the beneficial use of WTE bottom ash to impact the surrounding groundwater. Additionally, the direct human exposure risk was quantified and managed through institutional control (covering and encapsulation) and good construction practices. Conclusions from the 2014 study state that:

"The results of this analysis demonstrate that bottom ash, representative of the type tested here, when recycled in a manner consistent with the procedures and constraints identified in this report, will pose no significant threat to human health and the environment. Direct human exposure should not be a concern because the ash is encapsulated or covered with a paved surface. While a few elements leach above health-based thresholds, these elements should, in the vast majority of surficial aquifer conditions encountered, be diluted and attenuated to safe concentrations at distances of 100 ft or less from the roadway."

In order to provide a further technical evaluation and to ensure that the proposed uses were still protective of the surrounding groundwater, two additional IWEM modeling runs were conducted. The site conditions for each run were modified to reflect the specific conditions of the two proposed applications and utilized the same hydrogeologic and concentration inputs as the previous study. Results of the current IWEM modeling evaluation did not indicate predicted concentrations of COPC in exceedance of the regulatory thresholds at the modeled point of compliance. This data is consistent with the results of the prior study and support the conclusion that if appropriately constructed and maintained the two proposed uses would not be likely to pose a significant threat to human health and the environment.

Appendix A: 2014 Pasco Approval of Specified Materials for Recycling and Reuse of Treated Bottom Ash



Florida Department of Environmental Protection

BOB MARTINEZ CENTER
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32399-2400

RICK SCOTT
GOVERNOR

CARLOS LOPEZ-CANERA
LT. GOVERNOR

CLIFFORD D. WILSON III
INTERIM SECRETARY

December 5, 2014

via electronic mail

Michelle L. Baker, M.B.A.
County Administrator
8731 Citizens Drive
New Port Richey, Florida 34654-5598

RE: Approval of Specified Materials for
Recycling and Reuse of Treated Bottom Ash Residue from the
Pasco County Resource Recovery Facility, WACS ID No. 26254

Dear Ms. Baker

The Department has completed our review of your August 14, 2014, request for approval for recycling and reuse of the above referenced bottom ash materials under the provisions of Section 403.7045(5), Florida Statutes (F.S.). Your letter transmitted the results of use case analyses in the report, "Pasco County Use Case Scenarios to Examine the Recycling of Waste to Energy Ash in Road Construction Applications," which was prepared for the Pasco County Utilities Department by Dr. Timothy Townsend at the University of Florida.

The Department appreciates the time and care which your utilities department, and your Solid Waste Director, Mr. John Power, have taken to meet with the Department on several occasions during the preparation of the use case analyses and corresponding report that were provided with your request.

Based on our review of your August 14, 2014, application requesting the Department's authorization to utilize bottom ash from facilities owned or operated by you, Pasco County is hereby authorized and allowed to perform the proposed recycling or reuse activities in accordance with Section 403.7045(5), F.S., and the conditions of this Department Order.

Specified Materials:

The following material or materials (Specified Materials) are allowed for recycling or reuse within Pasco County by, or under the direction of, the Pasco County Utilities Department:

- Bottom Ash Residue as defined in Rule 62-701.200(7)(a), F.A.C., from the Pasco County Resource Recovery Facility (Facility), a waste-to-energy facility as defined in Section 403.7061(4), F.S. (bottom ash), and
- Any product or construction material, including asphalt or concrete, which contains bottom ash as referenced herein.

Required Treatment:

The Specified Materials for recycling and reuse shall be conditioned, by or under the direction of the Pasco County Utilities Department, in accordance with the following procedure:

Prior to recycling and reuse under this Order, bottom ash will be aged for a minimum period of 3 months. Aging will be conducted on top of or in a lined Class I landfill cell. During the entire treatment period, ash piles shall be no greater than 20 feet in height.

Specified Uses:

The recycling and reuse of the above specified materials are limited to, and only approved for, the following specified uses where the Specified Materials shall be as required herein:

1. Covered use as a road base course, where bottom ash residue from the Facility has been screened to remove large pieces of waste materials ($>3/4$ inch), and the road base course will be completely covered by a pavement layer;
2. Encapsulated use as a replacement for up to 50%, by weight, of the customarily used aggregate in Portland cement concrete pavement, where bottom ash residue from the Facility has been screened to remove large pieces of waste materials ($>3/4$ inch) and the fine fraction of the ash ($<3/8$ inch); and
3. Encapsulated as an aggregate in hot mix asphalt pavement, where bottom ash residue from the Facility has been screened to remove large pieces of waste materials ($>3/4$ inch) and the fine fraction of the ash ($<3/8$ inch).

Recycling and Reuse Conditions:

In accordance with the Department's approval allowing recycling and reuse of the Specified Materials, including bottom ash, as requested by the Pasco County Utilities Department (County), the County shall implement the recycling and reuse controls specified herein. The following controls and conditions are binding upon the County and are enforceable under Chapter 403, F.S:

1. Bottom ash shall be treated by conditioning, prior to recycling and reuse, in accordance with this Order.
2. The County shall not allow recycling, reuse, or disposal of the Specified Materials in any manner inconsistent with the requirements of Chapter 62-701, F.A.C., or this Order.
3. Bottom ash shall not be placed within 3 feet of groundwater, or 15 feet of wetlands or natural water bodies, or within 100 feet of a potable well that is being used or might be used for human or livestock water consumption.
4. When utilized as road base, the placement of the bottom ash shall not extend beyond the outside edge of the pavement. Bottom ash remaining outside the edge of the pavement after construction shall be removed and recycled in a manner consistent with this Order or placed in a permitted Class I lined landfill.

5. When utilized as road base, placement of the pavement shall be completed as soon as practicable after placement of the bottom ash.
6. When bottom ash is utilized as a road base course, only dense-graded asphalt mixes shall be placed as the overlying pavement layer with a 4-inch or greater as-built thickness.
7. The roadway shall be placed and maintained following generally accepted road construction practices consistent with those utilized in Pasco County at the time of the issuance of this Order.
8. When removed from service, asphalt or concrete products containing bottom ash as aggregates shall be managed as construction and demolition debris, recycled or reused in a manner consistent with this Order, or placed in a permitted Class I lined landfill.
9. When removed from service, bottom ash that has been used as a base course shall be recycled or reused in a manner allowed under this Order, or placed in a permitted Class I lined landfill.
10. Fugitive dust emissions from the storage, processing, transport or placement of bottom ash shall be controlled by wetting.
11. Ash used as an aggregate in asphalt and concrete shall be stored on site at batch plants for a period of no more than 120 hours. Loads shall be covered with a tarp, or a similar protective cover, during transportation and ash will not be transported during periods of inclement weather. Following batching of the concrete or asphalt products, the unused ash shall be recovered and either used in a subsequent allowed construction project or placed in a Class I lined landfill.
12. The County shall comply with the following record keeping requirements:
 - a. Whenever not the owner, the County shall receive written notice, from the owner or duly authorized agent of the owner (Owner) of the property where the Specified Materials are to be placed, providing the County express authorization for the placement of the Specified Materials, detailing the Owner's authorized placement dates, placement locations, and the maximum quantities of bottom ash that may be recycled or reused, or otherwise placed, on the Owner's property;
 - b. The County may receive such notices from Owner's electronically;
 - c. The County shall provide and maintain records detailing the actual placement dates, locations, quantities, the nature of recycling or reuse including the types of associated construction materials (i.e., road base course, concrete pavement, or asphalt pavement) where the Specified Materials were placed, and the dates and disposition whenever any Specified Materials are removed from service;
 - d. Notices and records shall be maintained in a centralized record storage system accessible from the Facility, and also in association with the particular construction project records for any related road construction project that utilizes the Specified Materials; and
 - e. Such notices and records shall be maintained by the County for a period of not less than 30 years after the removal of the Specified Materials from service.
13. Recycling and Reuse of the Specified Materials, and associated construction activities, shall be conducted in a manner that does not cause or contribute to violations of state water quality standards. Performance-based erosion and sediment control best management practices shall be implemented and maintained immediately prior to, during, and after construction as needed to stabilize all disturbed areas, including material storage, staging, and processing areas, to prevent adverse impacts to the water resources and adjacent lands. Erosion and

sediment control measures shall be installed and maintained in accordance with the State of Florida Erosion and Sediment Control Designer and Reviewer Manual (Florida Department of Environmental Protection and Florida Department of Transportation June 2007), available at www.dep.state.fl.us/water/wetlands/docs/erp/FLerosionSedimentManual_6_07.pdf, and the Florida Stormwater Erosion and Sedimentation Control Inspector's Manual (Florida Department of Environmental Protection, Nonpoint Source Management Section, Tallahassee, Florida, July 2008), available at www.dep.state.fl.us/water/nonpoint/docs/erosion/erosion-inspectors-manual.pdf.

14. The County shall immediately notify the Department in writing upon, or at least within 5 business days of, becoming aware of any condition, test result, or other information indicating that recycling or reuse of the Specified Materials, in accordance with this Order, may cause or contribute to violations of state water quality standards.
15. Upon reasonable notice to the County, Department staff or agents with proper identification shall have permission to enter, inspect, sample and test as the Department may claim needed to verify compliance with the requirements of Chapter 403, F.S., and this Order.

Uses other than as specified herein are not approved under this Order. Where ash from the Facility, or related materials, may be used or placed in a manner that does not comply with the Conditions of this Order, such materials shall be managed as a solid waste subject to the requirements of Chapter 62-701, F.S.

Administrative Rights

The Department's Order shall become final unless a timely petition for an administrative hearing is filed under sections 120.569 and 120.57, F.S., within **21** days of receipt of this Order. Persons who have filed such a petition may seek to mediate the dispute and choosing mediation will not adversely affect the right to a hearing if mediation does not result in a settlement. The procedures for petitioning a hearing and pursuing mediation are set forth below.

Persons affected by this Order have the following options:

- A. If you choose to accept the Department's decision regarding the Order, you do not have to do anything. This Order is final and effective as of the date on the top of the first page of this Order.
- B. If you choose to challenge the decision, you may do the following:
 1. File a request for an extension of time to file a petition for hearing with the Department's Agency Clerk in the Office of General Counsel within **21** days of receipt of this Order. This request should be made if you wish to meet with the Department in an attempt to resolve any disputes without first filing a petition for hearing or negotiate an agreement to mediate; or
 2. File a petition for administrative hearing with the Department's Agency Clerk in the Office of General Counsel within **21** days of receipt of this Order.

In addition to requesting an administrative hearing, any petitioner may elect to pursue mediation under Section 120.573, F.S., and must negotiate an agreement to mediate within **10** days after the deadline for filing a petition.

How to Request an Extension of Time to File a Petition for Hearing

For good cause shown, pursuant to Rule 62-110.106(4), F.A.C., the Department may grant a request for an extension of time to file a petition for hearing. Such a request must be filed (received) by the Agency Clerk in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida, 32399-3000, within **21** days of receipt of this Order. Petitioner, if different from the applicant, shall mail a copy of the request to the applicant at the time of filing. Failure to file a petition within this time period shall waive the right of anyone who may request an administrative hearing under Sections 120.569 and 120.57, F.S.

How to File a Petition for Administrative Hearing

A person whose substantial interests are affected by this Order may petition for an administrative proceeding (hearing) under Sections 120.569 and 120.57, F.S. The petition must contain the information set forth below and must be filed (received) by the Agency Clerk in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, MS 35, Tallahassee, Florida, 32399-3000, within **21** days of receipt of this Order. Petitioner, if different from the applicant, shall mail a copy of the petition to the applicant at the time of filing. Failure to file a petition within this time period shall waive the right of anyone who may request an administrative hearing under Sections 120.569 and 120.57, F.S.

Pursuant to Subsection 120.569(2), F.S., and Rule 28-106.201, F.A.C., a petition for administrative hearing shall contain the following information.

- a) The name, address, and telephone number of each petitioner; the name, address, and telephone number of the petitioner's representative, if any, the site owner's name and address, if different from the petitioner, the DEP facility number, and the name and address of the facility;
- b) A statement of when and how the petitioner received notice of the Department's action or proposed action;
- c) An explanation of how each petitioner's substantial interests are or will be affected by the Department's action or proposed action;
- d) A statement of the disputed issues of material fact, or a statement that there are no disputed facts;
- e) A concise statement of the ultimate facts alleged, including a statement of the specific facts the petitioner contends warrant reversal or modification of the Department's action or proposed action;
- f) A statement of the specific rules or statutes the petitioner contends requires reversal or modification of the Department's action or proposed action; and

- g) A statement of the relief sought by the petitioner, stating precisely the action petitioner wishes the Department to take with respect to the Department's action or proposed action.

How to Pursue Mediation

In addition to requesting an administrative hearing, any petitioner may elect to pursue mediation. The election may be accomplished by filing with the Department a mediation agreement with all parties to the proceeding (i.e., the applicant, the Department, and any person who has filed a timely and sufficient petition for hearing). The agreement must contain all the information required by Rule 28-106.404, F.A.C. The agreement, signed by all parties, must be received by the Agency Clerk in the Office of General Counsel of the Department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida, 32399-3000 within **10** days after the deadline for filing a petition, as set forth above. Choosing mediation will not adversely affect the right to a hearing if mediation does not result in a settlement.

Pursuant to Rule 28-106.404, F.A.C., an agreement to mediate must include the following.

- (i) The name, address, and telephone number of the persons who may attend the mediation, (also the DEP facility number, the name and address of the facility if applicable);
- (ii) The name, address, and telephone number of the mediator agreed to by the parties;
- (iii) How the costs and fees associated with the mediation will be allocated (the Department will not pay any of the costs of mediation);
- (iv) The agreement of the parties regarding the confidentiality of discussions and documents introduced during mediation to the extent authorized by law;
- (v) The date, time, and place of the first mediation session;
- (vi) The name of the party's representative who shall have authority to settle or recommend settlement; and
- (vii) The signature of the parties.

As provided in Section 120.573, F.S., the timely agreement of all parties to mediate will toll the time limitations imposed by Sections 120.569 and 120.57, F.S., for holding an administrative hearing and issuing a final order. Unless otherwise agreed by the parties, the mediation must be concluded within sixty days of the execution of the agreement. If mediation results in settlement of the administrative dispute, the Department must enter a final order incorporating the agreement of the parties. Persons seeking to protect their substantial interests that would be affected by such a modified final decision must file their petitions within **21** days of receipt of this notice, or they shall be deemed to have waived their right to a proceeding under Sections 120.569 and 120.57, F.S. If mediation terminates without settlement of the dispute, the Department shall notify all parties in writing that the administrative hearing processes under Sections 120.569 and 120.57, F.S., are resumed.

This Order is final and effective as of the date on the top of the first page of this Order. Timely filing a petition for administrative hearing postpones the date this Order takes effect until the

Ms. Michelle L. Baker
Recycling and Reuse of Treated Bottom Ash Residue from the
Pasco County Resource Recovery Facility, WACS ID No. 26254
December 5, 2014
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Department issues either a final order pursuant to an administrative hearing or mediation settlement.


Judicial Review

Any party to this Order has the right to seek judicial review of it under Section 120.68, F.S., by filing a notice of appeal under Rule 9.110 of the Florida Rules of Appellate Procedure with the Agency Clerk of the Department in the Office of General Counsel, Mail Station 35, 3900 Commonwealth Boulevard, Tallahassee, Florida 32399-3000, and by filing a copy of the notice of appeal accompanied by the applicable filing fees with the appropriate district court of appeal. The notice of appeal must be filed within thirty days after this order is filed with the clerk of the Department (see below).

Questions

The Department appreciates your work efforts to define the conditions under which the referenced materials may be safely reused in Pasco County. Any questions regarding the Department's approval of your request should be directed to Tim Bahr at (850) 245-8790, or Richard Tedder at (850) 245-8735. Questions regarding legal issues should be referred to Brynna Ross, Office of General Counsel, at (850) 245-2242. Contact with any of the above does not constitute a petition for administrative hearing, a request for a time extension to file a petition for hearing or an agreement to mediate.

Sincerely,

 for

Jorge R. Caspary, P.G., Director
Division of Waste Management
Florida Department of Environmental Protection

FILING AND ACKNOWLEDGMENT FILED, on this date, pursuant to §120.52 Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

Clerk

Date

Appendix B: IWEM Model Output Summaries

B.1 IWEM Model Results – Bottom Ash Amended Portland Cement Concrete



Evaluation Results

Recommendation: User-defined Liner

Number of Flow and Transport Simulations: 10000

9/19/2016 9:24:24PM

Facility Type	Waste Pile
Facility name	
Street address	
City	
State	
Zip	
Date of sample analysis	
Name of user	
Additional information	

Waste Pile Parameters		
Parameter	Value	Reference
Area of waste pile (m ²) [requires site specific v	4645	50000 ft2
Depth of base of the WP below ground surface (m)	0.2032	8 inch
Distance to well (m)	30.48	100 ft
Operational life (yr)	30	est.

Subsurface Parameters		
Subsurface Environment	Unconsolidated and Semiconsolidated Shallow Aquifers	
Parameter	Value	Reference
Ground-water pH value (metals only)	Distribution	Monte Carlo [See IWEM TBD 4.2.3.1]
Depth to water table (m)	Distribution	Monte Carlo [See IWEM TBD 4.2.3.1]
Aquifer hydraulic conductivity (m/yr)	Distribution	Monte Carlo [See IWEM TBD 4.2.3.1]
Regional hydraulic gradient	Distribution	Monte Carlo [See IWEM TBD 4.2.3.1]
Aquifer thickness (m)	Distribution	Monte Carlo [See IWEM TBD 4.2.3.1]

Regional Soil and Climate Parameters

Parameter	Value
Soil Type	Coarse-grained soil(sandy loam)
Climate Center	Tampa FL
Site-specific Infiltration rate (m/yr)	0.03
Recharge Rate (m/yr)	0.1031

Constituent Reference Groundwater Concentrations and Constituent Properties

Constituent Name	RGC (mg/L)	RGC Based On	Kd* (L/kg)	Decay Coeff* (1/yr)	Leachate Conc. (mg/L)
Molybdenum	0.035	User Defined			0.071

*If a site-specific value was entered by the user, it will be displayed here; otherwise, the model used the constituent properties listed at the end of the report.

Detailed Results for Parent Constituents -- User Defined Liner

Constituent Name	Leachate Conc. (mg/L)	DAF (mg/L)	Selected RGC	RGC (mg/L)	90th %ile Exp. Conc. (mg/L)	Below Benchmark?
Molybdenum	0.071	2.7	User Defined	0.035	0.0261	Yes

Constituent Name	CAS ID
Molybdenum	7439-98-7

Physical Properties		
Property	Value	Reference
Chemical Type	Metal	
Molecule Weight (g/mol)	95.9	
Log Koc (distribution coefficient for organic carbon)		
Ka: acid-catalyzed hydrolysis rate constant (1/mol yr)		
Kn: neutral hydrolysis rate constant (1/yr)		
Kb: base-catalyzed hydrolysis rate constant (1/mol yr)		
Solubility (mg/L)	1.00E+06	CambridgeSoft Corporation, 2001
Diffusivity in air (cm ² /sec)		
Diffusivity in water (m ² /yr)		
Henry's law constant (atm-m ³ /mol)		

Reference Ground-water Concentration Values		
Property	Value	Reference
Maximum Contamination Level (mg/L)		
HBN-Ingestion, Non-Cancer (mg/L)		
HBN-Ingestion, Cancer (mg/L)		
HBN-Inhalation, Non-Cancer (mg/L)		
HBN-Inhalation, Cancer (mg/L)		
HBN-Dermal, Non-Cancer (mg/L)		
HBN-Dermal, Cancer (mg/L)		

References

CambridgeSoft Corporation. 2001. ChemFinder.com database and internet searching. <http://chemfinder.cambridgesoft.com>. Accessed July 2001.

B.2 IWEM Model Results – Bottom Ash as Structural Base Under a Multi-Use Path



Evaluation Results

Recommendation: User-defined Liner

Number of Flow and Transport Simulations: 10000

9/19/2016 9:19:59PM

Facility Type		Waste Pile
Facility name		Pasco
Street address		
City		
State		FL
Zip		
Date of sample analysis		
Name of user		Justin G. Roessler
Additional information		
Waste Pile Parameters		
	Parameter	Value
Area of waste pile (m^2) [requires site specific v		53.53
Depth of base of the WP below ground surface (m)		0.2035
Distance to well (m)		30.28
Operational life (yr)		30
Subsurface Parameters		
Subsurface Environment		
Unconsolidated and Semiconsolidated Shallow Aquifers		
	Parameter	Value
Ground-water pH value (metals only)		Distribution
Depth to water table (m)		Distribution
Aquifer hydraulic conductivity (m/yr)		Distribution
Regional hydraulic gradient		Distribution
Aquifer thickness (m)		Distribution
	Reference	
		Monte Carlo [See IWEM TBD 4.2.3.1]
		Monte Carlo [See IWEM TBD 4.2.3.1]
		Monte Carlo [See IWEM TBD 4.2.3.1]
		Monte Carlo [See IWEM TBD 4.2.3.1]
		Monte Carlo [See IWEM TBD 4.2.3.1]
		Monte Carlo [See IWEM TBD 4.2.3.1]

Regional Soil and Climate Parameters

Parameter	Value
Soil Type	Coarse-grained soil(sandy loam)
Climate Center	Tampa FL
Site-specific Infiltration rate (m/yr)	0.10
Recharge Rate (m/yr)	0.1031

Constituent Reference Groundwater Concentrations and Constituent Properties

Constituent Name	RGC (mg/L)	RGC Based On	Kd* (L/kg)	Decay Coeff* (1/yr)	Leachate Conc. (mg/L)
Aluminium	7	MCL	4		37.9
Antimony	0.006	MCL			0.03
Molybdenum	0.035	User Defined			0.121

*If a site-specific value was entered by the user, it will be displayed here; otherwise, the model used the constituent properties listed at the end of the report.

Detailed Results for Parent Constituents -- User Defined Liner

Constituent Name	Leachate Conc. (mg/L)	DAF (mg/L)	Selected RGC	RGC (mg/L)	90th %tile Exp. Conc. (mg/L)	Below Benchmark?
Aluminium	37.9	49	MCL	7	0.7765	Yes
Antimony	0.03	9.7	MCL	0.006	0.0031	Yes
Molybdenum	0.121	5.1	User Defined	0.035	0.0237	Yes

Constituent Name	CAS ID
Aluminium	25116-44-6

Physical Properties		
Property	Value	Reference
ChemicalType	Organic	
Molecule Weight (g/mol)		
Log Koc (distribution coefficient for organic carbon)		
Ka: acid-catalyzed hydrolysis rate constant (1/mol yr)		
Kn: neutral hydrolysis rate constant (1/yr)		
Kb: base-catalyzed hydrolysis rate constant (1/mol yr)		
Solubility (mg/L)		
Diffusivity in air (cm ² /sec)		
Diffusivity in water (m ² /yr)		
Henry's law constant (atm-m ³ /mol)		

Reference Ground-water Concentration Values		
Property	Value	Reference
Maximum Contamination Level (mg/L)	7	USEPA, 1998d
HBN-Ingestion, Non-Cancer (mg/L)		
HBN-Ingestion, Cancer (mg/L)		
HBN-Inhalation, Non-Cancer (mg/L)		
HBN-Inhalation, Cancer (mg/L)		
HBN-Dermal, Non-Cancer (mg/L)		
HBN-Dermal, Cancer (mg/L)		

Constituent Name	CAS ID
Molybdenum	7439-98-7

Physical Properties		
Property	Value	Reference
ChemicalType	Metal	
Molecule Weight (g/mol)	95.9	
Log Koc (distribution coefficient for organic carbon)		
Ka: acid-catalyzed hydrolysis rate constant (1/mol yr)		
Kn: neutral hydrolysis rate constant (1/yr)		
Kb: base-catalyzed hydrolysis rate constant (1/mol yr)		
Solubility (mg/L)	1.00E+06	CambridgeSoft Corporation, 2001
Diffusivity in air (cm^2/sec)		
Diffusivity in water (m^2/yr)		
Henry's law constant (atm-m^3/mol)		

Reference Ground-water Concentration Values		
Property	Value	Reference
Maximum Contamination Level (mg/L)		
HBN-Ingestion, Non-Cancer (mg/L)		
HBN-Ingestion, Cancer (mg/L)		
HBN-Inhalation, Non-Cancer (mg/L)		
HBN-Inhalation, Cancer (mg/L)		
HBN-Dermal, Non-Cancer (mg/L)		
HBN-Dermal, Cancer (mg/L)		

Constituent Name	CAS ID
Antimony	7440-36-0

<u>Physical Properties</u>		
Property	Value	Reference
ChemicalType	Metal	
Molecule Weight (g/mol)	121.76	
Log Koc (distribution coefficient for organic carbon)		
Ka: acid-catalyzed hydrolysis rate constant (1/mol yr)		
Kn: neutral hydrolysis rate constant (1/yr)		
Kb: base-catalyzed hydrolysis rate constant (1/mol yr)		
Solubility (mg/L)	1.00E+06	CambridgeSoft Corporation, 2001
Diffusivity in air (cm ² /sec)		
Diffusivity in water (m ² /yr)		
Henry's law constant (atm-m ³ /mol)		

<u>Reference Ground-water Concentration Values</u>		
Property	Value	Reference
Maximum Contamination Level (mg/L)	0.006	USEPA, 2013
HBN-Ingestion, Non-Cancer (mg/L)		
HBN-Ingestion, Cancer (mg/L)		
HBN-Inhalation, Non-Cancer (mg/L)		
HBN-Inhalation, Cancer (mg/L)		
HBN-Dermal, Non-Cancer (mg/L)		
HBN-Dermal, Cancer (mg/L)		

References

CambridgeSoft Corporation. 2001. ChemFinder.com database and internet searching. <http://chemfinder.cambridgesoft.com>. Accessed July 2001.
USEPA. 1998d. Evaluation of the Potential Carcinogenicity of Ethyl Methanesulfonate (62-50-0) in Support of Reportable Quantity Adjustments Pursuant to CERCLA Section 102. Prepared by Carcinogen Assessment Group, Office of Health and Environmental Assessment, Washington, D.C.