

Attachment H

**Kentucky Division of Waste Management
May 2018 Corrective Action Plan Approval**



MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ENERGY AND ENVIRONMENT CABINET
Department for Environmental Protection

AARON B. KEATLEY
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300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601

May 9, 2018

Mr. Joseph Santangelo, Environmental Compliance Manager
Advanced Disposal Services
1184 McClellandtown RD
McClellandtown, PA 15458

RE: Corrective Action Plan Approval
Blue Ridge Landfill
2700 Winchester Road
Irvine, KY 40336
Agreed Order # DWM – 160048
AI # 998
Permit # 033-00004

Dear Mr. Santangelo,

The Kentucky Division of Waste Management (KDWM) personnel have completed review of the revised Corrective Action Plan submitted by Gradient on behalf of Advanced Disposal Services Blue Ridge Landfill, on November 17, 2018 and all comments submitted to the Cabinet thereon.

The Corrective Action Plan (CAP) with its addenda conducted a preliminary screening and evaluation of a number of remedial technologies to address the BES waste. The CAP then included a detailed analysis and comparative risk assessment for two remedial alternatives: Alternative 1: Closure-in-Place with Monitoring, and Alternative 2: Excavate and Redispose BES Waste. Based on the comparative analysis and risk assessment and on the criteria established in the agreed order, the CAP indicated the preferred alternative was Alternative 1: Closure-In-Place with Monitoring.

KDWM, with assistance from the Cabinet for Health and Family Services and Jim Berger, a Certified Health Physicist (CHP) with Advanced Technologies and Laboratories International, (ATL), Inc. (an outside technical expert KDWM retained), reviewed the CAP, its addenda, subsequent revisions, the associated correspondences between the agency and the company/consultants, and comments submitted by interested parties. KDWM has determined that either alternative would likely meet the regulatory standards of long-term protectiveness, but



agrees that the CAP's preferred alternative provides the greatest short-term protectiveness to human health and the environment. The CAP, its addenda, the associated correspondences, and KDWM's responses to all of the comments received (attached hereto) support KDWM's decision to issue approval of your plan. Please note, however, approval is subject to the following conditions:

- 1) Sections 2.5.1 and 4.2.1 of the CAP shall be amended to state that the Radionuclide Sampling Plan, i.e., groundwater monitoring plan shall require monitoring for radionuclides following landfill closure, during the 30-year post-closure period. This modification will be made to the solid waste landfill permit monitoring requirements as well.
- 2) Section 4.2.1 of the CAP shall be amended to state that future use of the landfill property shall be controlled to limit potential exposure, and to protect human health and the environment, by placing appropriate land use restrictions on the landfill property once the landfill enters the 30-year post-closure period and pursuant to applicable law at the time the post-closure period begins. The restrictions will run with the land and will include no residential use, no groundwater use for drinking water purposes, and no disturbance of the cap within the permitted waste boundaries.
- 3) The following sections shall be amended to include references to the IRMP and/or the interim cap as part of the overall remedy
 - a. Page 2 of the Executive Summary discussing alternative 1.
 - b. The last paragraph of Section 6.3.2 discussing alternative 1.
 - c. The second paragraph of Section 7 discussing alternative 1.
- 4) The portion of Section 4.2.1 discussing the final cover should include a reference to 401 KAR 48:090 Section 3(2)(b).
- 5) Include the Estill County Solid Waste Coordinator and the Estill County Health Department Environmentalist in the list of emergency contacts listed in CAP, Attachment C: Radiation Screening and Monitoring Plan.
- 6) That the CAP with the required amendments above, CAP addenda, all pertinent supporting documentation (i.e. Cabinet comments and clarification/response correspondences), and any other corrections or clarifications shall be compiled into a single, comprehensive report submitted to KDWM. Please label this report "Final Corrective Action Plan" with the date of submission.
- 7) That all plans required to be developed by the CAP (i.e. Radionuclide Sampling Plan, Interim Remedial Measures Plan, are submitted for review prior to implementation.
- 8) That necessary corresponding permit modifications are made in accordance with Kentucky regulations governing permit modification.

Advanced Disposal Services

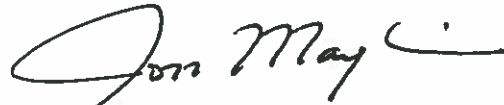
May 9, 2018

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Please submit the Final Corrective Action Plan as described in paragraph 6 within thirty (30) days of this letter. Please submit the Radionuclide Sampling Plan and Interim Remedial Measures Plan (IRMP) within ninety (90) days of this letter.

If you have any questions, please feel free to contact Tim Hubbard at (502) 782-6660 or at Tim.Hubbard@ky.gov. For permit modification questions, please contact Danny Anderson, Solid Waste Branch Manager at Danny.Anderson@ky.gov.

Sincerely,



Jon Maybriar, Director
Division of Waste Management

cc: Tim Hubbard, PG SFB
Danny Anderson, Manager SWB
Jeffery Cummins, Director DENF
Hon. Daniel Cleveland, OLS
Hon. Phil Comella, Attorney
Kurt Herman, M.Eng, PG, Gradient

Attachment I

Kentucky Energy and Environment Cabinet May 2018 Response to Comments on the Corrective Action Plan

Cabinet Response to Comments
Corrective Action Plan for the Blue Ridge Landfill
Estill County, Kentucky dated November 17, 2017
May 9, 2018

As required by the agreed order filed January 3, 2017, Advanced Disposal Services (ADS) submitted the *Corrective Action Plan (CAP) for the Blue Ridge Landfill, Estill County, Kentucky* on May 4, 2017. Following review and subsequent comments by the Energy and Environment Cabinet (Cabinet), ADS made revisions to the CAP and re-submitted the document on November 17, 2017. The Cabinet found the CAP to meet preliminary approval, and pursuant to Agreed Order # DWM-160048, Agency Interest No. 998, Permit # 033-00004, it was posted for a 30-day public comment period, which expired February 12, 2018.

In proposing the CAP, Blue Ridge conducted a preliminary screening and evaluation of a number of remedial technologies to address the BES waste. The CAP for the Blue Ridge Landfill then did a detailed analysis and comparative risk assessment for two remedial alternatives:

- Alternative 1 Closure-in-Place and Monitoring
- Alternative 2 Excavate and Redispose BES Waste
- Based on the comparative analysis and risk assessment and on the criteria established in the agreed order the preferred alternative proffered by ADS in the CAP based on the criteria is Alternative 1. According to the CAP, it provides the highest degree of overall protectiveness, poses the lowest short-term physical and radiological exposure-related risks to the community, in particular to workers, landowners, school students/faculty/staff, and residents in the immediate vicinity of the facility. Alternative 1 also, provides long-term effectiveness and protectiveness while also being implementable.

Paragraph 19(a) of the Agreed Order established factors Blue Ridge was required to consider for a proposed remedy. Paragraph 19(b) of the Agreed Order further requires the Cabinet to consider cost and community acceptance of the remedy as part of its evaluation. Overall protection of human health and the environment and compliance with law are the threshold criteria any proposed remedy must meet. The other factors are considered modifying or balancing factors.

The CAP indicates the preferred option is to leave waste in place under the conditions outlined in the CAP, which will become enforceable through permit modifications. The Cabinet preliminarily accepted Blue Ridge's preferred option, determining that leaving the TENORM in place is protective of human health and the environment because it limits potential public and worker exposure to the waste and other adverse impacts associated with excavating at the site, in addition to ensuring long-term protections at the site. The Cabinet then solicited public comment to consider community acceptance. The Cabinet allowed comments to be submitted on the CAP for thirty-two (32) days, and a total of 43 comments were received. After considering the comments, the Cabinet concluded that the CAP and its preferred option meets the regulatory standards for approval pursuant to KRS 224.1-400 and 401 KAR 100:030.

The comments were grouped according to the general nature of the comments and the technical issue or point raised in the comment. With this Response to Comments (RTC) document, the Cabinet intends to provide responses to each group of comments.

Specific Comments

- **Remedial Preferences/Suggestions Comments: Several commenters expressed their preferences or suggestions for remedial alternatives evaluated in the CAP.**

Response: Blue Ridge's CAP discussed two remedial alternatives. Alternative 1 (Closure-In-Place) is disposing the material in place subject to conditions stated in the CAP which would eventually be included in the operation/closure permits. Alternative 2 (Excavate and Redispose) is excavating the material from the landfill, then transporting it for disposal in another municipal solid waste landfill located in Pennsylvania. The CAP indicated that alternative 1 was the preferred remedial alternative.

The Cabinet evaluated the CAP and both of the alternatives pursuant to the Agreed Order's paragraph 19(a) factors and Kentucky law. The Cabinet determined both alternatives could meet the KRS Chapter 224 standards of protectiveness established by KRS 224.1-400 and 401 KAR 100:030. Although the Cabinet review determined both alternatives could meet the Cabinet's standards of protectiveness, the Cabinet preliminarily approved the CAP's expressed preference for the remedial alternative 1 (Closure-In-Place).

The Cabinet published the CAP and its preliminary determination for comments to evaluate the Agreed Order's paragraph 19(b) factors. A majority of commenters indicated a preference for alternative 2 (Excavate and Redispose) without providing any technical basis for their preference. Other commenters suggested alternative corrective actions not evaluated by the CAP, including removal and disposal at other facilities not specified by Blue Ridge. Some of the commenters wanted additional remedial measures beyond removal, such as indefinite monitoring or school relocation. Another commenter who stated a preference for Alternative 2 (Excavate and Redispose), also suggested acceptance of the Closure-In-Place remedy but commented on length of time proposed for groundwater monitoring. At least three commenters agreed with the CAP's preferred alternative 1 (Closure-In-Place) pursuant to terms to be included in a modified permit and monitoring. Two of those commenters, who estimate they live within one mile from Blue Ridge, highlighted an exposure concern for themselves, their property, the school, and the landfill workers that may result from potentially contaminated dust blowing offsite during removal.

Although the CAP and its supporting appendices, reports, and some of the comments provide sufficient justification for the disposal in place alternative, many of the comments indicate that the commenters may not fully appreciate the public safety and health risks associated with the significant landfill excavation project evaluated in alternative 2. Those generalized safety risks include, but are not limited to, odors, gasses, fugitive dusts, ground

and surface water impacts. Some of those issues are discussed more fully in specific responses below.

After considering comments regarding preference, the Cabinet determined the CAP's preferred remedy alternative 1 (Closure-In-Place) still provides the greatest short-term and long-term protection to human health and the environment. While the Cabinet has determined that both alternatives can meet the standards of protectiveness, none of the comments received altered the Cabinet's preliminary understanding of the remedial alternatives - that alternative 2 (Excavate and Redispose) provides less short-term protectiveness for human health and the environment, without providing any greater long-term protectiveness than alternative 1 (Closure-in-Place). This is especially true considering the greater physical risks and uncertainties associated with alternative 2 that are discussed in the responses that follow. The Cabinet is concerned with the short-term exposure to landfill workers and general public, the general health and safety risks associated with the potential excavation, the potential for offsite impacts from blowing dust as expressed by the commenters who live near the landfill, and with other harmful fugitive emissions generated during landfill excavation. As such, the CAP and its preferred alternative 1 (Closure-In-Place) is approved.

- **Costs Comments: Multiple commenters stated that cost should not be considered, or that differences in the estimated costs were insignificant to a company as large as Blue Ridge.**

Reponses: The CAP compares cost estimates for the two specific alternative remedies that were evaluated. Estimated costs associated with alternative 1 (Closure-In-Place) included additional funds for installing an interim cover, upgrading the final cover, and adding parameters to water monitoring. Further, changes that will likely increase closure costs will result in additional bonding through a separate permit action. Alternative 2 (Excavate and Redispose) estimates in the CAP largely reflect costs for equipment, labor, transport, and disposal in a municipal solid waste landfill. Based on Cabinet review, it does not appear that Blue Ridge's removal cost analysis was artificially high. The Cabinet determined that CAP likely does not fully evaluate all of the costs associated with the work. While the CAP mentions some of the externalized costs associated with alternative 2 (Excavate and Redispose) which would be borne by the community, those costs were not fully monetized. Such costs include, but are not limited to, potential traffic impacts on the community, increased disposal costs to the customers, potential emergency response costs (ambulance, police, etc.), wear to local infrastructure, or increased air pollution from landfill gasses (which, in addition to significant odors, likely includes the air release of harmful hydrogen sulfide) and vehicle/equipment exhausts.

While the Agreed Order requires the Cabinet to consider costs, and CAP includes a monetary value for the two options that the Cabinet considered in review, cost considerations did not play a factor in the Cabinet's determination to approve the CAP and

its preferred alternative. The Cabinet tends to agree with commenters that the monetary value associated with labor, excavation, transport, and disposal costs are not cost prohibitive. However, even had the costs for both alternatives been equal, the Cabinet's determination regarding the protectiveness of the alternatives would not have changed.

- **Groundwater Monitoring Comments: A number of commenters stated that the groundwater monitoring proposed in the CAP is inadequate for radionuclide constituents given the long half-lives of the radioisotopes.**

Response: ADS will be developing a Radioactive Sampling/Analysis Plan to sample groundwater and surface water including underdrains beneath the landfill liner. This plan will be handled through a modification to the groundwater monitoring plan in the facility's solid waste permit. In the interim, ADS has proposed to monitor groundwater and the two underdrains (located beneath the bottom liner) for radionuclides beginning in 2018 to establish a baseline. ADS has proposed to add radionuclides Ra-226, Ra-228, and gross alpha and gross beta activity analyses to the routine quarterly sampling of all five groundwater monitoring wells currently in the groundwater monitoring network for a year. After a one year period (four consecutive quarters), radionuclides will be sampled and analyzed from the two down gradient monitoring wells (MW-13 and MW-15R) on a semi-annual basis from 2019-2023. If no elevated levels of Ra-226 or Ra-228 are identified and no elevated radiological activity is found, radionuclides will be monitored every five years (2023, 2028, 2033, etc.) for the operating life of the landfill. Once the facility enters the 30-year post-closure period, unless there are elevated levels or radionuclides or radiological activity found, monitoring will cease.

For many sites contaminated with radionuclides, monitoring is typically more frequent initially, and then the frequency reduced over time if there are no increasing trends of radioactivity levels. Determining an appropriate interval and duration for groundwater monitoring for radionuclides is a question of mobility versus half-life of the radionuclides. The half-lives of the radionuclides and their primary decay products of concern in TENORM wastes are wide-ranging: Radon (Rn-222), in a gaseous state, is only 3.8 days; Radium (Ra-228) is 5.75 years, Lead (Pb-210) is 22.2 years, while the half-life of Ra-226, the primary isotope of concern is 1,600 years.

The main factors affecting potential migration to groundwater are the radionuclide's solubility and mobility. Shale bedrock units like the New Albany Shale, which is the primary geologic formation underlying the landfill, contain clay minerals which tend to sorb radionuclides with positive valence states such as Radium, Uranium and Thorium. According to studies performed on uranium mill and mill tailing sites, radium is moderately soluble in its movement to surface water and groundwater, and its solubility is affected by the presence of sulfate, organic materials, and pH of the solution or leachate. The key factor affecting potential for migration to groundwater is how radium reacts geochemically when

mixed with leachate, and subject to the degree to which acidic conditions may occur in the landfill.

The Sorption Coefficient (K_d) is also an important factor in groundwater chemistry which affects a chemical's adsorption and movement in water and its tendency to partition from soil to water in the environment. Most TENORM radionuclides have moderate to high K_d values and do not partition from soil to the aqueous phase very readily. The risk assessment performed by Risk Assessment Corporation (RAC) utilized the worst-case assumptions (highest potential mobility) for K_d values based on what has been referenced in the literature. The K_d for radium is 70, uranium is 35, lead is 100 and thorium is 3200, although uranium is not expected to be a radionuclide of concern with the BES waste. Lower K_d values, closer to 0, typically result in faster travel times within the aquifer. A good example is tritium, which has a K_d of 0.04, is very soluble, and moves readily with surface water and groundwater. Tritium is not known to be present in the BES wastes disposed of at Blue Ridge. Future groundwater monitoring at Blue Ridge will focus on observing trends in concentrations of radium for a period of time to determine if it is becoming more soluble due to conditions in the landfill.

The risk assessment conducted as part of the CAP assumes very conservative modeling assumptions for the groundwater pathway (including no cap and no liner) and uses upper bounding (worst case) maximum reasonable exposure estimates for calculating potential risk to groundwater contamination over time. The results show that the maximum risk would be to a future hypothetical resident consuming groundwater from a well located immediately adjacent to the landfill 2,700 years from the present day, which at 4.9×10^{-5} exceeds Kentucky's target risk level of 1×10^{-6} , but falls within the EPA's risk range. Again, this scenario assumes the landfill has no cap and no liner – all of which are required by federal and state law, Blue Ridge's solid waste permit, and the approved CAP for the Closure-In-Place alternative. However, maximum effective doses were well below the 25 mrem/yr dose limit for low-level radioactive disposal sites, and the maximum total radium (Ra-226 + Ra-228) concentration was well below the USEPA drinking water standard.

ADS will also develop an Interim Remedial Measures Plan that will include installation of an interim cap (low-permeability synthetic or geo-synthetic clay liner) over the BES waste. This additional liner should greatly reduce infiltration to groundwater and leachate generation.

Nevertheless, as a precautionary measure in response to these comments, the Cabinet will require ADS to modify their proposed groundwater monitoring plan by continuing groundwater monitoring for radionuclides following landfill closure, during the 30-year post-closure period. Therefore, monitoring for radionuclides will continue beyond the operating life of the landfill, through the 30-year post-closure period, likely through 2066. If elevated levels of radionuclides or elevated radiological activity is found, groundwater

monitoring will continue. This modification will be made to the solid waste landfill permit monitoring requirements.

In accordance with the solid waste landfill regulations, upon landfill closure, ADS is already required to place a deed notice on the property. To ensure the future use of the landfill property is controlled to limit potential exposure, and to protect human health and the environment, once the landfill enters the 30-year post-closure period, the Cabinet will require ADS to place appropriate land use restrictions on the landfill property, pursuant to applicable law at the time the post-closure period begins. The restrictions will run with the land and will include no residential use, no groundwater use for drinking water purposes, and no disturbance of the cap within the permitted waste boundaries.

- **Waste Characterization Comments: A number of commenters stated that there has been inadequate characterization of the TENORM wastes, therefore the true risks posed by the wastes is unknown.**

Response: The characterization of the TENORM wastes is representative of the BES waste that was disposed at the landfill. The waste characterization is based on the process knowledge of generation and characteristics of the specific waste material by radiation health professionals, and on the radioactivity data itself. The CAP and risk assessments performed as part of the CAP by RAC utilized the data that was available including the results of previous sampling of similarly processed oil and gas tank bottoms and fracking waste precipitate at the Fairmont Brine facility and from waste profile radio-analytical data provided by the other generators from reputable, accredited laboratories. According to representatives of the Cabinet for Health and Family Services (CHFS) who visited the Fairmont Brine facility and collected samples of a similarly processed oil and gas waste, the waste precipitate from Fairmont Brine which made up the majority of the material disposed at the landfill, was processed, which removed the parent radioactive isotopes, leaving Ra-226 and its decay products as the primary radionuclides of concern. This also means that the Ra-226 levels are at their maximum activity levels and there will be no in-growth.

The risk assessment calculated the potential average weighted concentration for each radionuclide based on the known data and utilized very conservative upper bounding (worst case) estimates in its dose and exposure calculations and scenarios including assumptions made for groundwater flow and modelling. For radionuclides which were not tested for in some of the shipments of BES wastes, conservative estimates of concentrations based on ratios of Ra-226 and Ra-228 levels were developed and used in the risk assessment. Gamma surveys have been conducted of the facility by Chase Environmental Group and CHFS, and EEC and CHFS collected samples of soil, groundwater, surface water and leachate from the facility. All of this data was taken into consideration for the exposure and risk assessment calculations.

The actual risks and estimated doses calculated by the risk assessment under most of the worker/public exposure scenarios for both alternatives is 1 to 2 orders of magnitude less than the target risk, allowing for a large safety factor to account for any uncertainties in the waste characterization as was alleged by one of the commenters. If one considers the activity levels of the waste could be potentially higher, it would still likely meet target risk levels and dose limits for Closure-in-Place.

Sampling of the BES waste in the landfill was considered and evaluated, but core sampling through the landfill would create a new risk to workers and the public from exposure to the BES waste and other municipal solid waste. Further, sampling could pose safety issues with methane and other gases and volatile organic compounds. In addition, locating the specific BES waste in the landfill to collect representative samples would be difficult, if not impossible because the BES waste was mixed with other solid wastes and spread throughout the 17 disposal cells. Any data from sampling would likely not improve the characterization of the waste. The results could actually end up indicating lower radioactivity due to dilution and mixing of the BES wastes with municipal solid waste and the daily cover material that consists of pulverized New Albany shale.

- **Short-Term Risk Comments: A number of commenters stated that Alternative 2 (Excavate and Redispose) Can Be Done Safely**

Response: The short-term cancer risk posed to a landfill worker and supervisor during the removal is estimated to exceed Kentucky's target risk level and creates the potential for direct exposure during excavation, transport, and re-disposal. If waste quantities and activity levels are assumed to be higher than the characterization data indicates (as one commenter suggested they may be), there would be a higher dose and possibly greater risk of exposure for the workers during excavation and loading of the material under the removal option. In any removal scenario, various work plans, such as health and safety plans, would need to be developed to reduce exposures to protect workers.

Further, under the removal option, the excavation surface would need to be monitored with a radiation detection instrument to mark the boundaries of material that is above the concentration, and the removal would continue until the target concentration of < 5 pCi/g is achieved. At this low level, and because the waste was mixed with other municipal solid waste and spread over 17 disposal cells, it will be difficult, if not impossible, to delineate the unpermitted TENORM waste from the naturally occurring radiological activity associated with the New Albany Shale used as daily cover or the other allowable wastes having radiological activity. Therefore, there would be significant uncertainty with ensuring the removal of all of the BES wastes. All of the time spent in close proximity to the waste would result in worker exposure to direct radiation levels and likely airborne contamination. Use of respiratory protection can reduce or prevent exposure to airborne radioactivity, but wearing such protection will slow the performance of the work and has

its own risks. There would also be general safety hazards associated with use of heavy, earthmoving equipment within the exclusion zone and outside the area from normal landfilling operations.

The removal work also poses additional physical risk to workers, students, and the public due to potential fugitive dusts and particulates from excavation and loading the waste. As this is a landfill, the Cabinet's concerns regarding dusts and particulates are not limited to radiological contamination, but extend to more general health risks. There is also an increased risk of truck accidents in transporting over 1,800 truckloads of contaminated TENORM waste, and will cause increased truck traffic into and out of the landfill and in the vicinity of two schools.

Removal of the TENORM wastes would not be simple and would include other challenges. Although the CAP briefly describes these generalized risks, the Cabinet's determination regarding short-term risks also drew upon its significant experience with landfill excavation, slide remediation, and other issues it has observed at other facilities. Waste cover will have to be removed to enable workers to access the potentially radioactive waste. Uncovering the BES waste that was mixed with and buried under several thousand cubic yards of solid waste would create significant odors due to the bacterial degradation and decomposition. The odors could spread to fairly long distances based on wind and weather patterns, and would likely adversely impact the day to day activities of nearly all of the nearby residents as well as students, faculty, and staff at the two schools during the entire removal operation. Deodorizers and other measures can be used, but Cabinet experience with other landfills suggests that odor control measures sometimes have mixed results. Gases typically associated with the odors and solid waste landfill operations include methane, ammonia, and hydrogen sulfide and other volatile organic compounds. Exposure to these gases and other potential contaminants could pose additional risks to workers and others in the vicinity of the removal area, and would require monitoring to ensure levels of fugitive chemical emissions and odor would not exceed allowable regulatory or health-based levels off-site including the schools and nearby residences.

Stormwater protection plans would need to be designed and implemented to control and redirect stormwater, to the extent possible, to prevent stormwater from entering the excavation area, which could cause additional infiltration, generate additional volumes of leachate in the landfill, and increase the potential for groundwater impacts. The removal could also disrupt or slow down normal waste disposal operations at the landfill as the removal areas of the landfill would need to be separated from the working face and the areas that receive solid waste on a daily basis.

Based on the Cabinet's experience with other responses that involve excavation, the 93 day estimated timeframe to identify, remove, load and transport impacted waste and re-cover the excavation area would likely end up being much longer. Weather conditions play a significant role in conducting excavations in an area with shale and clay soils. If conditions are too wet for the heavy equipment to operate, work would be postponed - sometimes for

several days at a time - until it is dry enough to continue. The longer the timeframe for the excavation means a longer time period the potential worker safety and public safety issues, including odor problems, increased truck traffic, and stormwater infiltration concerns, will persist.

- **Liner Design/Life Comments: Some commenters stated that the landfill design and liner life is inadequate given the half-lives of the BES waste.**

Response: Studies conducted on the service life of high-density polyethylene (HDPE) liners in landfills have indicated an estimated service half-life of up to 446 years, dependent on a number of factors, including temperature inside the landfill. Other studies indicated potentially longer service life for liners in low-level radioactive waste disposal facilities. The Blue Ridge Landfill has an engineered liner system designed and constructed to meet the requirements for permitted solid waste contained landfills in 401 KAR 48:080. The purpose of the liner is to prevent the migration of landfill leachate and contaminants from the landfill into groundwater. The liner system consists of five layers that provide a specific function to protect groundwater. From the bottom to the top, they include:

1. A 2-3 feet thick compacted clay layer that has low permeability;
2. A 60 ml HDPE designed to prevent migration of leachate while resisting material degradation from municipal solid wastes, and other solid or special wastes;
3. A geotextile cushion or geo-composite drainage layer on top of the HDPE geomembrane;
4. A 12-inch thick granular low-permeability layer that protects the liner and collects leachate; and
5. A geotextile layer on top of the granular layer to protect the leachate system.

ADS will be developing an Interim Remedial Measures Plan, which will include placing - either a synthetic liner or low-permeability soil layer interim cover over the BES waste as an additional barrier to further reduce the infiltration of water into the landfill and reduce leachate generation. The interim cover will be addressed as part of the landfill permit modification. ADS has agreed to comply with the updated TENORM regulation in 401 KAR 48:090 when the landfill is closed, estimated to be approximately 2034. The regulation requires both a synthetic liner and low-permeability soil layer be constructed as a final cap.

It is important to note that the risk assessment dose and risk calculations for the most likely future exposure scenario of a resident drinking groundwater from a well immediately adjacent to the landfill 2,700 years from the present, assumes the landfill has no cap, no interim cap, and no engineered liner. As noted in a previous response, the Cabinet will require land use restrictions be placed on the landfill property, pursuant to applicable law at the time the post-closure period begins, that will include no residential use, and no groundwater use for drinking water purposes. Therefore, the worst-case scenario risks calculated in the assessment do not account for protective measures presently in place at

the landfill, measures that will be undertaken as part of the CAP, or measures that will remain in place indefinitely (i.e. the institutional controls). The worst-case scenario calculated risk slightly exceeds the target risk level. However, even in the worst case scenario, the maximum effective radiation doses were well below the 25 mrem/yr dose limit for low-level radioactive disposal sites, and the maximum total radium (Ra-226 + Ra-228) concentration was well below the drinking water standard.

- **Risk Comparison Comments: Some commenters stated that the short-term risk posed to landfill workers as part of the Alternative 2 (Excavate and Redispose BES waste) is not great enough to justify long-term risk posed by leaving the wastes there.**

Response: The Excavate and Redispose option would pose an increased short-term radiological lifetime cancer morbidity risk for the landfill worker of 1.8×10^{-5} and the landfill supervisor at 2.2×10^{-6} compared with Kentucky's target risk level of 1×10^{-6} . This is due to the potential direct exposure to a worker and a supervisor from inhalation of particulates, soil ingestion, and external exposure from the excavation and loading of waste. If waste quantities and activity levels are assumed to be higher than the characterization data indicates, there could be a higher potential dose and an even greater risk of exposure for the workers in the excavation and during loading of the material under the removal option. In addition, as stated previously this option poses a higher physical risk to workers, students, and the public due to possible truck accidents in hauling the waste, disrupts normal landfill operations, will create odors from uncovering buried waste, will create challenges with handling stormwater run-on and runoff during the removal period, and will cause increased truck traffic into and out of the landfill and in the vicinity of two schools.

In order to ensure the future use of the landfill property is controlled in order to limit potential exposure, and protect human health and the environment, once the landfill enters the 30-year post-closure period, the Cabinet will require ADS to place appropriate land use restrictions through institutional controls on the landfill property, pursuant to applicable law at the time the post-closure period begins. The land use restrictions will run with the land and will include no residential use, no drinking water use and no disturbance of the cap. For calculating the potential long-term risk, the risk assessment conducted as part of the CAP assumes very conservative modeling assumptions for the groundwater pathway (including no final cap, no interim cap, and no engineered liner) and uses upper bounding (worst case) maximum reasonable exposure estimates for calculating potential risk to groundwater contamination over time. The results show that the maximum risk would be to a future hypothetical resident consuming groundwater from a well located immediately adjacent to the landfill 2,700 years from the present day, which at 4.9×10^{-5} exceeds the target risk level of 1×10^{-6} . However, maximum effective doses were well below the 25 mrem/yr dose limit for low-level radioactive disposal sites, and the maximum total radium (Ra-226 + Ra-228) concentration was well below the USEPA drinking water standard.

Estimated human health radiological risk from the TENORM waste is based on scientifically accepted approaches and is directly proportional to the quantity of radioactive materials in the waste. The risk assessment is from the overall risk of exposure and makes recommendations based on the lesser of the total risk, given the information available. Factored into the recommendation from the assessment is that certain exposures and risks have already been received (to account for the initial disposal), and that adding additional exposures and risks by unnecessarily excavating, relocating, and reburying the same wastes elsewhere with no additional long-term benefit is not warranted. Alternative 1: Closure-in-Place and Monitoring would be safe for the workers and the public and pose very little long-term future risk to residents with adequate institutional controls in place including placement of land-use restrictions stating no disturbance of the cap, no residential use, and no drinking water use.

- **Contingency Plan Comments: Some commenters stated the CAP is deficient since it does not include a Contingency Plan.**

Response: The Blue Ridge Landfill is operating under a contained solid waste landfill permit, and radionuclides will be added to their groundwater monitoring program as a permit modification. Between the landfill permit and 401 KAR 48:300/310, provisions which require groundwater and surface water assessment and corrective action, and additional financial assurance to insure corrective action is completed are already in place. If there are exceedances of any constituents in groundwater, radionuclides or others, the facility will be required to conduct an assessment and perform corrective action if necessary, including conducting additional remedial action. As noted above, in accordance with comments received, the Cabinet will require ADS to modify their proposed groundwater monitoring plan by continuing groundwater monitoring for radionuclides following landfill closure, during the 30-year post-closure period. Therefore, monitoring for radionuclides will continue beyond the operating life of the landfill, through the 30-year post-closure period, likely through 2066. If detection monitoring indicates elevated levels of radionuclides or elevated radiological activity exist, groundwater monitoring will continue and, if necessary, ADS will be required to conduct a groundwater assessment and potential corrective actions.

- **Host Agreement/Local litigation Comments: Multiple commenters discussed the host agreement and local litigation.**

Comment: Multiple commenters stated that because the disposal was a violation of the host agreement, the Cabinet should require a removal.

Response: As stated earlier, the Cabinet evaluated the CAP using the factors required by paragraph 19 of the Agreed Order and the laws it enforces. Host agreements are contracts between the local government and landfills, and their terms are enforceable by those parties. KRS Chapter 224 does not require host agreements. The Cabinet does not enforce

host agreements, dictate their terms, mediate disputes arising from them, or otherwise interpret their provisions. Statements in solid waste permits indicating the permit does not relieve the permittee from compliance with all local agreements and laws do not convey authority on the Cabinet to enforce the host agreement as part of the permit. Remedies associated with violations of the host agreement fall squarely within jurisdiction of local court.

Comment: One commenter stated before the Cabinet approves any CAP it should require Blue Ridge to enter into a new host agreement.

Response: KRS Chapter 224 neither requires landfills to enter into host agreements with counties, nor provides any mechanism for the Cabinet to enforce those agreements' terms. Pursuant to KRS 224.40-315, to obtain a construction permit for a new or significant expansion to a municipal solid waste disposal facility, the applicant must demonstrate that the local government has determined the new landfill or significant expansion will be consistent with the area solid waste management plan required by KRS 224.43-315. The statutes do not specifically set the forms of local contracts or ordinances, which also are necessary for landfill operations, nor do they require host agreements to be part of the local determination. Host agreements are contracts between the local government and the landfill owner/operator, and their terms are negotiable by those parties. The CAP is not the appropriate mechanism to resolve disputes related to host agreements or to leverage negotiations related thereto.

Comment: Multiple commenters noted that Advanced Disposal had not admitted it accepted TENORM in local litigation regarding the host agreement and local ordinance.

Response: The proposed remedial alternatives in the CAP and its addenda assume concentrations of radium based on all of the available data from the investigation and CAP development process. The assumed concentrations were derived in part from analytical data provided to the Cabinet by generators for some of the waste, including data from Fairmont Brine wastes. Other sources of data included samples of similar waste collected by the Cabinet for Health and Family Services at generators' facilities. Legal positions taken in local litigation do not affect the radioactivity assumptions that Blue Ridge used to develop the CAP or that the Cabinet used to evaluate it.

- **Long-term Economic Impact Comments: Multiple commenters indicated that the Cabinet should consider long-term economic or other financial impacts that might arise based on public perceptions.**

Response: As stated earlier, the Cabinet evaluated the CAP using the factors required by paragraph 19 of the Agreed Order and the statutes and regulations it enforces. The CAP and its preferred alternative meet the standards of protectiveness and is approvable

pursuant to Kentucky law. Potential long-term economic impacts based upon future public perception is not a technical factor related to human health or the environment that the Cabinet evaluates.

- **Public notice/participation Comments: At least two commenters asked questions or made comments regarding public participation and/or notice procedures.**

Response: Since the Office of Attorney General Criminal Branch concluded its investigation, the Cabinet has maintained a public website for open records associated with the disposal, investigation, and CAP development. In addition, the Cabinet published a near final draft of the Agreed Order through its website and various media outlets, solicited comments, and issued responses to comments on the Agreed Order. Furthermore, the Cabinet participated in two public meetings to discuss the disposal and Agreed Order. Those meetings were hosted and publicized by local officials and a local community group, and were held at the Estill County High School. Lastly, the Cabinet issued a press release and published a public notice announcing the CAP in the local paper, and solicited comments consistent with the solid waste permitting procedures set forth in Kentucky law.

- **Editorial Comments: Some commenters made specific suggestions for edits to CAP language.**

Response: Suggestions included things like adding local contact information for Estill County officials and inserting cross-references between CAP sections. The Cabinet reviewed these comments and the specific sections of the CAP they referenced. The Cabinet will request amendments it agreed with in the determination letter.

Attachment J

Kentucky Energy and Environment Cabinet January 2018 Public Notice on the Corrective Action Plan

PUBLIC NOTICE

Pursuant to Agreed Order # DWM - 160048
Agency Interest No. 998, Permit # 033-00004

The Energy and Environment Cabinet, Division of Waste Management has reviewed a Corrective Action Plan submitted on November 17, 2017 (CAP), its addenda, and all comments received on the CAP related to the disposal of unpermitted TENORM waste at the Blue Ridge Landfill, near Irvine, Kentucky. The CAP was submitted pursuant to the Agreed Order in file No. DWM – 160048 and the Cabinet accepted public comments on the CAP from January 11, 2018 through February 12, 2018.

The name and address of the permit holder and facility is:

Advanced Disposal Services Blue Ridge Landfill Inc.
2700 Winchester Road
Irvine, KY 40336

A copy of the CAP, the Cabinet's final determination letter, and responses to comments will be available for public inspection at the Estill County Public Library during regular library hours. The CAP and related records (including the Cabinet's comments on draft versions and responses thereto), public comments received on the CAP and responses thereto, the Cabinet's final determination letter, the Agreed Order, and other information related to the Cabinet's investigation can also be viewed on the internet at <http://dep.gateway.ky.gov/publicfiles/> or at the Division of Waste Management's Frankfort office between 8:30 AM and 4:00 PM weekdays by appointment only.

The Cabinet does not discriminate on the basis of race, color, religion, sex, national origin, sexual orientation, gender identity, ancestry, age, disability or veteran status. The Cabinet provides, on request, reasonable accommodations necessary to afford an individual with a disability an equal opportunity to participate in all services, programs and activities. To make an appointment or request materials in an alternate format, submit a written request to EEC.KORA@ky.gov at least 72 hours prior to the desired review date. Please include the

Agency Interest No. 998 and Agreed Order Number DWM – 160048 in the email request. For assistance with a records request, contact Emily Perkins at (502) 782-1786.

Attachment K

**Advanced Disposal Services, Inc. November 2017 Response to
Kentucky Energy and Environment Cabinet Comments on the
Revised Corrective Action Plan**



Advanced Disposal Services, Inc.
Blue Ridge Landfill
2700 Winchester Road
Irvine, KY 40336

606-723-5552

November 17, 2017

Mr. Jeffrey A. Cummins
Director, Division of Enforcement
Kentucky Energy and Environment Cabinet
Department for Environmental Protection

Re: Response to Blue Ridge Landfill Corrective Action Plan – Cabinet Comments Dated October 13, 2017

Dear Mr. Cummins:

This letter and the attachment are submitted on behalf of Advanced Disposal Services Blue Ridge Landfill, Inc., in accordance with the Agreed Order No. DWM-160048. This letter contains the response to the Kentucky Energy and Environmental Cabinet's (EEC) second set of comments (dated October 13, 2017, and received October 23, 2017) on the Corrective Action Plan (CAP), which is required as part of the Agreed Order. The associated revised CAP is attached.

EEC Comment #1:

"There is no final compliance date specified in the CAP as required by paragraph 19 (e) of the agreed order. The final compliance date is the date Blue Ridge anticipates completing all remedial actions listed in the CAP. Please provide a final compliance date in accordance with the agreed order."

Response #1:

Blue Ridge Landfill proposes that the final compliance date will be the date the EEC issues its final approval of the permit modifications to the facility's Solid Waste Permit necessary to implement the CAP. The contents of the permit modification are detailed in several of the responses below and include additional sampling and analysis, enhanced landfill cover, and modifications to the landfill gas extraction system. These modifications would propose milestone dates for interim compliance with sampling and monitoring, which would include a reduced frequency or extended monitoring period, depending on the results. The EEC's final approval of the permit modifications, many of which will continue for the life of the facility, will make the operational changes legally binding and, therefore, fulfill the purpose of the CAP, including interim and final compliance.

EEC Comment #2:

"In response to cabinet comment 3 requesting monitoring for radionuclides for groundwater, surface water, and leachate, ADS proposes to work with the cabinet to develop a Radionuclide Sampling Plan. The groundwater sampling plan proposed in the August 28, 2017 submission that includes monitoring for groundwater (quarterly at all groundwater monitoring well locations presumably for a year then monitoring of two downgradient wells-MW-13 and MW-15R on a semi-annual basis) for radionuclides is acceptable. The broader Sampling Plan must also include sampling of leachate and the two underdrains at the landfill for radionuclides on at least a semi-annual basis as these locations would provide more timely data points to determine if there are any resultant impacts from the BES waste. See comment 3

below. The cabinet recognizes the importance of determining background radioactivity levels in groundwater for the site, given the fact that the New Albany Shale has been demonstrated through screening to have naturally occurring radioactivity levels of Ra-226 and Ra-228. Further, it is important to establish the background activity levels and the ranges of activity in groundwater in order to use the data to determine potential future impacts from the BES waste. However, please note that in order to determine truly representative background levels in groundwater, a comparison must be made of the monitoring results from upgradient wells related to downgradient wells. Also, any changes to the groundwater monitoring requirements will need to be incorporated as amendments to the solid waste landfill permit."

Response #2:

Blue Ridge Landfill will develop a Radionuclide Sampling/Analysis Plan for additional monitoring of the groundwater and surface water and will seek regulatory approval of this plan through the permit modification process. Additionally, Blue Ridge landfill will submit an addendum to the existing Groundwater Assessment Report submitted in 2016, outlining the proposed radionuclide monitoring and frequency. However, because of the presence of naturally occurring radioactivity in *in situ* soil and the surrounding bedrock used as cover material, Blue Ridge Landfill cannot agree to include leachate monitoring in the sampling plan. Blue Ridge Landfill is not aware of any testing or monitoring procedure that can distinguish the radioactivity emitted from naturally occurring cover materials (soil and rock) from radioactivity that may be emitted from the BES Waste material. Accordingly, Blue Ridge Landfill believes that any leachate testing results would be inconclusive, ambiguous, and would not provide value in this remedial process. Should circumstances change, the EEC could use the permit modification process to address those changes.

EEC Comment #3:

"Section 4.2.1 Remediation Alternative 1: Closure-in-Place and Monitoring. In Section 2.1 Blue Ridge Landfill Overview, it is stated that the landfill operations are expected to continue until 2034 (unless an expansion is approved under the solid waste permit). In order to reduce potential exposure to workers and others to the BES waste during the active disposal life of the landfill, it is important to comply with the primary radiation safety principle 'As Low as Reasonably Achievable' (ALARA), which in essence means to make every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical. In order to ensure this level of protectiveness related to the BES waste, the cabinet requires an Interim Remedial Measures Plan (IRMP) be developed and implemented. The IRMP should include at a minimum: 1) a proposal for placing an additional low-permeable layer (clay, geosynthetic or a combination thereof) over the BES wastes (including a minimum 30-yard buffer around the waste area) as an interim measure to prevent surface water infiltration; 2) procedures for ensuring the BES waste remains covered and undisturbed until closure; 3) a plan for routine monitoring of leachate and the underdrains for radionuclides; 4) prohibiting recirculation of leachate at the landfill, and 5) procedures for notification of the City of Irvine Waste Water Treatment Plant if levels of radioactivity are found in leachate exceeding an action level and a plan for its proper handling and disposal. A radiation worker training and safety program must also be developed and implemented to meet the requirements of pending regulations by CHFS and 902 KAR 100:019."

Response #3:

Blue Ridge Landfill will submit the Interim Remedial Measures Plan as part of the permit modification processes referenced in Responses #1 and #2 above. This plan will address all aspects of Comment #3, with the following exception: because Blue Ridge Landfill will not conduct additional leachate monitoring (based on the reasons outlined in Response #2), this plan will not include provisions for leachate monitoring and wastewater treatment plant notifications. It is important to note that Blue Ridge Landfill does plan to include underdrain monitoring as part of the Radionuclide Sampling/Analysis Plan, and, therefore, the underdrain monitoring will be addressed as requested in Comment #3.

With regard to item 5 concerning notification to the City of Irvine Waste Water Treatment Plant, Blue Ridge Landfill's permit prohibits the contribution of "any radioactive wastes or isotopes of such half-life or concentrations as may exceed limits established by applicable State or Federal Regulations." US EPA (2015 "*Radionuclides in Drinking Water*") states "there are no current federal regulations concerning the disposal of radionuclides to the sewer." Similarly, Kentucky does not have regulations restricting the discharge of radionuclides to the sewer system. Because neither state nor federal regulations establish limits on the concentrations of radionuclides that may be discharged to a wastewater treatment plant through a sewer connection, we conducted further research to identify guidance relevant to the Blue Ridge Landfill.

Sampling conducted by the Commonwealth of Kentucky on leachate from the Blue Ridge Landfill in February 10, 2016 shows that radium-226 (Ra-226) and radium-228 (Ra-228) were below the minimum detectable concentration.¹ (See Exhibit A). The Nuclear Regulatory Commission has promulgated radionuclide standards for licensed nuclear facilities that discharge to sanitary sewers. See 10 C.F.R. § 20.1003; § 2003 (2015) these regulations set forth a standard of 600 pCi/L for Ra-226 and Ra-228 relating to discharges to sanitary sewer systems at nuclear facilities. These standards, however, do not apply to the Blue Ridge Landfill. Additionally, the NRC "determined that there was no widespread public health or safety concern due to potential radiation exposures associated with the handling, beneficial use, and disposal of sewage sludge." (See 70 Fed. Reg. 68,350 Nov. 10, 2005). The NRC's technical survey showed that "the most significant levels of radioactive materials in publicly owned treatment works (POTWs) are attributable to naturally occurring radioactive material (NORM)," not to manmade radiation. *Id.* at 68,351.

In sum, (1) there is no enforceable standard limiting the concentration of radionuclides from a landfill to a waste water treatment plant; (2) the only available data on Ra-226 and RA-228 in leachate at the Blue Ridge Landfill are non-detect measurements; and (3) the main source of radionuclides in sewage sludge is from NORM. Consequently, given the minor amount of radionuclides (if any) in the BES Waste material in proportion to the total amount of waste mass in the landfill, the high probability that any radionuclides would be naturally occurring, and the lack of an enforceable discharge standard, we do not believe leachate testing is required to satisfy Blue Ridge Landfill's permit with the Irvine Municipal Utilities.

EEC Comment #4:

"Section 4.2.1 Remediation Alternative 1: Closure-in-Place and Monitoring. In this section and in other portions of the CAP, an 'enhanced cap' is proposed to be placed over the BES waste as part of the final cover system when the landfill closes. The purpose of the enhanced cap, consisting of a low-permeability geo-synthetic clay liner (GCL) will be to further reduce long-term infiltration of surface water into the BES wastes. The cabinet agrees with the proposal to design and place the enhanced cap as outlined above in accordance with the updated pending regulatory requirements in 401 KAR 48:090 and 902 KAR 100:180, Section 6(2) (a). ADS must ensure that the construction methods and specifications for the additional low-permeability liner are consistent with the pending regulations. Financial assurance for the enhanced cap and additional monitoring must be provided pursuant to the closure care requirements in 401 KAR 48:310."

Response #4:

Blue Ridge Landfill proposes to conduct additional monitoring of the groundwater beginning during the first quarter of 2018. This additional monitoring will be conducted over the operating life of the landfill

¹ The concentration of Ra-226 was 524 pCi/L, below the MDA of 558 pCi/l and the concentration of Ra-228 was 60.1 pCi/L, below the MDA of 106 pCi/L. This means all that can be said about the Ra-226 result is that it is below 524 pCi/L and all that can be said about the Ra-228 result is that it is below 60.1 pCi/L.

and may be reduced over time based on the additional monitoring results. An outlined schedule is provided in Response 7B and will be further detailed in the minor permit modification. Blue Ridge Landfill does not believe long-term monitoring, extending beyond the current post-closure period, would be necessary. Based on the current operating life of the facility, the post-closure period will not end until 2064. In the unlikely event that radioactivity is identified in the groundwater and surface water as a result of the BES Waste, and it is determined additional monitoring activities are warranted, a plan for additional long-term monitoring will be developed, including any additional financial assurance.

EEC Comment #5:

"In response to cabinet comment 8 which related to the likelihood of radon in the landfill gas that is extracted and used to generate electricity on-site, and the potential for contamination in condensate that is collected from cooling of landfill gas, ADS proposes to relocate the existing landfill gas extraction wells in the BES waste area to other areas of the landfill and prohibit drilling extraction wells in the BES waste area. The proposed modifications will require amending the solid waste permit, and would reduce potential exposure to workers in future drilling of gas extraction wells in the area. However, moving the existing landfill gas extraction wells from the BES Waste area will not reduce the landfill gas generation from that area, and does not address potentially radon-contaminated methane gas, which could be released into the atmosphere. As an option, the extraction wells could remain in the BES Waste area, and the methane gas monitored for radon contamination. In addition, the leachate, including the condensate from the cooled landfill gas, should be monitored for radionuclides (see comment 3)."

Response #5:

Blue Ridge Landfill will modify the design of the landfill gas extraction system to avoid future extraction well installation or other disturbances within the BES Waste disposal area. Depending on the efficiency of the modified design (*i.e.*, if the standard 150-ft radius of influence cannot be achieved), Blue Ridge Landfill may propose the addition of surface extraction infrastructure for landfill gas. The potential infrastructure would be located immediately below the final cover system but above the BES Waste. The modified landfill gas system design will be included in the permit modification to be submitted to EEC, as referenced above.

EEC Comment #6:

"**Section 6.6 Implementability.** Other issues related to the logistics of implementation of Remedial Alternative 2 (Excavate and Redispose BES waste) which should be considered include whether there may be temporary disruptions of routine waste disposal of MSW from Estill, Madison and other surrounding counties during the removal operation, and the likelihood of additional heavy truck traffic at BRL and in the vicinity of BRL from trucks hauling BES waste out while trucks are hauling MSW to the landfill. Please provide an assessment of these potential impacts."

Response #6:

Blue Ridge Landfill agrees that logistical issues would cause significant implementability challenges for Remediation Alternative 2 (Excavate and Redispose BES Waste). The CAP includes a discussion of trucks needed to complete Remediation Alternative 2. The average trucks per day (24 trucks per day for more than 90 days) are provided in Table 4.3 and the total travel miles (more than 1.5 million miles) are provided in Table 6.4 of the CAP. Blue Ridge Landfill also considered the on-site and off-site injury and fatality risks associated with increased truck traffic that would be required to implement Remediation Alternative 2 (see Section 6.5.2, Table 6.4, and Attachment D) and addressed the damage to roadways in Section 6.5.3. In addition, Sections 6.5.2 and 6.6 of the CAP text have been updated to reflect potential disruptions of routine municipal solid waste (MSW) disposal at the Blue Ridge Landfill, an increase in local traffic and its potential disruption to a local school, and increased truck hauling impacts.

EEC Comment #7A:

"Section 6.7 Cost. Table 6.6. Attachment E. For Remedial Alternative 1 (Closure-in-Place and Monitoring), the estimate must include:

1. Development and implementation of the Interim Remedial Measures Plan (IRMP) referenced in Comment 3 including:
 - a. Design and construction costs for the IRMP liner.
 - b. Cost of routine monitoring for radionuclides in groundwater, leachate and underdrains and contingency disposal costs in the event leachate is contaminated with radionuclides and would need to be disposed at an alternate facility other than the WWTP.
2. Financial Assurance Costs for the enhanced cap and long-term monitoring."

Response #7A:

The cost estimate (see Section 6.7, Table 6.6, and Attachment E) has been updated to include the IRMP liner and routine monitoring.

EEC Comment #7B:

"Section 6.7 Cost. Table 6.6. Attachment E. For Remedial Alternative 2 (Excavate and Redispose BES Waste), the cost estimate for remedy implementation must include:

1. Additional project management costs if work is required to be conducted under radiation health and safety protocols with oversight by a certified health physicist. At a minimum, excavations of BES waste with material at these levels entails potential worker exposure and contamination that requires protective measures including: radiation hazard safety training for workers, protective clothing, personnel monitoring devices if radiation levels are such that a worker may exceed 100 mrems per year, monitoring of workers and equipment to assure absence of surface contamination, and initial air monitoring for particulate and radon levels to determine need for ongoing air monitoring during excavation work.
2. Stormwater controls to prevent contaminant migration during removal.
3. Air monitoring and potential mitigation measures (use of enzymes, deodorizers, *etc.*) to address nuisance odors and other potentially harmful gases, including hydrogen sulfide and methane, during the excavation."

Response #7B:

Blue Ridge Landfill will develop a permit modification that will include the items listed below.

1. A modification to the Environmental Monitoring Plan to include the following:
 - i. Additional underdrain and groundwater monitoring (including the tentative schedule outlined below):
 1. Groundwater and underdrain baseline testing – 2018.
 2. Additional routine monitoring of the groundwater and underdrains – 2019-2023.
 3. Five years of additional monitoring of the groundwater and underdrains (reduced to five based on the routine monitoring results) – 2028-2034.
 4. Annual additional monitoring to continue through end of the post-closure care period if elevated results are identified.

- ii. The Final Cover Plan to include the enhanced final cover system. The proposed enhanced final cover will reduce infiltration from approximately 1 inch per acre per year to <math><1/2</math> inch per acre per year. Estimating an enhanced final cover area of 4 acres, this would reduce infiltration on an annual basis from 27,000 gallons to less than 13,000 gallons in that area.
- iii. The landfill gas extraction system, to avoid future installation into the BES Waste and the possible addition of surface infrastructure.

Blue Ridge Landfill agrees that costs for Remediation Alternative 2 should include appropriate health and safety and engineering controls described above. To account for these factors, we added a line item in our detailed cost estimate calculations table for Remediation Alternative 2 in Attachment E. The additional cost was calculated by applying a cost adjustment factor as outlined in Appendix B of US EPA and US ACE (2000), an industry-standard method for cost estimation. The cost adjustment factor includes personal protective equipment, additional health and safety professionals, training, health and safety-related monitoring equipment (*e.g.*, air monitoring for particulates or personal radiation monitors), and engineering controls (*e.g.*, stormwater management). The calculation assumed light work-modified Level D protection, as provided in the updated Attachment E. Section 6.7 of the CAP was revised accordingly.

EEC Comment #8:

"Section 6.7 Cost. Table 6.6. Attachment E. A 7.0% annual discount rate was used to calculate the net present value of future costs based on a USEPA and USACE reference from 2000. The rate may not be realistic at the current time. It may be more appropriate to use a more recent discount rate utilized by the U.S. Office of Management and Budget (OMB) of 1.7 to 2.7% in order to ensure the project costs are not underfunded."

Response #8:

We used a representative discount rate of 7% provided in US EPA and US ACE (2000, p. 4-4), "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," which is a typical industry standard used to develop cost estimates for remedial action alternatives. To address EEC's concerns, we conducted a sensitivity analysis of costs using 2% and 10% discount rates. The sensitivity analysis only applied to Remediation Alternative 1, because no incremental costs are associated with future operation and maintenance (O&M) activities in Remediation Alternative 2 (see Attachment E). The results of this sensitivity analysis indicated that incremental costs of \$470,800 and \$463,000 are expected for the 2% and 10% discount rates, respectively, compared to \$464,900 using the 7% discount rate.

EEC Comment #9:

"Section 6.7 Cost. Attachment E. Under Remediation Alternative 1: Closure-in-Place and Monitoring, the future monitoring costs are projected for a timeframe of 30 years, typical for post-closure monitoring of solid waste landfills. However, due to the presence of the BES waste, which includes radionuclides with very long half-lives, monitoring costs should be estimated for a minimum of 100 years, consistent with the maximum period controls can be relied upon per 902 KAR 100:022 Section 27."

Response #9:

Blue Ridge Landfill reaffirms that the current financial assurances and post-closure monitoring period are adequate and sufficient. In the unlikely event that additional or longer-term measures are needed based on the results of the Radionuclide Sampling/Analysis Plan, Blue Ridge Landfill will adjust the post-closure monitoring period and financial assurances at that time.

EEC Comment #10:

"Section 6.7 Cost. Attachment E. Section 4.0 includes estimated disposal cost (quoted from a third party provided by ADS) in a commercial hazardous waste landfill at \$1,585,200 for 39,630 cubic yards. Is this the Mostoller Landfill in Pennsylvania? Also, Section 4.1 has the cost itemized as 'Landfill Non-hazardous Solid Bulk Waste.' Please clarify the description in the chart."

Response #10:

The estimated disposal cost was for BES Waste to be re-disposed of at the Mostoller Landfill, a facility operated by ADS that is permitted to accept waste containing technologically enhanced naturally occurring radioactive material (TENORM). The cost of \$1,585,200 for 39,630 yards in Attachment E pertains to hauling costs for the BES Waste quoted to ADS by a third party. There are no costs for disposal of the BES Waste at the Mostoller Landfill because ADS also operates that facility. Sections 4.0 and 4.1 of the table for "Remediation Alternative 2: Excavate and Redispose BES Waste" in Attachment E have been updated for clarity.

Additional Item

The results of the well survey performed in the downgradient vicinity of the landfill are attached (see Exhibit B). No additional wells were identified based on the survey.

Please contact me at (724) 244-9511 or at joseph.santangelo@advanceddisposal.com should you have any further questions or comments.

Sincerely;



Joseph Santangelo
Environmental Compliance Manager
Advanced Disposal – Blue Ridge Landfill

Exhibit A

ER_FAIRMONTBRIN_03-07-16

03/04/2016 - 03/04/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/L	Uncertainty	MDA	Code	Method
BB01267	FAIRMONT_BRINE_Processing_Concrete_Basin_Setting_Tank	3/4/16	Sludge						
				Bi-214	994000	37200	2670	=	GAMMA
				Pb-214	995000	41700	4350	=	GAMMA
				Ra-226	950000	67600	43000	=	GAMMA
				Ra-228	207000	7150	5450	=	GAMMA

Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Bueck

04/08/16

Code:
 "U" Less than MDA or greater than MDA with high counting uncertainty.
 "U*" Analyte not detected. Activity based on software calculation, not identified peak(s).
 "=" No qualifier necessary
 "J" Value is estimated.
 "R" Not useable for intended purpose

Friday, April 8, 2016

ER_BLUERIDGE_LF_03-07-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	03/04/2016 - 03/04/2016		
							MDA	Code	Method
BB01255	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	125	5.23	2.10	=	GAMMA
				Pb-214	131	5.64	2.24	=	GAMMA
				Ra-226	131	11.2	20.7	=	GAMMA
				Ra-228	96.6	3.78	3.18	=	GAMMA
BB01256	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	5.37	0.306	0.321	=	GAMMA
				Pb-214	5.69	0.297	0.354	=	GAMMA
				Ra-226	9.78	1.22	2.76	=	GAMMA
				Ra-228	1.57	0.164	0.600	=	GAMMA
BB01257	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	1.02	0.0868	0.177	=	GAMMA
				Pb-214	1.09	0.0786	0.165	=	GAMMA
				Ra-226	2.34	0.529	1.53	=	GAMMA
				Ra-228	1.57	0.119	0.307	=	GAMMA
BB01258	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	3.05	0.214	0.402	=	GAMMA
				Pb-214	3.36	0.202	0.280	=	GAMMA
				Ra-226	6.21	0.965	2.43	=	GAMMA
				Ra-228	1.62	0.167	0.582	=	GAMMA

ER_BLUERIDGE_LF_03-07-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	03/04/2016 - 03/04/2016		Method
							MDA	Code	
BB01259	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	150	6.21	2.35	=	GAMMA
				Pb-214	156	6.67	2.50	=	GAMMA
				Ra-226	166	13.6	22.5	=	GAMMA
				Ra-228	114	4.39	3.39	=	GAMMA
BB01260	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	64.6	2.67	1.12	=	GAMMA
				Pb-214	65.5	2.81	1.08	=	GAMMA
				Ra-226	71.4	5.90	10.2	=	GAMMA
				Ra-228	48.4	1.88	1.59	=	GAMMA
BB01261	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	5.49	0.309	0.301	=	GAMMA
				Pb-214	5.90	0.305	0.334	=	GAMMA
				Ra-226	10.3	1.27	2.68	=	GAMMA
				Ra-228	1.41	0.164	0.697	=	GAMMA
BB01262	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	3.83	0.246	0.267	=	GAMMA
				Pb-214	4.34	0.275	0.269	=	GAMMA
				Ra-226	7.23	1.17	2.44	=	GAMMA
				Ra-228	1.17	0.149	0.555	=	GAMMA

ER_BLUERIDGE_LF_03-07-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	03/04/2016 - 03/04/2016		
							MDA	Code	Method
BB01263	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	4.86	0.415	0.515	=	GAMMA
				Pb-214	5.60	0.426	0.522	=	GAMMA
				Ra-226	7.32	1.77	4.41	=	GAMMA
				Ra-228	1.80	0.292	1.10	=	GAMMA
BB01264	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	1.01	0.0685	0.128	=	GAMMA
				Pb-214	1.10	0.0742	0.169	=	GAMMA
				Ra-226	2.77	0.479	1.34	=	GAMMA
				Ra-228	1.61	0.0948	0.282	=	GAMMA
BB01265	BLUE_RIDGE_LANDFILL_Retention_Pond	3/4/16	SURFACE WATER	Bi-214	2.38	10.6	46.9	U	GAMMA
				Pb-214	16.1	29.5	51.6	U	GAMMA
				Ra-226	174	138	487	U	GAMMA
				Ra-228	33.8	47.3	81.3	U	GAMMA
BB01266	BLUE_RIDGE_LANDFILL_Retention_Pond	3/4/16	SURFACE WATER	Bi-214	30.5	28.5	57.5	U	GAMMA
				Pb-214	38.0	27.4	59.0	U	GAMMA
				Ra-226	584	246	544	U*	GAMMA
				Ra-228	11.3	51.6	95.2	U	GAMMA

Scott

ER_BLUERIDGE_LF_03-07-16

03/04/2016 - 03/04/2016

LAB #	Location	Collection Date Matrix	Analysis Type	Value pCi/L	Uncertainty	MDA	Code	Method
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Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Buck

04/08/16

Code:
 "U" Less than MDA or greater than MDA with high counting uncertainty.
 "U*" Analyte not detected. Activity based on software calculation, not identified peak(s).
 "-" No qualifier necessary
 "J" Value is estimated.
 "R" Not useable for intended purpose

Friday, April 8, 2016

ER_BRINE_DRY_03-07-16

03/04/2016 - 03/04/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	MDA	Code	Method
BB01930	FAIRMONT_BRINE_Processing_Concrete_Basin_Setting_Tank_Dried	3/4/16	Sludge	Bi-214	1810	67.7	5.02	=	GAMMA
				Pb-214	1880	77.5	7.68	=	GAMMA
				Ra-226	2040	141	72.0	=	GAMMA
				Ra-228	433	14.7	11.1	=	GAMMA

This sample when dried became a very light, fine powder. This may be of concern for its distribution in the environment.

Stephanie C Busck

04/08/16

Results are reported using the activity concentrations from the peak associated with radium.226 (Ra226) due to the fact that bismuth.214 (Bi214) and lead.214 (Pb214) are not in secular equilibrium with Ra226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium.235 (U235) which contributes slightly to a peak in the same area as the Ra226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra226 rather than potentially lower activity concentrations.

Stephanie C Busck

04/08/16

Code:

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"=" No qualifier necessary

"J" Value is estimated.

"R" Not useable for intended purpose

Friday, April 8, 2016

ER_BLUERIDGE_LF_02-12-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/L	Uncertainty	02/10/2016 - 02/10/2016		
							MDA	Code	Method
BB01216	BLUE_RIDGE_LANDFILL Leachate Tank	2/10/16	Leachate						
				Bi-214	31.2	28.7	58.2	U	GAMMA
				Pb-214	30.2	27.9	59.0	U	GAMMA
				Ra-226	524	254	558	U	GAMMA
				Ra-228	60.1	50.4	106	U	GAMMA
				Gross Alpha	37.52	23.40	26.58	U	GFPC
				Gross Beta	646.80	26.92	41.77	=	GFPC

Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Buck

04/08/16

Code:

"U" Less than MDA or greater than MDA with high counting uncertainty.

"U*" Analyte not detected. Activity based on software calculation, not identified peak(s).

"=" No qualifier necessary

"J" Value is estimated.

"R" Not useable for intended purpose

Friday, April 8, 2016

ER_BLUERIDGE_LF_02-12-16

02/10/2016 - 02/10/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	MDA	Code	Method
BB01268	BLUE_RIDGE_LANDFILL_Soil	2/10/16	soil	Bi-214	3.66	0.194	0.226	=	GAMMA
				Pb-214	4.05	0.202	0.251	=	GAMMA
				Ra-226	7.55	0.855	1.95	=	GAMMA
				Ra-228	1.65	0.129	0.419	=	GAMMA

Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Buck

04/08/16

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 "R" Not useable for intended purpose

Friday, April 8, 2016

ER_BLUERIDGE_LF_02-12-16

02/10/2016 - 02/10/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	MDA	Code	Method
BB01268	BLUE_RIDGE_LANDFILL_Soil	2/10/16	soil						
				Bi-214	3.66	0.194	0.226	=	GAMMA
				Pb-214	4.05	0.202	0.251	=	GAMMA
				Ra-226	7.55	0.855	1.95	=	GAMMA
				Ra-228	1.65	0.129	0.419	=	GAMMA

Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Buck

04/08/16

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 "R" Not useable for intended purpose

Friday, April 8, 2016

ER_BLUERIDGE_LF_02-12-16

02/10/2016 - 02/10/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/L	Uncertainty	MDA	Code	Method
BB01216	BLUE_RIDGE_LANDFILL Leachate Tank	2/10/16	Leachate						
				Bi-214	31.2	28.7	58.2	U	GAMMA
				Pb-214	30.2	27.9	59.0	U	GAMMA
				Ra-226	524	254	558	U	GAMMA
				Ra-228	60.1	50.4	106	U	GAMMA
				Gross Alpha	37.52	23.40	26.58	U	GFPC
				Gross Beta	646.80	26.92	41.77	=	GFPC

Code:
 "U" Less than MDA or greater than MDA with high counting uncertainty.
 "U*" Analyte not detected. Activity based on software calculation, not identified peak(s).
 "=" No qualifier necessary
 "J" Value is estimated.
 "R" Not useable for intended purpose

Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Busck

04/08/16

Friday, April 8, 2016

ER_BLUERIDGE_LF_03-07-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	03/04/2016 - 03/04/2016		
							MDA	Code	Method
BB01255	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL						
				Bi-214	125	5.23	2.10	=	GAMMA
				Pb-214	131	5.64	2.24	=	GAMMA
				Ra-226	131	11.2	20.7	=	GAMMA
				Ra-228	96.6	3.78	3.18	=	GAMMA
BB01256	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL						
				Bi-214	5.37	0.306	0.321	=	GAMMA
				Pb-214	5.69	0.297	0.354	=	GAMMA
				Ra-226	9.78	1.22	2.76	=	GAMMA
				Ra-228	1.57	0.164	0.600	=	GAMMA
BB01257	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL						
				Bi-214	1.02	0.0868	0.177	=	GAMMA
				Pb-214	1.09	0.0786	0.165	=	GAMMA
				Ra-226	2.34	0.529	1.53	=	GAMMA
				Ra-228	1.57	0.119	0.307	=	GAMMA
BB01258	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL						
				Bi-214	3.05	0.214	0.402	=	GAMMA
				Pb-214	3.36	0.202	0.280	=	GAMMA
				Ra-226	6.21	0.965	2.43	=	GAMMA
				Ra-228	1.62	0.167	0.582	=	GAMMA

ER_BLUERIDGE_LF_03-07-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	03/04/2016 - 03/04/2016		
							MDA	Code	Method
BB01259	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	150	6.21	2.35	=	GAMMA
				Pb-214	156	6.67	2.50	=	GAMMA
				Ra-226	166	13.6	22.5	=	GAMMA
				Ra-228	114	4.39	3.39	=	GAMMA
BB01260	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	64.6	2.67	1.12	=	GAMMA
				Pb-214	65.5	2.81	1.08	=	GAMMA
				Ra-226	71.4	5.90	10.2	=	GAMMA
				Ra-228	48.4	1.88	1.59	=	GAMMA
BB01261	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	5.49	0.309	0.301	=	GAMMA
				Pb-214	5.90	0.305	0.334	=	GAMMA
				Ra-226	10.3	1.27	2.68	=	GAMMA
				Ra-228	1.41	0.164	0.697	=	GAMMA
BB01262	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	3.83	0.246	0.267	=	GAMMA
				Pb-214	4.34	0.275	0.269	=	GAMMA
				Ra-226	7.23	1.17	2.44	=	GAMMA
				Ra-228	1.17	0.149	0.555	=	GAMMA

ER_BLUERIDGE_LF_03-07-16

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	03/04/2016 - 03/04/2016		
							MDA	Code	Method
BB01263	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	4.86	0.415	0.515	=	GAMMA
				Pb-214	5.60	0.426	0.522	=	GAMMA
				Ra-226	7.32	1.77	4.41	=	GAMMA
				Ra-228	1.80	0.292	1.10	=	GAMMA
BB01264	BLUE_RIDGE_LANDFILL_Soil	3/4/16	SOIL	Bi-214	1.01	0.0685	0.128	=	GAMMA
				Pb-214	1.10	0.0742	0.169	=	GAMMA
				Ra-226	2.77	0.479	1.34	=	GAMMA
				Ra-228	1.61	0.0948	0.282	=	GAMMA
BB01265	BLUE_RIDGE_LANDFILL_Retention_Pond	3/4/16	SURFACE WATER	Bi-214	2.38	10.6	46.9	U	GAMMA
				Pb-214	16.1	29.5	51.6	U	GAMMA
				Ra-226	174	138	487	U	GAMMA
				Ra-228	33.8	47.3	81.3	U	GAMMA
BB01266	BLUE_RIDGE_LANDFILL_Retention_Pond	3/4/16	SURFACE WATER	Bi-214	30.5	28.5	57.5	U	GAMMA
				Pb-214	38.0	27.4	59.0	U	GAMMA
				Ra-226	584	246	544	U*	GAMMA
				Ra-228	11.3	51.6	95.2	U	GAMMA

ER_BLUERIDGE_LF_03-07-16

03/04/2016 - 03/04/2016

LAB #	Location	Collection Date Matrix	Analysis Type	Value pCi/L	Uncertainty	MDA	Code	Method
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Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.

Stephanie C Buck

04/08/16

Code:

"U" Less than MDA or greater than MDA with high counting uncertainty.

"U*" Analyte not detected. Activity based on software calculation, not identified peak(s).

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"R" Not useable for intended purpose

Friday, April 8, 2016

ER_BRINE_DRY_03-07-16

03/04/2016 - 03/04/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/g	Uncertainty	MDA	Code	Method
BB01930	FAIRMONT_BRINE_Processing_Concrete_Basin_Setting_Tank_Dried	3/4/16	Sludge						
				Bi-214	1810	67.7	5.02	=	GAMMA
				Pb-214	1880	77.5	7.68	=	GAMMA
				Ra-226	2040	141	72.0	=	GAMMA
				Ra-228	433	14.7	11.1	=	GAMMA

This sample when dried became a very light, fine powder. This may be of concern for its distribution in the environment.

Stephanie C Buck

04/08/16

Results are reported using the activity concentrations from the peak associated with radium.226 (Ra226) due to the fact that bismuth.214 (Bi214) and lead.214 (Pb214) are not in secular equilibrium with Ra226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium.235 (U235) which contributes slightly to a peak in the same area as the Ra226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra226 rather than potentially lower activity concentrations.

Stephanie C Buck

04/08/16

Code:
 "U" Less than MDA or greater than MDA with high counting uncertainty.
 "U*" Analyte not detected. Activity based on software calculation, not identified peak(s).
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 "R" Not useable for intended purpose

Friday, April 8, 2016

ER_FAIRMONTBRIN_03-07-16

03/04/2016 - 03/04/2016

LAB #	Location	Collection Date	Matrix	Analysis Type	Value pCi/L	Uncertainty	MDA	Code	Method
BB01267	FAIRMONT_BRINE_Processing_Concrete_Basin_Settling_Tank	3/4/16	Sludge						
				Bi-214	994000	37200	2670	=	GAMMA
				Pb-214	995000	41700	4350	=	GAMMA
				Ra-226	950000	67600	43000	=	GAMMA
				Ra-228	207000	7150	5450	=	GAMMA

Results are reported using the activity concentrations from the peak associated with radium-226 (Ra-226) due to the fact that bismuth-214 (Bi-214) and lead-214 (Pb-214) are not in secular equilibrium with Ra-226 even after allowing each sample to sit sealed for 21 days. These activity concentration results could be slightly elevated due to the interference from uranium-235 (U-235) which contributes slightly to a peak in the same area as the Ra-226 peak. Given that these samples are being used to make public health decisions, the decision was made to err on the side of reporting potentially higher activity concentrations for Ra-226 rather than potentially lower activity concentrations.


Stephanie C Buck

04/08/16

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 "R" Not useable for intended purpose

Friday, April 8, 2016

Exhibit B

Date: 11/15/2017
To: Jay Warzinski, Joseph Santangelo – Advanced Disposal Services
CC: 
From: Kari Wallover – Cornerstone Environmental Group
Subject: Blue Ridge Groundwater Users Survey
Project No.: 170068

Cornerstone Environmental Group, LLC, on behalf of Advanced Disposal Services, conducted a groundwater users inventory study to verify the validity of the 1992 water well and spring survey results, and to identify any new wells and residents located downgradient of the Blue Ridge landfill. A map created with information obtained from the Estill County Property Valuation Authority (PVA) has been attached identifying the area of focus for the groundwater users inventory. To ensure that all residents and wells were thoroughly identified, the survey was conducted within a one mile radius of the permitted waste area in the downgradient (northwest) direction (see attached map).

A team of Cornerstone personnel canvassed the above mentioned area in attempt to obtain the following information from residents/properties:

- Resident Name
 - Resident Address
 - Resident Telephone Number
 - Type of Groundwater Source (Dug Well, Drilled Well, Cistern, Spring, City Water)
 - Surface Water Use and Purpose of Use
 - Well Information: Date Drilled, Total Depth of Well, Depth to Top of Water, Casing Depth, Top of Well Elevation, if pump is located within well, if well is sealed, Elevation of Spring, and Type of Rock
 - Size of Household
-

- Water Use
- Approximate Yield
- Quality Problems: Such as iron, sulfur, manganese, or muddy
- Quantity Problems
- Well treatment
- Permission to Sample Well
- Any additional, applicable comments from resident

In efforts to obtain as much information as possible, Cornerstone Environmental Group made multiple efforts to obtain the above information both in person and remotely (telephone, mail). If a resident was not at their residence during the field canvassing, a letter was left at the residence outlining Cornerstone's contact information and a summary of above information needed from the resident.

According to the supplied Estill County Property Valuation Administrator, eighty-three (83) parcels in total exist within the downgradient area of interest. Each of these parcels were visited during the groundwater user inventory by Cornerstone personnel. All residents were attempted to be contacted in person at their dwelling. As stated above, if a resident was not in their dwelling at the time of the survey, the above outlined letter was left on their property. Any letters sent back to Cornerstone have their information recorded in the groundwater user inventory database. All addresses without a dwelling were deemed parcels only, and no letter was left at the address. However, owners of those parcels within the downgradient area were attempted to be contacted and entered into the groundwater user inventory database. All information gathered during the survey can be found in the included inventory spreadsheet. No new wells were found during the groundwater user inventory survey.

The wells of primary attention in closest proximity to the downgradient direction of the landfill are wells 36, 37, and 64 (located at property locations 32 and 33). Owners at PVA property locations 32 and 33 were contacted in person. As seen on the included survey map and 1992 well source map, well locations 36, 37, and 64 were presumed to exist on or near these properties. The owner of PVA lot 32 stated there was no well on his property. The owner of PVA lot 33 stated that there had been a well on his property but several years ago he had filled the well with rock to prevent anyone from falling down into the well. He/his family have owned the property for a number of years. Given the owner's

description it is Cornerstone's opinion that well 64 is that same well, just located in a different place due to a different person locating it. No other wells were located in the vicinity, thus well 64 was the only well located of the three wells of primary attention.

All confirmations of well locations can be found on the supplemental spreadsheet included with this narrative.

ID	PARCEL	COMMENT	Parcel ID	Name	Address1	Address2	Note from Survey	City	Zip	Location	Description	Area
2	5.03		054-00-00-005.03	RADER DOROTHY	C/O B. JODI BREADEN	1418 CAYTON RD		FLORENCE	KV 41042	WINCHESTER RD 0	WINCHESTER TRACT 1-B 12ACRE	239.781
3			054-00-00-002.00	MORRIS JAMES S & MARGARET	3570 WINCHESTER RD		City Water	IRVINE	KV 40336	WINCHESTER RD 3570	3570 WINCHESTER RD LOT 8 91 MO HO	153.293
4	3.01		054-00-00-003.01	MORRIS JAMES S & MARGARET	3570 WINCHESTER RD			IRVINE	KV 40336	WINCHESTER RD 3570	WINCHESTER RD 2 LOTS 8 & 199 DW MO 28X70	264.445
5	5.01		054-00-00-005.01	TOLER WARREN F & ELIZABETH		89 CEDAR GROVE RD		IRVINE	KV 40336	WINCHESTER RD 3628	3628 WINCHESTER RD TR1 A-C 6.39 A & HOUSE	232.23
6	4		054-00-00-004.00	MARGISON HENRY D	19 PINEVIEW CT			SANDGAP	KV 40481	WINCHESTER RD 3640	3640 WINCHESTER RD LOT	301.228
7	5.02		054-00-00-005.02	KELLEY GR JR & MELISSA	3644 WINCHESTER RD			IRVINE	KV 40336	WINCHESTER RD 3644	3644 WINCHESTER RD 15.52 ACRES & HOUSE	311.082
8	4.01		054-00-00-004.01	MARGISON HENRY	19 PINEVIEW CT		Structure Burnt Down	SANDGAP	KV 40481	WINCHESTER RD 3640	KY 89 AT CALLOWAYS CREEK & GARAGE	260-225
9	2.01		054-00-00-003.00	TIPTON STEVEN WARREN	550 DRY BRANCH SPUR			IRVINE	KV 40336	WINCHESTER RD 3640	DRY BRANCH 36 ACRES & HOUSE	262.569
10	9		054-00-00-009.00	WEST JEFFREY & HARRIS JENNIFER	125 AZALEA CT	3648 WINCHESTER RD		IRVINE	KV 40336	WINCHESTER RD 4270	4270 WINCHESTER RD 24.79A & HOUSE & GAR	301.501
11	7.01		054-00-00-007.01	MULBRIN JEFFREY	2301 DRY BRANCH RD	3648 WINCHESTER RD		IRVINE	KV 40336	WINCHESTER RD 0	CALLOWAYS CREEK 15 ACRES	229.636
12	5.0		054-00-00-050.00	ANDREWS CHARLES	2301 DRY BRANCH RD		Charles Andrews; City Water	IRVINE	KV 40336	DRY BRANCH RD 0	DRY BRANCH RD ACRAGE	287.706
13	5.01		054-00-00-051.00	ANDREWS CHARLES	2301 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 2301	2301 DRY BRANCH RD LOT & HOUSE	242.321
14	5.2		054-00-00-052.00	ANDREWS CHARLES	2301 DRY BRANCH RD		Charles Andrews; City Water	IRVINE	KV 40336	DRY BRANCH RD 0	DRY BRANCH RD 1/2 ACRE LOT	244.31
15	4.7		054-00-00-047.00	ELKINS CLIFFORD D & CAROL J	2405 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 2405	2405 DRY BRANCH RD 5 TRACTS & HOUSE	215-430
16	6		054-00-00-006.00	TUTTLE KENNY S	1254 DRY RIDGE RD			IRVINE	KV 40336	WINCHESTER RD 3955	3955 WINCHESTER RD 34 AC & HOUSE & BARN	235-179
19	8		054-00-00-008.00	REED CHARLES & BONNIE L	11 DRY RIDGE RD			IRVINE	KV 40336	DRY RIDGE RD 11	11 DRY RIDGE RD 35.94 A & HOUSE & BARN	272.551
22	22		055-00-00-022.00	MUNCY MICHAEL G & BRIDGETTE	121 OAK VALLEY			IRVINE	KV 40336	WITT RIDGE RD 1355	1355 WITT RIDGE RD 1 ACRE & HOUSE	213.43
23	23		055-00-00-023.00	PITTS MARGARET	P O BOX 603			IRVINE	KV 40336	CALLOWAYS CREEK 0	CALLOWAYS CREEK 3 ACRES	232.448
24	18		055-00-00-020.00	RICHARDSON LARRY G & FAYE R	3645 WINCHESTER RD		Glenn Richardson; City Water; No Surface Water	IRVINE	KV 40336	WINCHESTER RD 3645	3645 WINCHESTER RD 39 ACRES & HOUSE & GA	173.973
25	20.01		055-00-00-020.01	RICHARDSON LARRY GLENN & ZELLA FAYE	3645 WINCHESTER RD			IRVINE	KV 40336	WINCHESTER RD 3505	3505 WINCHESTER RD 20 ACRES & 92 MOHO	139.363
26	19.01		055-00-00-019.01	BARNES ASA BOONE	726 WISEMAN CROSSING			IRVINE	KV 40336	WINCHESTER RD 0	WINCHESTER RD 1/2 A	217.689
27	15		055-00-00-055.00	STAMPER ALGIN	111 OAK ST			IRVINE	KV 40336	CALLOWAYS CREEK 0	CALLOWAYS CREEK 24 TO ACRES	158.956
28	18		055-00-00-018.00	STAMPER ALGIN	111 OAK ST			IRVINE	KV 40336	HWY 89 WINCHESTER RD 0	WINCHESTER RD 25 ACRES	158.273
32	19		055-00-00-019.00	BARNES NDRMA	C/O BOONE BARNES	726 WISEMAN CROSSING	Larry Nilaks, City Water. Stated no well on property	IRVINE	KV 40336	WINCHESTER RD 3292	3292 WINCHESTER RD 4 ACRES & BLDG	162.180
33	16		055-00-00-016.00	HINDS ARLINE R	HINDS MARK A & WALLACE G	3170 WINCHESTER RD	Mark Himes; Dog Well; City Water; Well filled w/ rocks no longer used	IRVINE	KV 40336	WINCHESTER RD 3170	3170 WINCHESTER RD 11.6 ACRES & 09 MOHO	279.289
34	7		054-00-00-007.00	MULBRIN JEFFREY J	3648 WINCHESTER RD		Use Kiboria; Phone# 726-0210; Caterer; Household size 4. Talk to owner for permission to sample	IRVINE	KV 40336	WINCHESTER RD 3648	CALLOWAYS CK 38 ACRES & HOUSE	308.299
38	21		068-00-00-021.00	ROSE CORNELL	2236 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 2236	2236 DRY BRANCH RD 2 ACRES & HOUSE	259.25
40	20.01		068-00-00-020.01	HENRY GREGORY	2180 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 2180	2180 DRY BRANCH 1 ACRE & HOUSE	222.704
41	20		068-00-00-020.00	HENRY GREGORY	2180 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD LOT 600X295X600X900	DRY BRANCH RD LOT 600X295X600X900	154.618
43	32		068-00-00-032.00	COLE KENNY	2730 JACKS CREEK PIKE			LEXINGTON	KV 40515	DRY BRANCH RD 1451	1451 DRY BRANCH RD 31 ACRES & HOUSE & BA	294.417
44	10		068-00-00-010.00	SONS STEVEN & GLORIA	3560 NEW FOX RD			IRVINE	KV 40336	DRY BRANCH RD 0	DRY BRANCH RD 12.5 ACRES	206.435
45	9		068-00-00-009.00	TYLSTER CHARLENE	150 WALLING ROAD		Cherlene Tester; City Water	IRVINE	KV 40336	WALLING RD 150	150 WALLING RD 2.68 ACRES & HOUSE	232.259
46	10		068-00-00-010.00	SONS LARRY & DONNA	150 WALLING RD			IRVINE	KV 40336	WALLING RD 150	150 WALLING RD LOT 2 ACRES & 8.92 MH 12x60	233.311
47	3.01		068-00-00-003.01	SONS LARRY & DONNA	150 WALLING RD			IRVINE	KV 40336	WALLING RD 150	150 WALLING RD 5 ACRES & 86 MH W/ADD & B	207.432
48	3.01		068-00-00-003.01	SONS LARRY & DONNA	150 WALLING RD		City Water	IRVINE	KV 40336	WALLING RD 150	150 WALLING RD 5 ACRES & 86 MH W/ADD & B	207.432
49	14.01		068-00-00-014.01	LONG GARY & LISA K	1813 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 1813	1813 DRY BRANCH RD TRACT 1 HOUSE	231.724
50	18		068-00-00-018.00	HENRY TIM	230 TIMBERLINE TRAIL			IRVINE	KV 40336	DRY BRANCH RD 2145	2145 DRY BRANCH RD 1 ACRE & HOUSE & MH	247.418
51	22		068-00-00-022.00	HENRY JEFFREY FLOYD		2255 DRY BRANCH RD		IRVINE	KV 40336	DRY BRANCH RD 2241	2241 DRY BRANCH RD 2 TRACTS & HOUSE	286.15
53	17	FRANCHISED LANDFILL	069-00-00-017.00									
54	79	FRANCHISED LANDFILL	069-00-00-079.00									
55	7	FRANCHISED LANDFILL	069-00-00-007.00									
56	9	FRANCHISED LANDFILL	069-00-00-009.00									
56	16.06		068-00-00-016.06	POWELL TERESA	C/O POWELL TERESA & MARSHALL	2051 DRY BRANCH ROAD		IRVINE	KV 40336	DRY BRANCH RD 2051	DRY BRANCH 2 TRACTS & 07 DRW MH 48X28	248.621
60	34		054-00-00-054.00	HORN JEWELL & ALVIRTA F	P O BOX 813			IRVINE	KV 40336	WALLING RD 450	WALLING RD 14 ACRES & MOBILE HO & BLDGS	151.291
61	10.01		068-00-00-010.01	SONS BARRY W & DONALDA	145 WALLING RD			IRVINE	KV 40336	WALLING RD 145	145 WALLING RD 12.5 ACRES & 87 MH 28X60	301.321
62	7		068-00-00-002.00	CASE PAMELA	49 WALLING RD			IRVINE	KV 40336	WALLING RD 49	WALLING RD 10 ACRES	229.794
64	10.03		054-00-00-010.03	WATSON HAROLD E	C/O HARRISON JOHN K	4150 WINCHESTER RD		IRVINE	KV 40336	WINCHESTER TRACT 0	WINCHESTER TRACT	278.482
67	13.01		054-00-00-013.01	TIPTON STEVEN W	550 DRY BRANCH SPUR			IRVINE	KV 40336	WINCHESTER RD 0	WINCHESTER TRACT 146X500X362	313.597
68	13.01		054-00-00-013.01	TIPTON STEVEN W	550 DRY BRANCH SPUR			IRVINE	KV 40336	WINCHESTER RD 0	WINCHESTER TRACT 146X500X362	313.597
69	8.01		068-00-00-008.00	SONS LARRY & DONNA	150 WALLING RD		City Water	IRVINE	KV 40336	WALLING RD 0	WALLING RD LOT 2 ACRES & 8.92 MH 12x60	233.311
70	13		068-00-00-013.00	WALLING RAY & SHARON JOYCE	& MARY & RICKY WALLING	250 WALLING ROAD	Ray and Sharon Walling, Dog Well; Well in Use; Phone#723-8076	IRVINE	KV 40336	WALLING RD 250	250 WALLING RD 1.5 ACRES & HOUSE	278.522
73	8.01		068-00-00-008.01	MORRIS RUSSELL JR	855 WALLING RD		Russel Morris; Neighbor stated well was on this property but filled in years ago	IRVINE	KV 40336	WALLING RD 355	855 WALLING RD 4.72 ACRES & 10 MH 28X48	278.522
76	13		054-00-00-013.00	GOULD JEFFREY & ROBIN	2927 DRY BRANCH ROAD			IRVINE	KV 40336	WINCHESTER RD 0	WINCHESTER RD 145 ACRES	247.216
77	10.04		054-00-00-010.04	BRAND PATRICK & WHITNEY	4152 WINCHESTER RD			IRVINE	KV 40336	WINCHESTER RD 4152	WINCHESTER RD 5.03A & 09 DRW CLAY 28X52	304.478
80	13.03		055-00-00-013.03	WAITE E PHILLIP III & SUZANNE	507 CANTRILL ST			IRVINE	KV 40336	WITT RIDGE RD 1558	WITT RIDGE RD TRACTS 38 & 3C& GARAGE	273.437
81	13.03		055-00-00-013.03	WAITE E PHILLIP III & SUZANNE	507 CANTRILL ST			IRVINE	KV 40336	WITT RIDGE RD 1558	WITT RIDGE RD TRACTS 38 & 3C& GARAGE	273.437
83	21		055-00-00-021.00	JONES HARRY C & ANITA	P O BOX 62			IRVINE	KV 40336	WITT RIDGE RD 0	WITT RIDGE RD 67 ACRES & HOUSE	399.572
86	16.05		068-00-00-016.05	LONG JAMES & PATRICIA	1809 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 0	DRY BRANCH 3 ACRES	351.151
87	16.04		068-00-00-016.04	HOWELL WILLIAM R & LISA G	101 JUDY LANE			IRVINE	KV 40336	DRY BRANCH RD 1811	1811 DRY BRANCH RD 1 ACRE & 2000 DRW MOHO	234.615
88	16		068-00-00-016.00	PUCKETT DIANNA	2051 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 2051	2051 DRY BRANCH 1 87 ACRES & HOUSE	250.656
89	6.01		068-00-00-006.01	STONE DEBRA S & LARRY W	1105 TWIN CREEK RD			IRVINE	KV 40336	WALLING RD 0	WALLING RD 3 TRACTS	270.412
90	6		068-00-00-006.00	PEPPER GARY LEE	143 WALLING RD			IRVINE	KV 40336	WALLING RD 143	143 WALLING RD 20.29 ACRES & 97 MH 50X26	270.410
93	10.01		054-00-00-010.01	BARDOFF JEFF & JENNIFER	C/O HARRISON JOHN K	4150 WINCHESTER RD		IRVINE	KV 40336	WINCHESTER RD 4150	4150 WINCHESTER RD 3 ACRES & HOUSE	278.446
94	8.0		054-00-00-080.00	ANDREWS CHARLES	2301 DRY BRANCH RD		Charles Andrews; City Water	IRVINE	KV 40336	DRY BRANCH RD 0	DRY BRANCH RD 4 ACRES	287.488
95	15.07		068-00-00-015.07	HENRY JEFFREY F	2255 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 0	DRY BRANCH 32.5 ACRES	275.526
96	26		055-00-00-026.00	TUTTLE N J -HEIRS	% JOHN PAUL TUTTLE	P O BOX 118		IRVINE	KV 40336	CALLOWAYS CREEK	CALLOWAYS CREEK 5 ACRES	628.421
101	17.02		068-00-00-017.02	HIX PAUL DAVID & DEBORAH KAY	% WALLING DEBORAH HIX	475 CAMPBELLS BRANCH RD		RAVENNA	KV 40472	DRY BRANCH RD 0	DRY BRANCH RD LOT 410 X 125	154.459
102	17.01		068-00-00-017.01	BIRCHFIELD STEPHEN F	81 MIK LANE			IRVINE	KV 40336	HIX LANE 91	81 MIK LANE 2 ACRES	109.812
106	6.02		054-00-00-006.02	STONE LARRY & DEBRA	1105 TWIN CREEK		Steven Birchfield; City Water; Phone# 606-641-9932	IRVINE	KV 40336	WALLING RD	WALLING RD 1.5 ACRES	301.001
107	6.01		068-00-00-006.01	STONE DEBRA S & LARRY W	1105 TWIN CREEK RD			IRVINE	KV 40336	WALLING RD 0	WALLING RD 3 TRACTS	270.412
108	6.01		068-00-00-006.01	STONE DEBRA S & LARRY W	1105 TWIN CREEK RD			IRVINE	KV 40336	WALLING RD 0	WALLING RD 3 TRACTS	270.412
109	10.03		055-00-00-010.03	RICHARDSON LARRY GLENN & ZELLA FAYE	3645 WINCHESTER RD			IRVINE	KV 40336	WINCHESTER RD 0	WINCHESTER RD 10 ACRES	174.878
110	20.01		055-00-00-020.01	RICHARDSON LARRY GLENN & ZELLA FAYE	3645 WINCHESTER RD			IRVINE	KV 40336	WINCHESTER RD 0	WINCHESTER RD 10 ACRES	173.475
111	16		068-00-00-016.00	PUCKETT DIANNA	2051 DRY BRANCH RD			IRVINE	KV 40336	DRY BRANCH RD 2051	2051 DRY BRANCH 1 87 ACRES & HOUSE	250.656
112	19		068-00-00-019.00	WHITNEY RUSSELL	C/O ADRIANE RUSSELL	3122 DALE HOLLOW RD		LEXINGTON	KV 40515	WINCHESTER RD 0	WINCHESTER RD 10 ACRES	227.504
113	17.03		068-00-00-017.03	WALLING DEBORAH HIX	475 CAMPBELLS BRANCH RD			RAVENNA	KV 40472	DRY BRANCH		

SURROUNDING WELL INFORMATION

Well ID	Survey Information
4	Owner not available, letter left at location. Well location unconfirmed
5	Owner not available, letter left at location. Well location unconfirmed
6	Owner not available, letter left at location. Well location unconfirmed
36	Not found, told by owner this well no longer existed.
37	Not found, told by owner this well no longer existed.
38	Owner not available, letter left at location. Nearby resident stated no well present. Well location unconfirmed.
39	Owner not available, letter left at location. Well location unconfirmed
42	Owner not available, letter left at location. Well location unconfirmed
18	Owner not available, letter left at location. Well location unconfirmed
48	PVA property owner #73 had active hand-dug well on property. It is Cornerstone's assumption this is Well #48.
41	Owner not available, letter left at location. Well location unconfirmed
27	Owner not available, letter left at location. Well location unconfirmed
51	Owner not available, letter left at location. Well location unconfirmed
25	Owner not available, letter left at location. Well location unconfirmed
50	Nearby owner indicated resident used city water, and no nearby well on property.
64	Property owner stated this well has been filled in by rock.

Notes:

- No new wells found during groundwater user inventory survey.
- Property Owner of Parcel #72 stated a well existed on the Parcel #72 at one time, but was filled in years ago.
- Property Owner of Parcel #34 stated the resident has a cistern on their property. Contact information was recorded.

Attachment L

**Kentucky Energy and Environment Cabinet
October 2017 Comments on the
Revised Corrective Action Plan**



MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

AARON B. KEATLEY
COMMISSIONER

300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601

October 13, 2017

CERTIFIED MAIL No. 7015 3430 0000 4915 4510
Return Receipt Requested

Mr. Philip Comella, Esq.
Freeborn & Peters, LLP
311 S. Wacker Dr. Ste. 3000
Chicago, IL 60606

Re: AI Name: Advanced Disposal Services Blue
Ridge Landfill Inc.
AI No. 998
Case No. DWM-160048
Activity No. ERF20160001
Estill County

Dear Mr. Comella:

As part of the Agreed Order executed on January 3, 2017, the Cabinet received a Corrective Action Plan (CAP) on May 4, 2017. The Cabinet reviewed the CAP and commented on it in a letter dated July 21, 2017. Blue Ridge submitted a revised CAP on August 28, 2017. The Cabinet has reviewed the revised CAP and is subsequently providing these attached comments on the revised CAP. As required by the Agreed Order, please provide a revised CAP addressing the comments pursuant to paragraph 20 within thirty (30) days of receipt of the comments.

We appreciate your cooperation in this matter. Should you have questions regarding the comments you may contact me at (502) 782-6848 or Tim Hubbard, Environmental Scientist Consultant Senior in the Division of Waste Management's Director's office at (502) 782-6660.

Sincerely,

E-Signed by Cummins, Jeff
VERIFY authenticity with e-Sign 



Jeffery A. Cummins, Director
Division of Enforcement

Enclosure

Cabinet Comments
Revised Corrective Action Plan (CAP)
Blue Ridge Landfill, Estill County, Kentucky
October 5, 2017

The Response to Cabinet Comments dated July 21, 2017 and the CAP for the Blue Ridge Landfill, Estill County, Kentucky, prepared for Advanced Disposal Services (ADS) Blue Ridge Landfill, Inc. by Gradient Corporation, dated August 28, 2017 have been reviewed. The CAP was revised to address previous comments provided by the cabinet. Throughout the following comments below, this document will be referred to as the CAP.

1. There is no final compliance date specified in the CAP as required by paragraph 19 (e) of the agreed order. The final compliance date is the date Blue Ridge anticipates completing all remedial actions listed in the CAP. Please provide a final compliance date in accordance with the agreed order.
2. In response to cabinet comment 3 requesting monitoring for radionuclides for groundwater, surface water, and leachate, ADS proposes to work with the cabinet to develop a Radionuclide Sampling Plan. The groundwater sampling plan proposed in the August 28, 2017 submission that includes monitoring for groundwater (quarterly at all groundwater monitoring well locations presumably for a year then monitoring of two downgradient wells-MW-13 and MW-15R on a semi-annual basis) for radionuclides is acceptable. The broader Sampling Plan must also include sampling of leachate and the two underdrains at the landfill for radionuclides on at least a semi-annual basis as these locations would provide more timely data points to determine if there are any resultant impacts from the BES waste. See comment 3 below. The cabinet recognizes the importance of determining background radioactivity levels in groundwater for the site, given the fact that the New Albany Shale has been demonstrated through screening to have naturally occurring radioactivity levels of Ra-226 and Ra-228. Further, it is important to establish the background activity levels and the ranges of activity in groundwater in order to use the data to determine potential future impacts from the BES waste. However, please note that in order to determine truly representative background levels in groundwater, a comparison must be made of the monitoring results from upgradient wells related to downgradient wells. Also, any changes to the groundwater monitoring requirements will need to be incorporated as amendments to the solid waste landfill permit.
3. **Section 4.2.1 Remediation Alternative 1: Closure-in-Place and Monitoring.** In Section 2.1 Blue Ridge Landfill Overview, it is stated that the landfill operations are expected to continue until 2034 (unless an expansion is approved under the solid waste permit). In order to reduce

potential exposure to workers and others to the BES waste during the active disposal life of the landfill, it is important to comply with the primary radiation safety principle “As Low as Reasonably Achievable” (ALARA), which in essence means to make every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical. In order to ensure this level of protectiveness related to the BES waste, the cabinet requires an Interim Remedial Measures Plan (IRMP) be developed and implemented. The IRMP should include at a minimum: 1) a proposal for placing an additional low-permeable layer (clay, geosynthetic or a combination thereof) over the BES wastes (including a minimum 30-yard buffer around the waste area) as an interim measure to prevent surface water infiltration; 2) procedures for ensuring the BES waste remains covered and undisturbed until closure; 3) a plan for routine monitoring of leachate and the underdrains for radionuclides; 4) prohibiting recirculation of leachate at the landfill, and 5) procedures for notification of the City of Irvine Waste Water Treatment Plant if levels of radioactivity are found in leachate exceeding an action level and a plan for its proper handling and disposal. A radiation worker training and safety program must also be developed and implemented to meet the requirements of pending regulations by CHFS and 902 KAR 100:019.

4. **Section 4.2.1 Remediation Alternative 1: Closure-in-Place and Monitoring.** In this section and in other portions of the CAP, an “enhanced cap” is proposed to be placed over the BES waste as part of the final cover system when the landfill closes. The purpose of the enhanced cap, consisting of a low-permeability geo-synthetic clay liner (GCL) will be to further reduce long-term infiltration of surface water into the BES wastes. The cabinet agrees with the proposal to design and place the enhanced cap as outlined above in accordance with the updated pending regulatory requirements in 401 KAR 48:090 and 902 KAR 100:180, Section 6(2) (a). ADS must ensure that the construction methods and specifications for the additional low-permeability liner are consistent with the pending regulations. Financial assurance for the enhanced cap and additional monitoring must be provided pursuant to the closure care requirements in 401 KAR 48:310.
5. In response to cabinet comment 8 which related to the likelihood of radon in the landfill gas that is extracted and used to generate electricity on-site, and the potential for contamination in condensate that is collected from cooling of landfill gas, ADS proposes to relocate the existing landfill gas extraction wells in the BES waste area to other areas of the landfill and prohibit drilling extraction wells in the BES waste area. The proposed modifications will require amending the solid waste permit, and would reduce potential exposure to workers in future drilling of gas extraction wells in the area. However, moving the existing landfill gas extraction wells from the BES Waste area will not reduce the landfill gas generation from that area, and does not address potentially radon-contaminated methane gas, which could be released into the atmosphere. As an option, the extraction wells could remain in the BES Waste area, and the methane gas monitored for radon contamination. In addition, the leachate, including the condensate from the cooled landfill gas, should be monitored for radionuclides (see comment 3).

6. **Section 6.6 Implementability.** Other issues related to the logistics of implementation of Remedial Alternative 2 (Excavate and Redispose BES waste) which should be considered include whether there may be temporary disruptions of routine waste disposal of MSW from Estill, Madison and other surrounding counties during the removal operation, and the likelihood of additional heavy truck traffic at BRL and in the vicinity of BRL from trucks hauling BES waste out while trucks are hauling MSW to the landfill. Please provide an assessment of these potential impacts.

7. **Section 6.7 Cost. Table 6.6. Attachment E**

A. For Remedial Alternative 1 (Closure-in-Place and Monitoring), the estimate must include:

1. Development and implementation of the Interim Remedial Measures Plan (IRMP) referenced in Comment 3 including:
 - a. Design and construction costs for the IRMP liner.
 - b. Cost of routine monitoring for radionuclides in groundwater, leachate and underdrains and contingency disposal costs in the event leachate is contaminated with radionuclides and would need to be disposed at an alternate facility other than the WWTP.
2. Financial Assurance Costs for the enhanced cap and long-term monitoring.

B. For Remedial Alternative 2 (Excavate and Redispose BES Waste), the cost estimate for remedy implementation must include:

1. Additional project management costs if work is required to be conducted under radiation health and safety protocols with oversight by a certified health physicist. At a minimum, excavations of BES waste with material at these levels entails potential worker exposure and contamination that requires protective measures including: radiation hazard safety training for workers, protective clothing, personnel monitoring devices if radiation levels are such that a worker may exceed 100 mrems per year, monitoring of workers and equipment to assure absence of surface contamination, and initial air monitoring for particulate and radon levels to determine need for ongoing air monitoring during excavation work.
2. Stormwater controls to prevent contaminant migration during removal.
3. Air monitoring and potential mitigation measures (use of enzymes, deodorizers, etc) to address nuisance odors and other potentially harmful gases, including hydrogen sulfide and methane, during the excavation.

8. **Section 6.7 Cost. Table 6.6. Attachment E.** A 7.0% annual discount rate was used to calculate the net present value of future costs based on a USEPA and USACE reference from 2000. The rate may not be realistic at the current time. It may be more appropriate to use a more recent

discount rate utilized by the U.S. Office of Management and Budget (OMB) of 1.7 to 2.7% in order to ensure the project costs are not underfunded.

- 9. Section 6.7 Cost. Attachment E.** Under Remediation Alternative 1: Closure-in-Place and Monitoring, the future monitoring costs are projected for a timeframe of 30 years, typical for post-closure monitoring of solid waste landfills. However, due to the presence of the BES waste, which includes radionuclides with very long half-lives, monitoring costs should be estimated for a minimum of 100 years, consistent with the maximum period controls can be relied upon per 902 KAR 100:022 Section 27.

- 10. Section 6.7 Cost. Attachment E.** Section 4.0 includes estimated disposal cost (quoted from a third party provided by ADS) in a commercial hazardous waste landfill at \$1,585,200 for 39,630 cubic yards. Is this the Mostoller Landfill in Pennsylvania? Also, Section 4.1 has the cost itemized as “Landfill Non-hazardous Solid Bulk Waste”. Please clarify the description in the chart.

Attachment M

**Advanced Disposal Service, Inc. August 2017 Response to
Kentucky Energy and Environment Cabinet Comments on the
Corrective Action Plan**

August 28, 2017

Mr. Jeffrey A. Cummins
Director, Division of Enforcement
Kentucky Energy and Environment Cabinet
Department for Environmental Protection

Re: Response to Blue Ridge Landfill Corrective Action Plan – Cabinet Comments dated July 21, 2017

Dear Mr. Cummins:

On behalf of Advanced Disposal Services Blue Ridge Landfill, Inc. and in accordance with the Agreed Order Case No. DWM – 160048, Gradient, in collaboration with Risk Assessment Corporation (RAC), is submitting this response to the Cabinet's July 21, 2017, comments on the Blue Ridge Landfill Corrective Action Plan (CAP) dated May 3, 2017. The CAP and its attachments have been revised accordingly and are submitted herein.

Energy and Environment Cabinet (EEC) Comment #1:

In the Executive Summary of the Corrective Action Plan (CAP), it is stated that "...Kentucky allows TENORM with "radiation levels" up to 2,000 pCi/g, generated within the State, to be disposed of in solid waste landfills, and therefore has implicitly determined that solid waste landfills can safely contain TENORM below this radioactivity level." Further **Sec. 2.5.1 State of Kentucky Landfill Requirements**, states "Since Kentucky allows TENORM up to 2,000 pCi/g generated within the state to be disposed of in solid waste landfills, the State has already determined that these landfills can safely contain whatever risk these materials may pose". These are misstatements of the Commonwealth's requirements for TENORM provided under the Central Midwest Interstate Low-Level Radioactive Waste Commission, which states that "TENORM with concentrations greater than 2,000 pCi/g shall be disposed of at the regional low-level radioactive waste disposal facility and TENORM waste with concentrations less than 2,000 pCi/g shall be disposed of in accordance with the method approved by the appropriate state regulatory agency." The Commonwealth has not concluded that municipal solid waste landfills can safely contain TENORM below 2,000 pCi/g. As page 14 of the CAP notes, regulations for TENORM waste are currently pending by the Cabinet for Health and Family Services (CHFS) and the Energy and Environment Cabinet (EEC). The regulations will include specific requirements for the operation and closure for contained landfills and other disposal facilities which accept TENORM waste in order to be protective of public health and the environment.

Response #1:

The Executive Summary of the CAP has been revised accordingly. Conforming changes have also been made to Section 2.5.1 (State of Kentucky Landfill Requirements) of the CAP.

EEC Comment #2:

The Executive Summary of the CAP states that "sampling investigations indicate that radionuclide concentrations in areas of the landfill containing the BES Waste are below those of samples from naturally occurring radioactive material (NORM) inside and outside of the permitted solid waste boundary." This does not seem to be possible, considering the average radium concentrations in the wastes as described in the RAC reports. Please clarify this statement.

Response #2:

To clarify, the BES Waste was mixed with municipal solid waste (MSW) when it was disposed of at the Blue Ridge Landfill; therefore, radionuclide concentrations of the *in situ* BES Waste mixed with MSW were compared to background levels. The Executive Summary of the CAP has been revised accordingly.

EEC Comment #3:

In accordance with the landfill operating permit, groundwater, storm water, surface water, and leachate are routinely monitored for a "suite of constituents" (Table 2.4 and Remediation Alternative 1, page 25 of the Plan). The constituents currently monitored in these media do not include radionuclides. Due to the presence of TENORM wastes, the groundwater monitoring plan and surface water monitoring plan required pursuant to 401 KAR 48:300 and 48:090 for the solid waste contained landfill permit must be amended to include radionuclides (particularly radium-226, radium-228, gross alpha, and gross beta) as parameters for monitoring groundwater and surface water in addition to other parameters that are currently analyzed. For storm water and surface water discharges from the facility, the KPDES permit will also need to be amended to add these parameters. Leachate analysis should also include radionuclide parameters and appropriate heavy metals prior to discharge to the wastewater treatment plant (WWTP). The WWTP must be capable of treating and testing for the relevant parameters.

Response #3:

Advanced Disposal Services (ADS) will work with the Cabinet to develop a Radionuclide Sampling Plan. Given the elevated background NORM in the region, establishing statistically significant background concentrations will be an important component of the monitoring plan. The Radionuclide Sampling Plan will also factor in the regulations for TENORM waste that are currently being prepared by CHFS and the EEC, to the extent that they apply. The Radionuclide Sampling Plan will be submitted under separate cover for Cabinet review and approval.

In the interim, ADS will perform quarterly groundwater sampling at all monitoring well locations (see Figure 2.3 of the CAP) for radium-226 [Ra-226], radium-228 [Ra-228], gross alpha, and gross beta in order to establish Site-specific background concentrations of naturally occurring radionuclides (which are known to be present regionally). Subsequently, ADS will sample monitoring wells downgradient (MW-13, MW-15R) of the BES Waste on a semi-annual basis to determine if radionuclides have impacted groundwater. The semi-annual sampling will include analyses for the aforementioned radionuclides.

EEC Comment #4:

Remediation Alternative 2, as described in the Executive Summary, is to "excavate and transport the BES Waste from the BRL to another disposal facility, where it would be redispersed, subject to similar environmental controls." The re-disposal site considered in the evaluation is the Mostoller Landfill, in Somerset, PA - a facility approved by the state of Pennsylvania to receive TENORM wastes. Are the environmental controls for the two landfills "similar" or are there more stringent design and operating requirements at the Mostoller landfill, based on its approval to receive TENORM waste?

Response #4:

The engineering design and environmental controls for the Blue Ridge Landfill and the Mostoller Landfill are similar. Based on our evaluation, Pennsylvania imposes no additional controls from a design or operational standpoint upon a landfill that accepts TENORM as opposed to one that does not, except to limit, on a monthly basis, the total amount of TENORM accepted.

Attached to this letter is a figure providing a comparison between base liners and final cross sections of the Blue Ridge and Mostoller Landfills. Based on this comparison, we believe the environmental controls are essentially the same, except with regard to the final cover design, because we believe the Blue Ridge Landfill liner offers more environmental protection.

All permitted Pennsylvania solid waste landfills, whether they accept TENORM or not, must contain a double composite liner system. Even though the Blue Ridge Landfill contains a single composite liner, the high-density polyethylene liners are both 60 mil thick, and the Blue Ridge Landfill liner is underlain by 3 ft of low-permeability soil along its floor. Importantly, however, the Blue Ridge Landfill bottom grades are constructed with a 10% slope, as compared to a 4% slope at the Mostoller Landfill. Therefore, leachate at the bottom of the Blue Ridge Landfill flows quicker to the leachate collection sump, where it is lifted out of the landfill to the publically owned treatment works (POTW).

Also, the Blue Ridge Landfill's permitted final cover is more protective than the Mostoller Landfill's final cover. The Mostoller Landfill's final cover has a geomembrane that is 30 mil thick *versus* 40 mil thick for the Blue Ridge Landfill's final cover. Also, the Blue Ridge Landfill's vegetative cover is 12 in thicker.

Pennsylvania imposes no additional radioactive testing (*i.e.*, Ra-226, Ra-228, gross alpha, gross beta) for groundwater, stormwater, or leachate for ADS Pennsylvania landfills that accept TENORM wastes. Nor is the Mostoller Landfill subject to different closure requirements or a longer post-closure period.

EEC Comment #5:

The BRL and immediate surrounding area are described in Section 2 of the CAP. Some information that would be important to consider in the risk assessment which is not included in the Risk Assessment Corporation (RAC) documents is the estimated population, land use and groundwater usage in the vicinity of the landfill currently and projected into the future. Also, please provide information on the potentially 'exposed populations and estimated or modelled effects of radiation doses, if any, on these groups.

Response #5:

Information about the population and land and groundwater use in the area surrounding the Blue Ridge Landfill has been added to the risk assessment (Attachment A2 of the CAP) to provide context to the dose estimates presented in the report. In addition, further groundwater use information will be provided in the well survey update (see Response #10). The exposure scenarios and parameters used in the radiological risk assessment were selected to provide bounding estimates of the potential radiation doses to members of the public or workers. To address releases to the atmosphere, potential public receptors located closest to the disposal area were identified, characterized, and the doses calculated. Any member of the public at more distant locations would receive lower doses or no dose at all. Similarly, the evaluation of the groundwater exposure pathway was designed to be bounding. A hypothetical well was assumed to be located directly downgradient from the source and the water extracted for human consumption directly. Any potential impacts to groundwater wells located at greater distances or in geological formations that supply drinking water would result in lower doses. RAC's risk assessment (Attachment A2 of the CAP) was updated to clarify these points.

EEC Comment #6:

The landfill is estimated to operate approximately 40 more years, after which the approved closure plan will be implemented. Closure will include: capping of the landfill pursuant to the requirements of 401 KAR 48:080 and the landfill permit, recording of an environmental covenant which prevents disturbance of the cap and prevents residential and groundwater use, 30 year post-closure maintenance and groundwater monitoring, and a plan for long-term maintenance and monitoring. The lifetime of the landfill cap, used for the RAC evaluation, is 200 years. How do these expectations and closure practices compare with those of a landfill authorized to receive TENORM wastes, such as the Mostoller facility?

Response #6:

We provide a comparison of the Blue Ridge and Mostoller Landfills' physical characteristics and closure requirements in Response #4.

We also note that Section 4.2.1 of the CAP has been revised to reflect that an enhanced cap will be placed over the BES Waste area, and the landfill gas collection system will be modified to relocate landfill gas extraction wells out of the BES Waste area (see Response #8).

EEC Comment #7:

Original quarterly landfill waste reports submitted by the facility indicated that the TENORM waste was used as alternate daily cover. ADS later submitted revised reports to indicate that the material was not used as daily cover but was mixed with municipal solid waste (MSW) and covered in place with soil and additional MSW. Due to uncertainty as to the disposition of the TENORM waste, it is recommended that the risk calculations for "maximum reasonable exposure" be revised by RAC to address possible use of the material as alternate daily cover. Figure 2.10 below indicates the highest levels measured in the Gamma Scan Survey are shown outside of the permitted solid waste boundary. A brine filtration sock was found in the material and ADS has stated the material originated from an oil and gas well located in eastern Kentucky that had been disposed of years earlier and resurfaced as part of constructing a new landfill cell. Please provide information as to how potential exposure resulting from incidental resurfacing of previously buried TENORM waste will be addressed.

Response #7:

ADS is certain the BES Waste was not used as daily cover and does not believe that evaluating this hypothetical scenario would yield meaningful or realistic data. Immediately after learning about the possible TENORM disposal, ADS reviewed the disposal records and discovered that the material was wrongly coded as "alternative daily cover," a designation used for soil, not for sludges. ADS management interviewed the former Site manager, who confirmed that the material was not used as daily cover. Last, if the material was used as daily cover, the extensive gamma ray scans conducted in the spring and summer of 2016 would have shown increased activity at the surface, but the scans did not. ADS is certain that the BES Waste was mixed with MSW and disposed of in the sections of the landfill shown in Figure 2.5 of the CAP.

Further, ADS has buried the BES Waste under additional MSW and a protective 6-in cover, and final Site plans include burial of the BES Waste with a minimum of 30 ft of additional MSW and the final cover system. These measures will prevent resurfacing and further reduce exposure potential.

Regarding the brine filter sock, this material appears to have been present at the ground surface from direct placement, not resurfacing. No additional filter socks were found in or around the adjacent waste pile. The sock was removed for analytical testing, and the adjacent waste pile was excavated and disposed of at a different facility (the Mostoller Landfill in Somerset, PA).

EEC Comment #8: Potential Additional Source

One other issue that should be considered is the likelihood of radon in the collected landfill gas that is extracted, transported, treated, and then used to generate electricity at the onsite 1600-kilowatt electrical generation plant. The method of "treatment" is not specified and radon from this potential source does not appear to have been modeled or measured. From Section 2.1.3 of the CAP: The vertical gas extraction wells collect methane gas and transport it to an on-site treatment facility. A header system collects condensate as the landfill gas is cooled. This condensate is removed and disposed of, along with the landfill leachate. The remaining treated gas is used for electricity generation at the landfill.

Response #8:

The percentage of total methane gas production in the BES Waste area is a small fraction of the total gas production. As such, it is unlikely to be a significant source of exposure. Nonetheless, to further reduce methane generation from the area of the landfill where BES Waste was disposed of, ADS intends to relocate

the existing landfill gas extraction wells from the BES Waste area to other areas of the landfill and prohibit drilling landfill gas extraction wells in the BES Waste area (see Figure 4.1 of the CAP).

EEC Comment #9: 2.5.2 State of Kentucky Remediation Requirements

This section states that identification of final remediation goals for the proposed remedy can be based on USEPA Region IX Preliminary Remediation Goals (PRGs) pending review by the cabinet of site-specific conditions." Pursuant to KRS 224.1-530, the cabinet uses the Regional Screening Levels (RSL) Table published by USEPA Region 3 as screening levels in conformance with the Risk-Based Concentration Table Users Guide.

Response #9:

Section 2.5.2 of the CAP has been updated to reflect that KRS 224.1-530 specifies use of US EPA Region 3 Regional Screening Levels.

EEC Comment #10: Table 3-1 Site-Specific Factors for Remedial Action Objective Determination

For groundwater use, it is stated that there is not potable water use at the site and that a 1992 well search identified 16 wells within one mile of the downgradient (northwest) site boundary. Updated information must be provided related to water use in the vicinity of the site.

Response #10:

An updated well search is underway. As part of that well search, the Kentucky Geological Survey database¹ for water supply wells and springs was queried for wells and springs within 1 mile of the Site boundary. The results of the database query are provided in Section 2.1 and Figure 2.2b (2017 Water Well Survey Results) of the revised CAP. In addition, a well survey within 1 mile of the downgradient (northwest) Site boundary is currently being implemented. Details of this well survey methodology are provided in Attachment G of the CAP, and its results will be submitted to the Cabinet in a separate report upon completion.

EEC Comment #11:

Figure 2-9 noted on page 23 could not be located in the CAP.

Response #11:

Figure 2.9 is included on page 10 of the original CAP (embedded in the report text). The CAP List of Figures was updated to clarify that Figure 2.9 is embedded in Section 2.3 of the report.

EEC Comment #12: 4.2.1 Remediation Alternative 1: Closure-in-Place and Monitoring

It is stated that "sampling will be conducted for the closure period of 2 years and the post-closure care period of at least 30 years." Page 25 notes that long-term monitoring of surface water and groundwater beyond the "containment zone" will be conducted to ensure protectiveness. Clarify what area is included in the containment zone.

Measures must be taken to ensure long-term protectiveness for Remediation Alternative 1: Closure in Place and Monitoring, due to the nature of long-term decay of the TENORM constituents. This section states that "prior to construction of the final cover system, a minimum of 30 feet of MSW will be placed on top of the BES waste", with the final cap to be constructed in phases upon closure of the landfill. It should be noted that the closure and final cap requirements for facilities disposing of TENORM wastes may be amended by the pending regulations. Following closure of the site under the solid waste contained landfill permit requirements, 401 KAR 48:080 and 48:090, and the pending amended regulations for TENORM disposal, the site should be subject to regular inspections, a long-term monitoring program, and an

¹ The Kentucky Geological Survey Data Repository can be accessed at: <http://www.uky.edu/KGS/water/research/gwreposit.htm>.

operations and maintenance (O&M) Plan to ensure overall stability and performance of the cap and an environmental covenant pursuant to KRS 224.80 should be filed to restrict future use of the property. A Five Year Review and annual certification is also required under 401 KAR 100:030 Section 8 (3)(b).

Response #12:

The Blue Ridge Landfill will comply with the final regulations regarding TENORM that would apply to the Blue Ridge Landfill's receipt of BES Waste in late 2015 to early 2016. Section 4.2.1 of the CAP was revised to indicate that ADS will comply with these pending regulations, and to clarify that the containment zone consists of waste that is located within the landfill containment systems, consisting of the landfill liner system, leachate collection system, landfill gas management system, and stormwater controls (as described in Section 2.1 of the CAP).

In addition, as described in Response #3, ADS will work with the Cabinet to develop a Radionuclide Sampling Plan. Given the elevated background NORM in the region, establishing statistically significant background concentrations will be an important component of the monitoring plan. The Radionuclide Sampling Plan will also factor in the regulations for TENORM waste that are currently being prepared by CHFS and EEC, to the extent that they are relevant.

EEC Comment #13: 4.2.2 Remediation Alternative 2, Excavate and Redispose BES Waste

Please describe measures that would be employed to control storm water run-on and runoff while the TENORM material is excavated during the estimated 90-day construction period. Explain the procedures for handling and disposal of water in the excavation.

Response #13:

ADS agrees that stormwater controls would be necessary to control stormwater run-on and run-off during a potential excavation of the BES Waste. However, details regarding these controls are typically provided during remedial design, and thus would be premature to include within the scope of this CAP (prior to remedy selection). Such stormwater controls, however, would increase the engineering design and construction effort required, thereby increasing the overall cost and further reducing the implementability of Remediation Alternative 2.

The CAP has been revised (Section 4.2.2) to indicate that stormwater controls would be required to implement Remediation Alternative 2.

EEC Comment #14: 4.2.2 Remediation Alternative 2, Excavate and Redispose BES Waste

A typo is noted in "...amount of soil and overlying MSW to be excavated is approximately 16,300 cubic yards (45,575 cubic yards) assuming a "fluff factor" of 15%. It should be 18,745 cubic yards assuming a 15% fluff factor.

Response #14:

We agree that the correct amount of potentially excavated soil and MSW overlying the BES Waste should be 18,745 yd³ (assuming a fluff factor of 15%). Section 4.2.2 of the CAP was revised accordingly.

EEC Comment #15: 6.5.1 Short-Term Radiological Risks

It is unclear as to whether the RAC report includes the potential risk incurred by the receiving landfill facility workers including the Landfill Laborer, Supervisor and Other Landfill Customers. Please clarify.

Response #15:

The radiological risks to landfill facility workers at a landfill to which the excavated waste is shipped for redispal were not evaluated explicitly because the specific details of the receiving landfill are unknown.

However, it was assumed that the risks would be comparable to those experienced during the original disposals at the Blue Ridge Landfill.

EEC Comment #16: Table 6-3 Cancer Morbidity Risk Estimates for the Remediation Alternatives During Excavation.

The excess cancer risk for the Landfill Laborer (1.8×10^{-5}) and Supervisor (2.2×10^{-6}) is within the USEPA risk range of 1×10^{-4} to 1×10^{-6} but it exceeds Kentucky's target risk level of 1×10^{-6} .

Response #16:

Table 6.3 of the CAP has been updated to explain that for Remediation Alternative 2 (Excavate and Redispose BES Waste), the risk estimates for the future Landfill Laborer and Supervisor exceed Kentucky's target cancer risk of 1×10^{-6} (401 KAR 100:030). Based on a comparative analysis of the remediation alternatives, including consideration of the Kentucky target risk level, Remediation Alternative 1 would provide a higher level of overall protectiveness than Remediation Alternative 2.

Attachment A2 of the CAP has also been updated to reflect that the Kentucky's target risk level of 1×10^{-6} was exceeded for the Remediation Alternative 2. We now also reference Kentucky risk levels alongside those of US EPA throughout Attachment A2 of the CAP.

EEC Comment #17: 6.5.3 Green and Sustainable Remediation (GSR)

For Remediation Alternative 2, hauling the TENORM and associated wastes from the landfill over county and state roads to another disposal location could damage the roadways which would need to be repaired. This would increase the cost for labor, materials and fuel, and would also increase air emissions from heavy equipment for road repair.

Response #17:

We agree that hauling TENORM from the Blue Ridge Landfill to another facility could cause road damage. Repairing road damage would increase the costs and air emissions for Remediation Alternative 2. Section 6.5.3 of the CAP has been revised accordingly.

EEC Comment #18: 6.6 Implementability

Decontamination of the trucks after each shipment will generate additional waste which would have to be properly disposed.

Response #18:

We agree that decontamination of trucks and excavation equipment would generate additional waste that would have to be properly managed and disposed. This would further impact the implementability and cost of Remediation Alternative 2. Section 6.6 of the CAP has been revised accordingly.

EEC Comment #19: 6.7 Cost

Additional costs will be incurred for laboratory analytical analyses to add radionuclides to the surface water, groundwater and leachate samples. There could also be additional costs for leachate disposal if the levels are elevated above levels accepted by the Irvine Municipal Utility Wastewater Treatment Plant. Additional radiation safety procedures may be necessary when collecting and handling these media during sampling.

Response #19:

As described in Response #3, ADS will work with the Cabinet to develop a Radionuclide Sampling Plan. For the purposes of the CAP, we prepared a cost estimate of sampling for these additional analytes. The table below provides a summary of these costs and assumptions used in the calculations. ADS will adhere to appropriate health and safety procedures for its workers and contractors performing the sampling.

Summary of Additional Costs for Radionuclide Sampling

Sampling Frequency	Total Number of Samples	Total Cost	Total Present Value Cost at 7% ^a
Quarterly (2 years) ^{b,c}	40	\$5,800	\$5,200
Semi-annual (28 years) ^{b,c}	112	\$16,800	\$7,300
Totals	152	\$22,800	\$12,500

Notes:

(a) Total present value was estimated based on the method presented by US Army Corps of Engineers and US EPA (2000) ("A Guide to Developing and Documenting Cost Estimates During the Feasibility Study"), using a 7% discount rate.

(b) Sampling includes groundwater from all monitoring wells for the first 2 years and downgradient wells (MW-13, MW-15R) only for up to 28 years (locations shown in Figure 2.3). Analytical analyses include gross alpha, gross beta, and gamma spectroscopy. An additional 10% was added for field and trip blanks.

(c) No additional labor costs were included for sampling.

In addition, an enhanced cap will be placed over the BES Waste area as part of the final cover system, and the landfill gas collection system will be modified to relocate landfill gas extraction wells from the BES Waste area (see Response #8). Costs for these landfill modifications have been added to Remediation Alternative 1.

Section 6.7 and Attachment E of the CAP have been revised accordingly. These costs do not alter the conclusion that Remediation Alternative 1 is more cost-effective than Remediation Alternative 2.

EEC Comment #20: Table 6.6 Summary of Incremental Remediation Alternative Costs

There would be some increased costs for monitoring long-term for radionuclides at the landfill which would be in addition to the other constituents that are monitored.

Response #20:

We agree that long-term monitoring for radionuclides would increase costs. Please refer to Response #19, above.

In addition, an enhanced cap will be placed over the BES Waste area, and the landfill gas collection system will be modified to relocate landfill gas extraction wells from the BES Waste area (see Response #8). Costs for these landfill modifications have been included in Remediation Alternative 1.

Section 6.7 of the CAP and Attachment E have been revised accordingly. These costs do not alter the conclusion that Remediation Alternative 1 is more cost-effective than Remediation Alternative 2.

EEC Comment #21:

Although some of the exposure factors used by RAC will need to be recalculated as noted in further comments on the risk assessment reports, it is evident that radiation doses received by individual workers and members of the public, during the placement of the wastes in the landfill are low and within regulatory limits. The modeling of potential groundwater exposure and dose into the future does appear to be reasonably conservative. Estimated future radiation doses to a worker and maximally exposed member of the public from wastes left in the landfill will also be quite low. The adverse impacts of excavating and relocating the wastes will likely be greater than those of leaving them in place, due in large part to the potential for accidents during the physical actions to excavate, transport, and redispense of the wastes.

Therefore it seems clear that "Remediation Alternative 2: Excavate and Redispense the BES Waste" would present a higher potential risk than "Remediation Alternative 1: Closure-in-place and Monitoring." However, for the purposes of ensuring safety of the landfill workers, it is recommended that ADS develop

a landfill worker training and safety program to meet the requirements of 902 KAR 100:019 including the use of personnel radiation badges (dosimeters) to measure potential doses in real time.

Response #21:

We agree that Remediation Alternative 2 (Excavate and Redispose the BES Waste) poses higher potential risk than Remediation Alternative 1 (Closure-in-Place and Monitoring).

ADS understands and agrees that the safety of our landfill workers is vitally important. The dose assessment conducted by RAC has shown that landfill workers received limited doses during the BES Waste disposals, and that potential future doses are at very low levels given the depth of the BES Waste if left in place. Given the conditions at the Blue Ridge Landfill, under Federal law, environmental conditions would not require the landfill workers to wear dosimeters (10 CFR 20.1502). Thus, ADS does not believe that it is necessary to equip their workers with personnel radiation badges (dosimeters).

ADS has developed a Radiation Screening and Monitoring Plan for the Blue Ridge Landfill that describes waste material profiling and testing prior to landfill acceptance. ADS has also installed radiation monitors to prevent future NORM/TENORM disposals. Because the Blue Ridge Landfill will not receive additional TENORM waste, dosimeters, per the proposed TENORM regulations, would not be required.

ADS landfill workers will be trained on the Radiation Screening and Monitoring Plan for the Blue Ridge Landfill.

RAC 2016 Dose and Risk Assessment (Attachment A1) and RAC 2017 Radiological Risk Assessment (Attachment A2)

EEC Comment #22:

The original 2016 Risk Assessment was reviewed by the KY Department of Public Health, whose comments were used to revise the RA in 2017. If we assume that these parameters are representative of reasonable maximum exposure (RME), the result of the revised risk assessment is that the dose calculated for the most exposed receptor (landfill worker) results in a potential risk of 2.0E-05, which is within the USEPA risk range, but above our *de minimis* value of 1.0E-06. As with all risk assessments, there were many assumptions made, some of which seem to err on the side of conservatism, with some notable exceptions, shown below.

The risk assessment parameters that were used for the most exposed receptor include:

- **Soil ingestion rate - 330 mg/day over an 8 hour workday.** This is less conservative than the KDEP recommended rate of 480 mg/day, but it is in line with USEPA and is a reasonable value for an outdoor worker
- **Exposure Time - 20 minutes per disposal for the most exposed receptor).** (The landfill worker). This leads to a soil ingestion rate per disposal of only 13.75 mg. This is particularly important for extremal exposure, which drives the risk for these workers.
- **Inhalation rate - 1.8 m³/hour.** This is less conservative than the KDEP recommended rate of 2.5 m³/hour, but is probably reasonable for the level of activity for a landfill worker.

Additional issues and assumptions were made in the risk assessment that may need to be considered and re-evaluated including:

- The fact that **TENORM waste from in-state** was also disposed of at the site, but the areas of the site that received these wastes are **not included** in the risk assessment.
- The assumption that the heavy-equipment operator is inside an air-conditioned cab exposed only to filtered air.
- The assumption that the TENORM waste in question was covered within an hour of receipt, since there is uncertainty as whether the TENORM may have been used as alternate daily cover or placed in disposal cells. Due to the uncertainty of the disposition of the TENORM, it is recommended that the risk calculations for the most exposed receptor be recalculated to account for the increased time of exposure as the worker would grade the cover material over the entire working face at the end of the day and would also remove it at the beginning of the next work day.

Response #22:

The radiological dose and risk calculations performed for the CAP represent bounding scenarios whereby the results are expected to overestimate actual doses and risks significantly. Although the exposure parameters are, in many respects, representative of a reasonable maximum exposure (RME), there are some instances in which a slightly larger value might be considered, as suggested by the reviewer. However, it is important to note that the underlying transport calculations used to determine the media concentrations, such as concentrations in air and groundwater, were not designed to provide realistic estimates of dose or risk; they were deliberately high-sided, resulting in higher estimates of risk than would actually occur.

We believe that part of the confusion is because we use the terms "landfill laborer" and "landfill worker" interchangeably, and we revised the exposure times between the 2016 Dose and Risk Assessment and the 2017 Radiological Risk Assessment. The exposure times were increased slightly based on comments received from KYDPH.

In the 2016 Dose and Risk Assessment, the landfill laborer/worker receptors are broken into two groups: laborers/workers and heavy-equipment operators. The laborer/worker is assumed to spend 15 minutes, or 0.25 hours, per disposal 1 m from the truck containing TENORM waste, plus 5 minutes at 1 m from a truckload of unshielded TENORM waste. The heavy-equipment operator is assumed to spend 20 minutes, or 0.33 hours, per disposal sitting in the cab of the equipment.

In the 2017 Radiological Risk Assessment, we only calculated doses and risks for the landfill laborer/worker, because the heavy-equipment operator will receive a lower dose. Here, the landfill laborer/worker is assumed to spend 20 minutes, or 0.33 hours, per disposal 1 m from the truck containing TENORM waste, plus 5 minutes at 1 m from a truckload of unshielded TENORM waste.

In the appendix to the 2017 Radiological Risk Assessment, we revised the 2016 dose calculations based on the comment we received from KYDPH on January 20, 2017. In those calculations, we also assume 20 minutes, or 0.33 hours, per disposal 1 m from the truck containing TENORM waste.

These assumptions will tend to overestimate actual exposures because the same individual is assumed to be present at every disposal of the TENORM waste, and the wind is assumed to be always blowing towards that individual from the waste. Additionally, landfill workers are not typically at the working face of the landfill.

All heavy-equipment operators at the Blue Ridge Landfill work from inside air-conditioned cabs that filter the incoming air. These assumptions will tend to overestimate actual exposures from external radiation, because this assumes the same individual was present at every disposal of the TENORM waste.

Although the heavy-equipment operator is located at the active face and on the landfill for longer than each disposal, the waste is continuously being covered by fresh loads of municipal waste.

EEC Comment #23: Comparison to North Dakota TENORM Risk Assessment

The volume of BES waste was compared with proposed allowable TENORM disposal regulations in other states. As an example, Argonne National Laboratory produced a document for the North Dakota Department of Health, in which they propose allowing TENORM wastes containing an average concentration of less than or equal to 50 pCi/g of total radium (independent of background radium levels) to be disposed of in either Industrial Landfills or Special Wastes Landfills, provided the following conditions are met:

- No more than 25,000 tons of TENORM wastes are disposed of in a single year
- The average thorium activity concentration in the waste does not exceed 24 pCi/g (assuming a thorium to radium ratio of 49% at 50 pCi/g total radium)
- TENORM wastes must be covered by at least 2 m (6 ft) of a combination of the landfill cover materials and clean wastes that do not contain radionuclides

If we calculate the inventory in Ci for a year's worth of TENORM that would be allowed based on this assessment, the annual result is approximately 0.59 Ci from Radium and 0.55 Ci from Thorium, for a total of 1.14 Ci.

Comparing that to BES waste at BRLF (which is neither an Industrial Landfill nor a Special Waste Landfill), approximately 1157 tons of out-of-state TENORM wastes were disposed of at BRLF, with an average concentration of total radium of approximately 700 pCi/g. If we assume the same thorium to radium ratio of 49%, the result is 673 pCi/g for thorium (NOTE: The thorium to radium activity ratios in the RA/CAP, which were derived from the filter sock found at the landfill, would result in even higher thorium levels). If we calculate the inventory in Ci for the 92 loads of out-of-state TENORM, the result is approximately 0.73 Ci from Radium and 0.66 Ci from Thorium, for a total of 1.4 Ci. This not only exceeds what would be allowed in a ND industrial or special waste landfill, but only accounts for out-of-state TENORM. In addition, the average concentration of each load is 14 times that allowed in ND (with at least one load above 2000 pCi/g).

Argonne National Laboratory. 2014. "Radiological Dose and Risk Assessment of Landfill Disposal of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in North Dakota." Environmental Science Division. November. Available at [https://www.ndhealth.gov/EHS/TENORM/ArgonneStudy/ANL-NDDH%20TENORM%20Landfill%20Study%20\(ANL%20EVS-14_13\)%20Final%20Report.pdf](https://www.ndhealth.gov/EHS/TENORM/ArgonneStudy/ANL-NDDH%20TENORM%20Landfill%20Study%20(ANL%20EVS-14_13)%20Final%20Report.pdf).

Response #23:

The reviewer is correct; those conditions are being proposed for North Dakota Industrial Landfills or Special Wastes Landfills as possible criteria for accepting TENORM wastes. They are established assuming continuous annual TENORM disposals of 25,000 tons per year at the stated concentrations. The BES Waste disposal at the Blue Ridge Landfill was a single event in which the BES Waste was disposed of and will not continue in the future. The North Dakota TENORM study also evaluated the radiological doses and risks associated with both landfill worker and future resident scenarios. The authors determined

that the total activity that can be brought into the landfill while remaining in compliance with the 100 mrem/year public dose limit is as follows (reported here only for the most limiting case of the waste placement landfill worker, see Table 6.10, p. 73/140 and Table 6.15, p. 79/140 of the North Dakota report for others): 1.2 Ci Th-232, 5.0 Ci Ra-228, 2.6 Ci Ra-226, and 110 Ci Pb-210 (from Table 6.15, p. 79/140 of the North Dakota report). Additionally, the depth to the TENORM waste used to derive allowable concentrations in the North Dakota report was only 2 m, or ~6 ft. In the case of the Blue Ridge Landfill, the depth to the TENORM waste will be at least 30 ft, which will reduce potential doses substantially.

EEC Comment #24: Attachment A1 Waste Handling Procedure, Page 5

It is mentioned that ADS added sawdust to absorb the excess liquid to seven of the 92 loads. Based on information received, L. R. Daniels also solidified some of the waste. Eleven (11) unsealed truckloads of waste mixed with absorbent were trucked from the Ashland area to the Blue Ridge Landfill. Some of the waste from Fairmont Brine Processing appears to have been hauled in an uncovered trailer instead of being sealed. Given the nature of the waste and its small particle size, fugitive dust emissions from the trucks must be considered.

Response #24:

The particle size distribution of the various wastes that were hauled to the Blue Ridge Landfill is not known and is not something that is reported in the literature. It can be assumed that the addition of sawdust and other materials to solidify the wastes reduced the magnitude of any fugitive dust emissions from this source significantly. For RAC's analysis, it was assumed that the waste material could be characterized like soil that is susceptible to suspension, so that particulate emissions would not be underestimated and in all likelihood would be overestimated. Fugitive dust emissions during transportation to the Site were not evaluated explicitly. This pathway was eliminated from further consideration based on the exposure concentration and exposure duration for a member of the public to a passing truck hauling the waste. Attachment A2 of the CAP has been revised to clarify this aspect.

EEC Comment #25: Attachment A1 Fracking Waste and Treatment, Page 11

The waste from Fairmont Brine was described as "Exploration and production soil and debris". However the physical nature of the Fairmont Brine waste is not that of a soil; rather it is a chemical precipitate resulting from Fairmont's operations which extract radionuclides, recycle salts and water and concentrate the radionuclides through a chemical precipitation process. The resulting Fairmont Brine material is different from the soils and debris generated directly from the exploration and production facilities, as it is made up of much smaller particulates which should be considered for fugitive emissions.

Response #25:

A chemical precipitate is likely to be more uniform in nature than soil, with regard to particle size. RAC assumed the characteristics of soil and debris with a variety of particle sizes in the respirable range, so that potential exposures were not underestimated. Attachment A2 of the CAP has been revised to clarify this aspect.

EEC Comment #26: Attachment A1 Particulate Emissions and Inhalation and Ingestion Doses During Disposal, Page 34

It is stated that "Radionuclide emissions during disposal are based on EPA emission model for aggregate handling and storage piles during drop loading operations as described in AP-42 Compilation of Air Pollutant Emission Factors (EPA 1995). Aggregate material is typically much drier and particulate aggregate is more easily dispersed in air than the solidified brines that comprise most of the TENORM material disposed in the Blue Ridge Landfill." Therefore the AP-42 emission factor for aggregate may not be the most appropriate factor.

Response #26:

We agree with the reviewer's comments. However, in the absence of specific data on a more realistic emission factor for this material, the AP-42 emission factor for aggregate material was considered to be a cautious assumption that ensured emissions, and thus, doses, would not be underestimated. Attachment A2 of the CAP has been revised to clarify this aspect.

EEC Comment #27: Attachment A1 Equation 2, Page 35

What was the value of "k" used in the calculations for the "particle size multiplier"?

Response #27:

The value used for k was 0.48, and is from AP-42 Section 13.2.4 – Aggregate Handling and Storage Piles. This assumes that particles less than 15 µm in size are respirable. This parameter is defined in Table 4 of the revised Attachment A2 of the CAP.

EEC Comment #28: Attachment A1, Page 36

Please describe if the wind speed used in the air emission model was representative. The standard meteorological for wind speed measurements is 10 meters. Often the actual wind speed in the vicinity of the emission source is significantly different due to the surface of the local terrain and boundary layer effects.

Response #28:

The wind speed used in the emission calculations was based on the mean measured wind speed at Lexington, Kentucky, as provided in the referenced website (<http://www.climate-zone.com/climate/united-states/kentucky/lexington>). Lexington is located about 50 km from the Blue Ridge Landfill. When site-specific data are lacking, US EPA allows for the use of meteorological data from nearby airports when performing an air quality analysis using the AERMOD code. Because there were not Site-specific data, the nearest location with meteorological data available was used. In flat-plane environments, wind speed and direction will tend to be constant. Meteorological measurements are typically taken at the 10-m level and away from structures and trees, to avoid perturbations caused by these features. Thus, the wind speed measured at Lexington would be representative of the regional airflow. Local topography and features can influence both wind speed and direction. In general, these features will tend to decrease wind speed in valleys and near the ground surface, and increase wind speed at ridge tops. The disposal of BES Waste did not occur on a ridge top or at 10 m, and thus, the average wind speed at ground level would be lower than the mean value of 9.1 mph that was used in the calculation. Therefore, releases were overestimated and provided an upper-bound estimate of radionuclide releases. Using a mean wind speed accounts for times of higher and lower wind speeds during the disposal. If the wind speed was higher during the disposals, releases would be higher (based on the suspension model), but relative air concentrations would also decrease due to increased dilution. If, for example, the wind speed during all the disposals was doubled, to 18.2 mph instead of 9.1 mph, the total dose to an individual who was present for all disposals would increase by only a factor of 1.07.

EEC Comment #29: Attachment A1, Page 38

The inhalation dose to off-site receptors was calculated using the "classic Gaussian plume model" as described in the second edition of *Workbook of Atmospheric Diffusion Estimates* (Turner 1994 and is shown as Equation 10. The basic Gaussian equation model and dispersion coefficients were first published by Turner in the 1968-1969 time period (the report dated their reference to 1995). The model/equation is somewhat dated and has a high margin of error, and there are better approaches to modeling downwind transport today in the peer reviewed published literature. Also the model does not consider particulate deposition and re-suspension and treats the behavior of any particles entrained in the emission plume as following the ~streamlines of air flow (modeled as behaving as gas molecules where the momentum and inertia and mass differences between the gas molecules and entrained particles are not accounted for.) Also

the model equation is a point source model and a more accurate approach would have been to use an area source model to accurately capture the receptor concentrations close to the source. The dispersion coefficients developed by Turner were based on very different terrain than is present at Blue Ridge Landfill. Also the model assumes a statistical Gaussian plume (concentration profile) and works better for elevated point sources instead of ground-level area sources.

Response #29:

The Gaussian Plume model has certainly been around for many years, and is still relied on by the Nuclear Regulatory Commission (NRC) (as implemented in Reg. Guide 1.111) and US EPA (as implemented in the CAP88 code) to demonstrate compliance with radiation doses to off-site persons from airborne releases. Until recently, US EPA has also relied on the Gaussian plume model (as implemented in the ISC2 code) for demonstrating compliance with non-radiological Prevention of Significant Deterioration (PSD) requirements. Advances in atmospheric dispersion modeling have led to the development of the AERMOD code as a replacement for ISC2. However, a study performed by Arthur Rood and published in the peer-reviewed literature (Rood, 2014) compared the results from AERMOD and ISC2. He concluded that: "Based on the overall performance of ISC2, assessment models that rely on the Gaussian plume model are not necessarily inferior to the current state-of-the-art models in terms of meeting regulatory performance objectives" (Rood, 2014). The fact that US EPA and NRC still use the Gaussian Plume model is a testament to its reliability for demonstrating compliance with regulations.

It is important to understand that the purpose of this assessment was not to accurately estimate the dose to any individual, hypothetical or real. Rather, it was to provide an upper-bound estimate of dose to a hypothetical person that can be compared with regulatory limits that are intended to be protective of human health. This type of bounding assessment is endorsed by NRC, US DOE, and US EPA as a means of evaluating sources using a simple analysis to determine if there is a potential for impacts. For example, US EPA allows the use of AERSCREEN (a simplified version of AERMOD) to be run first, and if compliance can be demonstrated using AERSCREEN, then a detailed analysis using AERMOD is not necessary. This approach of using simplified models and assumptions that result in upper-bound dose estimates is what was used in this assessment.

Consideration of processes such as deposition and area sources will only decrease the estimated dose. Deposition depletes the plume of particles, resulting in lower air concentrations and, consequently, lower inhalation doses. An area source provides initial dilution of the plume, and thereby lower air concentrations and inhalation dose. All dispersion models rely on empirically determined dispersion coefficient formulations that were determined in different environments than those where they are used. The Gaussian Plume formulation for an elevated plume works equally as well for a ground-level release, because reflection of the plume from the ground surface is accounted for in the equation.

Reference (provided as an attachment to this letter):

Rood, AS. 2014. "Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset." *Atmos. Environ.* 89:707-720.

EEC Comment #30: Attachment A1, Table 11. Parameters for Emission Model during Disposal and Transport in Air, Page 39

The emission factor indicates that 2.01 grams of particulate matter is being released to the atmosphere per load. This emission factor was developed for soil placement at a construction site and is not representative of the particle size distribution for Blue Ridge which affects its transport and inhalation properties. Also the waste from Ohio and West Virginia should have emission factors representative of their respective waste characteristics.

Response #30:

As stated earlier, there are no airborne emission factors that we are aware of that pertain to the unloading of solidified brine. Moreover, we have not received or identified any particle size information that would pertain to airborne particulates or particles in the brine. Based on photographs of the material we reviewed (Attachment A1 of the CAP; Figure 6), the solidified brine appears very wet, and the description provided by the generator states that sawdust was added to the mixture to absorb the water and solidify it. Based on this description, we would not expect any fugitive releases from the material, because by its very nature (*i.e.*, brine is a liquid), the material is too wet to support fugitive emissions. As stated earlier, the purpose of the assessment was to provide an upper-bound estimate of doses. By assuming that the material is similar to a dry aggregate soil, an upper-bound estimate of releases to the air is provided. An assessment of TENORM doses to landfill workers in North Dakota (Argonne National Laboratory, 2014) also had the same difficulty in addressing suspended particulates during disposal. That study used the RESRAD methodology, which employs a mass loading factor approach. This approach assumes that all the dust in the air is from the TENORM disposal (an extreme upper-bound assumption) and used a mass-loading factor of 1 mg/m^3 , which the authors state is appropriate for landfills. Thus, the Argonne National Laboratory assessment also assumed a fugitive emission rate from TENORM that was based on general landfill operations and not specific to actual TENORM waste characteristics.

Reference:

Argonne National Laboratory. 2014. "Radiological Dose and Risk Assessment of Landfill Disposal of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in North Dakota." ANL/EVS-14/13. Environmental Science Division. November.

EEC Comment #31: Attachment A1 Uncertainty in Dose Estimates, Source Term, Pages 50-51

It is stated that "the bulk of TENORM activity received was from Fairmont Brine. Based on mean exposure readings taken on the shipments and the conversion factor developed by PADEP, the Ra-226/228 concentrations were estimated. Concentrations of the remaining radionuclides were estimated based on activity ratios from a single sock sample that maximized thorium isotope concentrations." Please clarify this statement as no brine filtration socks were disposed of by Fairmont Brine. Filter socks are typically generated on-site at oil and gas exploration/production facilities.

Response #31:

First, we wish to correct the statement that RAC used the conversion factor developed by PADEP. In our original report (Attachment A1 of the CAP), we used this factor, but based on earlier comments provided by the EEC, we modified this approach and instead used the actual measurements to develop a Site-specific conversion factor of $0.377 \text{ } \mu\text{R hour}^{-1}$ per pCi g^{-1} total radium (Attachment A2 of the CAP).

For some loads, complete data for all relevant radionuclides were not available. To fill the gaps in a scientifically rigorous manner, radionuclide ratios from the filter sock found near the location where the TENORM waste was disposed of were used as follows:

U-238 for all loads was based on the activity ratio of U-238 to Ra-226 of 0.0818; Th-230 for all loads except Fairmont Brine loads 5-40 (see Attachment A1 of the CAP for details) was determined using the activity ratio of Th-230 to Ra-226 of 1.0370.

EEC Comment #32: Dose Estimates Page 53

The exposure times for the landfill workers should be recalculated to address their day to- day work activities. The dose estimates were calculated "assuming a laborer spends 0.25 hours per disposal at a distance of 1.0 m from the TENORM container, and 0.083 hours 1 meter from the waste pile." A landfill equipment operator spends much of the work day at the working face, spreading incoming waste and is still

in the vicinity of the TENORM waste and can be exposed to additional inhalation hazards as the operator works around the disposal area with incoming waste loads.

Response #32:

Landfill worker job duties and exposure times were based on conversations with David Rettell, who directly observed operations at the Blue Ridge Landfill to ensure the exposure parameters were reliable. Additionally, heavy-equipment operators at the Blue Ridge Landfill work from inside air-conditioned cabs that use filtered air, and although the heavy-equipment operator is located at the active face and on the landfill for longer than each disposal, the waste is continuously being covered by fresh loads of municipal waste. See also Response #22 for details on the exposure times.

EEC Comment #33:

The risk assessment does not consider air scouring at the atmosphere/soil-waste interface and the generation of airborne inhalable particulate matter being generated from the equipment activity during placement of waste and its use and management as ADC.

Response #33:

Air scouring is a function of wind speed, the geometry of the soil surface relative to wind direction, the amount of loose unconsolidated soil, and the moisture content of the soil. Mechanistic models for these types of processes are research-grade and not suitable for this type of assessment. The AP-42 emission factors for wind erosion are empirically based and would implicitly include these types of processes. Air scouring and wind erosion would only be applicable to waste that is exposed at the surface. Thus, once buried, wind erosion releases are not possible. Because the waste spends little time exposed on the surface, release during the disposal (*i.e.*, releases from material suspended when the material is disposed) is the dominant release process, and thus the only process that was considered.

Further, as described in Response #7, ADS is certain that the BES Waste was not used as daily cover.

EEC Comment #34:

The risk assessment should include calculations for incidental residential exposure as it was reported that local citizens were allowed to drive up to the working face to dump their loads in their personal vehicles during the time span for receipt of the TENORM waste.

Response #34:

This assessment does not directly address the possibility of residential exposure. However, exposure to any resident that may have been at the landfill during the BES Waste disposal would be bounded by that of the landfill laborer, who spent more time in closer proximity to the waste than a resident. Thus, residential doses would be quite small. Attachment A2 of the CAP has been revised to reflect this.

Cornerstone Environmental 2017 BES Waste Depth Memo (Attachment B)

EEC Comment #35:

As a point of clarification the CAP prepared by Gradient notes that 92 separate loads of TENORM waste (1,157 tons) were disposed at the landfill, which the cabinet has confirmed. However, the Cornerstone memorandum in Attachment B and the Agreed Order indicates 47 sealed boxes of TENORM waste were disposed at the landfill.

The RAC reports indicate that the TENORM wastes of concern have been covered with a minimum of 30 feet of municipal waste, while the Cornerstone memorandum indicates that there may be as little as 0 feet of cover in 8 of the 17 affected landfill grids. Please clarify these statements.

Response #35:

We agree with the Cabinet that the CAP correctly states that 92 separate loads of BES Waste (1,157 tons) were disposed of at the landfill (see also RAC, 2016, Dose and Risk Assessment, Attachment A1 of the CAP). The Cornerstone Memorandum (Attachment B of the CAP) has been revised accordingly. Further, final Site plans include burial of the BES Waste with a minimum of 30 ft of additional MSW.

Weaver 2017 Radioactive Material Screening Plan (Attachment C)

EEC Comment #36:

Page 45. Procedures to detect radioactive materials should include: Profiling in-state generated waste and drilling mud waste.

EEC Comment #37:

The Ludlum Model 375P-1000 with dual plastic scintillation detectors as described in the Screening Plan is an instrument typically used by landfills to screen incoming waste for radioactive material content. Paragraph 19 c of the agreed order requires ADS to submit "A plan for detecting and preventing the disposal of unpermitted TENORM wastes at the Facility that shall be incorporated into the Permit as a condition." For purposes of this agreement "unpermitted TENORM waste" means out-of-state generated TENORM waste material with combined concentrations of Radium 226 and 228 greater than 5 pCi per dry weight gram of waste material over background." At 10 $\mu\text{R/h}$ the acceptable background variation of $\pm 20\%$ would be equivalent to 2 $\mu\text{R/h}$. Based on the average radiation level on the BES Wastes of 0.377 $\mu\text{R/h}$ per pCi/g of total Ra-226 and Ra-228 determined by RAC, the screening process would therefore not be able to determine TENORM concentrations less than approximately 5 to 6 pCi/g of TENORM. Section 3.1.2 of the Screening Plan recommends setting the instrument to alarm at 5 times background. If the background is 10 $\mu\text{R/h}$, the alarm would be at 50 $\mu\text{R/h}$. This would be a net of 40 $\mu\text{R/h}$ above background, which, based on 0.377 $\mu\text{R/h}$ per pCi/g of total Ra-226 and Ra-228, would be equivalent to alarming at a TENORM concentration of slightly over 100 pCi/g. Therefore, ADS should consider setting the instrument to trigger an alarm at a lower total radium concentration threshold of 5 to 10 pCi/g in order to provide a "go/no go" signal with possible further evaluation by other instrumentation to quantify the levels. It is recommended that ADS consult with the Cabinet for Health and Family Services (CHFS) to determine overall acceptability of the radiation portal monitor.

EEC Comment #38:

The Screening Plan for the Ludlum monitor does not include a detailed description of the installation and operation of such an instrument. For example, the distance between the detectors, the distance from the centerline of the waste container to the detectors, the speed at which the container would pass through the sensitive detection region (or length of counting time, if a static measurement), and, finally, the minimum detection sensitivity (e.g., exposure rate [$\mu\text{R/h}$] and activity concentration [pCi/g] of the system for a typical container of waste) should be estimated for TENORM and other potential radioactive contents when operating the system in a screening mode. Note that the instruments may be set to display in exposure rate, count rate, or integrated counts over a preset monitoring period. Please provide the additional information for the monitor.

EEC Comment #39:

10 $\mu\text{R/h}$ is a typical background exposure rate to be expected. The background recorded by the screening instrument may be lower, depending on the effect of shielding around the detectors. It should not be necessary to collect 100 individual background measurements to determine an accurate and reproducible average; 20 individual determinations are usually adequate to determine the average. The average background and source response level should be determined, along with the acceptable variability ($\pm 20\%$ or $\pm 3\sigma$) should be recorded and the instrument performance compared with those values by completing a "control chart" for each day of use (more often if the background is found to be highly variable).

EEC Comment #40:

Ideally, after triggering an alarm setting, additional evaluations could be used to identify the radioactive source, estimate the activity or concentration in the waste, and determine whether contamination and radiation levels are compliant with Department of Transportation regulations. These actions typically require a level of technical training and experience associated with professional radiation protection personnel. The level of sophistication described in the Screening Plan is beyond what needs to be readily available "in-house" at the landfill. Without extensive training and experience, use of gamma spectrometers and radiation contamination survey instruments and procedures, interpretation of the results, and actions based on the findings, relative to Federal and State regulations may easily cause greater "harm" than they prevent. If an alarm is triggered and a recheck confirms that level, the vehicle should be rejected and impounded, and notification made to CHFS Dept. for Public Health, Radiation Health Branch. Actions beyond Step 2 of Section 5 of the Screening Plan, raise the necessary knowledge, training, and experience to a completely different level. It is recommended that ADS consider contracting with radiation safety professionals for any activities related to the assessment and detailed screening for suspect waste shipments. At a minimum, such a firm could assist in developing a worker safety program, a comprehensive Screening Plan and providing appropriate training and oversight in its implementation.

EEC Comment #41:

A radiation level greater than 50 mR/h in the vehicle cab (screening step 5.C.3) could be indicative of a major problem. Please clarify.

EEC Comment #42:

Page 4 typo. Should be Screening

EEC Comment #43:

It is unclear as to the training requirements for the Supervisor who has been given responsibility for implementing the screening plan. It is recommended that a radiation safety professional handle portable hand-held screening of suspected TENORM materials.

EEC Comment #44: Section 6.2 Action Level 2, Paragraph A

It states that workers should stop leakage of material leaking from the vehicle and "try to catch material leaking from the vehicle" in a container or absorbent material. Only specially equipped, trained radiation professionals should attempt to address leaks, contain or handle potentially radioactive materials utilizing appropriate personnel protective equipment.

EEC Comment #45: Section 7 Characterization, Page 15

It states that it may be necessary to unload waste from a vehicle to remove a radiation source if it is determined to be a medical radionuclide, consumer product, NORM, TENORM or potassium-40 to obtain a sample for characterization. This work should only be done by trained radiation safety professionals.

Response to Comments #36-45:

The Radioactive Material Screening Plan (Attachment C of the CAP) has been revised per Comments #36-45 and based on subsequent discussions with the Cabinet.

EEC Comment #46: Comments from the Community

The cabinet received comments from members of the community that obtained the CAP through an Open Records request. The comments requested information on potential future safeguards that could be implemented to make the landfill more protective should the waste be left in place as proposed under the preferred remedial alternative including whether the landfill or the portion of the landfill which received the TENORM waste be closed under the requirements for a hazardous waste landfill including a RCRA

Subtitle C cap and whether additional bonding should be required due to the presence of the TENORM waste? Other comments on the Weaver 2017 Radioactive Material Screening Plan (Attachment C) noted that the Emergency Contact List does not include any local contacts (i.e., the Solid Waste Coordinator and the County Health Department) and also noted that the document contains grammatical errors and should be written in layman's language.

Response #46:

We acknowledge the community's comments and will work collaboratively with the Cabinet in response to these comments.

Sincerely,

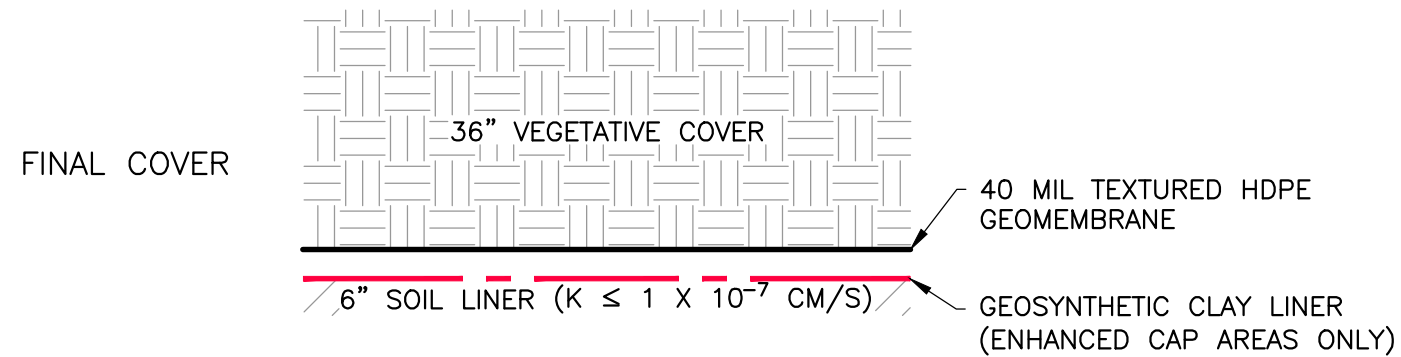
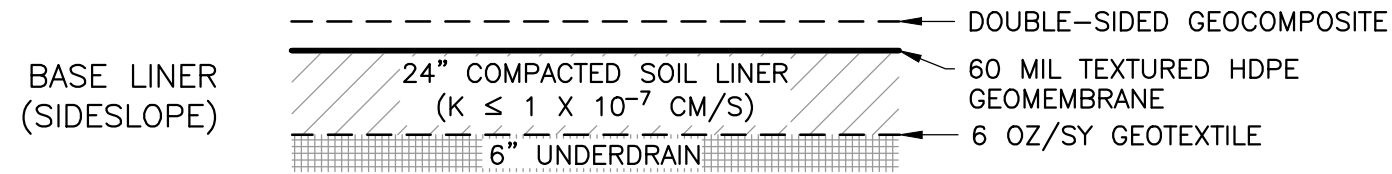
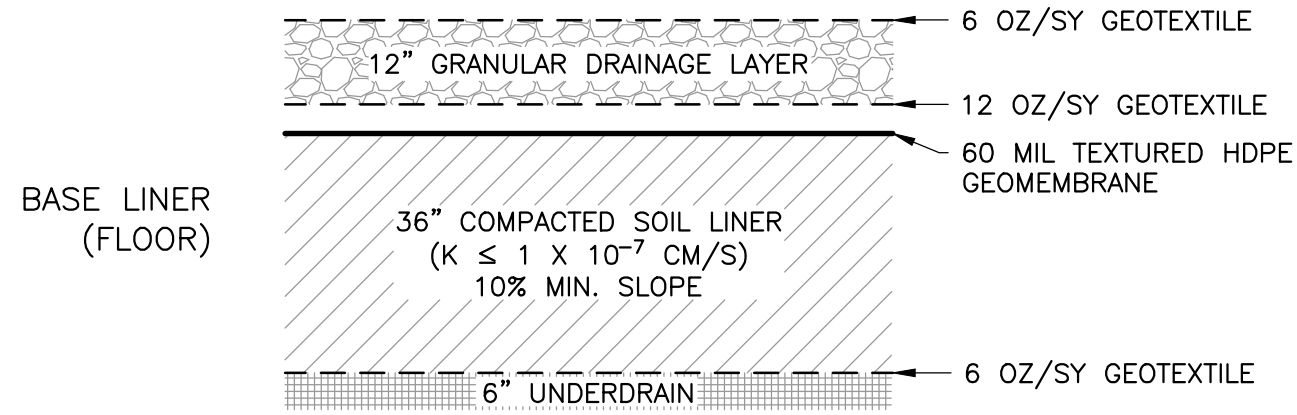
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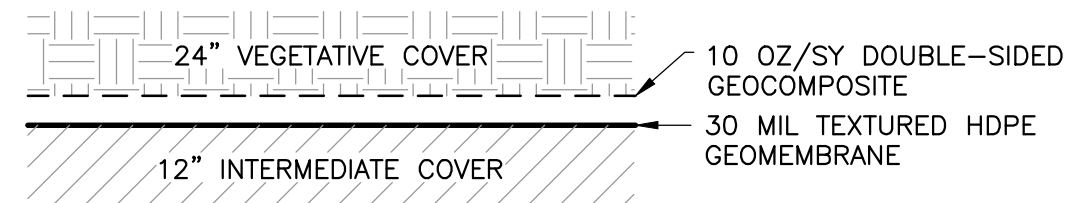
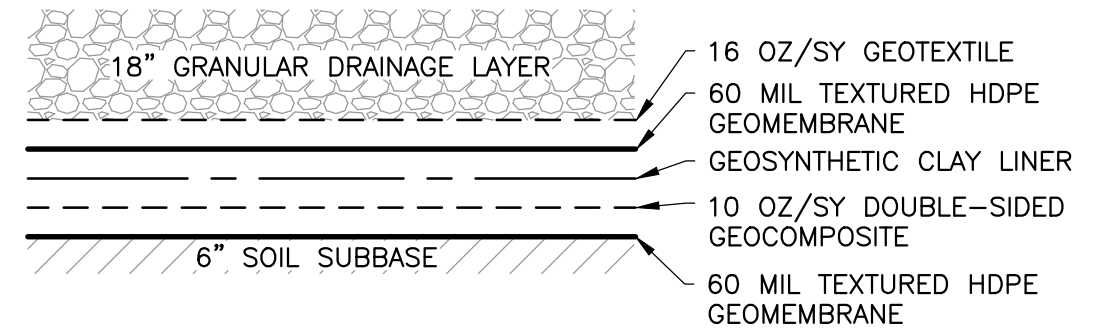
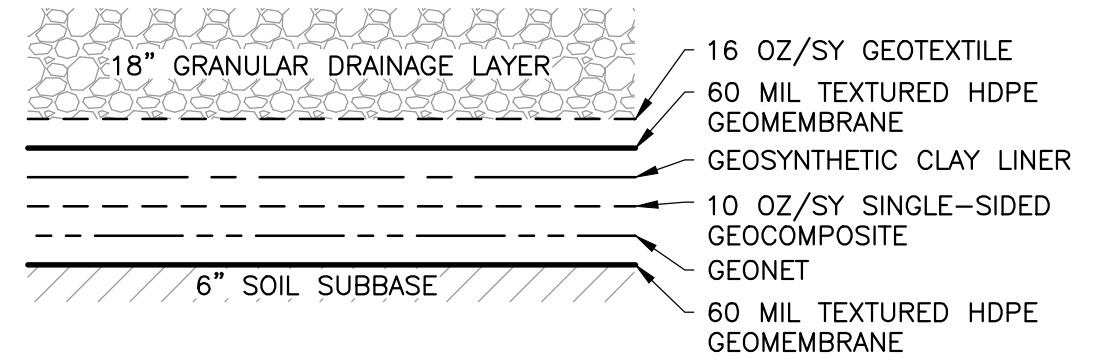
Kurt Herman, M.Eng., P.G.
Principal

Attachments: Weaver Consultants (2017), "Liner System Comparison Blue Ridge vs. Mostoller"
Rood (2014), "Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset"

BLUE RIDGE

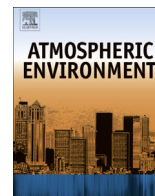


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Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset



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HIGHLIGHTS

- Steady-state and Lagrangian puff models compared.
- SF₆ tracer data at 140 samplers in concentric rings 8- and 16-km from release point.
- Paired and unpaired 1- and 9-h average concentrations performance objectives.
- Puff models showed the lower bias and variance and higher correlation.
- Steady-state models were less likely to underpredict concentrations.

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ABSTRACT

The performance of the steady-state air dispersion models AERMOD and Industrial Source Complex 2 (ISC2), and Lagrangian puff models CALPUFF and RATCHET were evaluated using the Winter Validation Tracer Study dataset. The Winter Validation Tracer Study was performed in February 1991 at the former Rocky Flats Environmental Technology Site near Denver, Colorado. Twelve, 11-h tests were conducted where a conservative tracer was released and measured hourly at 140 samplers in concentric rings 8 km and 16 km from the release point. Performance objectives were unpaired maximum one- and nine-hour average concentration, location of plume maximum, plume impact area, arc-integrated concentration, unpaired nine-hour average concentration, and paired ensemble means. Performance objectives were aimed at addressing regulatory compliance, and dose reconstruction assessment questions. The objective of regulatory compliance is not to underestimate maximum concentrations whereas for dose reconstruction, the objective is an unbiased estimate of concentration in space and time. Performance measures included the fractional bias, normalized mean square error, geometric mean, geometric mean variance, correlation coefficient, and fraction of observations within a factor of two. The Lagrangian puff models tended to exhibit the smallest variance, highest correlation, and highest number of predictions within a factor of two compared to the steady-state models at both the 8-km and 16-km distance. Maximum one- and nine-hour average concentrations were less likely to be under-predicted by the steady-state models compared to the Lagrangian puff models. The characteristic of the steady-state models not to under-predict maximum concentrations make them well suited for regulatory compliance demonstration, whereas the Lagrangian puff models are better suited for dose reconstruction and long range transport.

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1. Introduction

The steady-state model AERMOD and Lagrangian puff model CALPUFF are the U.S. Environmental Protection Agency (EPA) preferred models for demonstrating regulatory compliance in the near field (<50 km) and far field (>50 km), respectively. The

CALPUFF model has also been used in non-regulatory retrospective studies of radiation dose in the near field (Rood et al., 2008) and far field environments (Grogan et al., 2007). Demonstration of regulatory compliance and accident consequence analysis are generally prospective assessments, whereas dose reconstruction and epidemiological studies are generally retrospective in nature. The assessment questions for the prospective and retrospective analyses are fundamentally different and require different model performance objectives.

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For the prospective analysis, the assessment question is whether air emissions will exceed ambient air quality standards, or result in impacts that are unacceptable. This assessment question can initially be addressed using conservative assumptions and simple models. It may not be critical to accurately estimate temporal and spatial variations in concentration, as long as the estimated impacts do not exceed the standards within a safety margin of error. More detailed model applications may be required if simple models cannot demonstrate that regulatory standards are achieved.

For a retrospective assessment, the assessment question is an unbiased estimate of the temporal and spatial distribution of concentration and deposition. Examples of a retrospective analysis include the dose reconstructions performed at U.S. Department of Energy Facilities (Farris et al., 1994; Till et al., 2000, 2002; Rood et al., 2002) and other special studies (Rood et al., 2008; Grogan et al., 2007). Simple models may be used in initial scoping calculations. However, ultimately an unbiased estimate of the temporal and spatial distribution of air concentration and deposition with estimated uncertainty is desired.

The purpose of this paper is to examine the performance of AERMOD, CALPUFF, and two legacy models using the Winter Validation Tracer Study (WVTS) dataset conducted in February 1991 at the former Rocky Flats Environmental Technology Site (RFETS). Performance objectives were tailored toward addressing the assessment questions posed by the prospective and retrospective analysis. Two legacy models, Industrial Source Complex Short Term Version 2 (ISC2) (EPA, 1992) and Regional Atmospheric Transport Code for Hanford Emission Tracking (RATCHET) (Ramsdell et al., 1994), were included in the evaluation because the formulations of these models are currently used in radiological assessment codes (EPA, 2007; Chanin et al., 1998; Ramsdell et al., 2010). Model simulations and performance evaluation of ISC2 using the WVTS was originally reported in Haugen and Fontino (1993). Performance evaluation of RATCHET using the WVTS dataset was originally reported in Rood (1999) and Rood et al. (1999). Model-predicted concentrations for ISC2 and RATCHET were taken from Haugen and Fontino (1993) and Rood (1999), respectively, and were used without modification.

A description of the tracer measurements and meteorological data is provided first, followed by modeling protocol, performance objectives, and performance measures. Finally, the model performance results, in terms of addressing the prospective and retrospective assessment questions, are discussed.

2. Methods

Model performance was evaluated in terms of fundamental plume properties, paired ensemble mean concentrations, and

concentrations unpaired in space. The WVTS dataset and meteorological data are presented first, followed by modeling protocol, performance objectives, and performance measures.

2.1. Winter Validation Tracer Study

The WVTS was conducted in February 1991 near the former RFETS located on the Front Range of the Colorado Rocky Mountains about 25 km northwest of Denver (Brown, 1991). The study consisted of 12 separate tests (Table 1). For each test, an inert tracer (sulfur hexafluoride [SF₆]) was emitted continuously for 11 h from a 10-m high stack located on the east side of the main plant complex (Fig. 1). The main plant complex was located about 2.5 km east of the foothills on an alluvial plain ranging in elevation from 1750 m to 1850 m above sea level. The primary purpose of the study was to gather data for validation of emergency response atmospheric transport models. Samplers were arranged in concentric circles 8-km and 16-km from the release point so as to capture any possible transport trajectories. One-hour average air concentrations were then measured for the last nine hours of the release at each of the 140 samplers. Six tests were performed under nighttime conditions, four under daytime conditions, one under day–night transition, and one under night–day transition. A total of 108 h of data were recorded. Seventy-two samplers were distributed at the 8-km distance and 68 samplers at the 16-km distance. Sampler elevations ranged from about 1600 m to 2600 m above sea level. The study domain is considered near field because the maximum distance to the samplers is <50 km.

Previous investigators (Haugen and Fontino, 1993) used this data set in a performance evaluation of the TRAC (Hodgin, 1991) and ISC2 models. The electronic copy of this data set was obtained from Haugen and Fontino (1993) for use in the model performance evaluation for the Historical Public Exposures Studies at Rocky Flats (Rood, 1999). These data included the observed hourly-average concentrations for all 12 tests, the sampler ID numbers and locations, and the TRAC and ISC2 predicted concentrations. The ISC2 results provided by Haugen were used in this paper without modification.

2.2. Meteorological data

Meteorological data were recorded for every tracer test at the 10-m and 61-m level from the RFETS 61-m tower located 790 m west and 87 m south of the release point. Only data from the 10-m level were used in the model simulations. Data were provided as 15-min averages of wind speed and direction, temperature, heat flux, and standard deviations of these parameters. Hourly averages of these data were calculated using EPA protocol (EPA, 2000).

Table 1
Winter Validation Tracer Study start and end times and source strength.

Test	Start date	Start time (MST) ^a	End date	End time (MST) ^a	MFC ^b (kg h ⁻¹)	CWL ^c (kg h ⁻¹)	Average (kg h ⁻¹)
1	02/03/91	20:00:00	02/04/91	07:00:00	13.71	13.24	13.48
2	02/04/91	20:00:00	02/05/91	07:00:00	13.05	12.16	12.61
3	02/06/91	20:00:00	02/07/91	07:00:00	13.71	13.33	13.52
4	02/07/91	20:00:00	02/08/91	07:00:00	16.53	16.84	16.69
5	02/09/91	13:00:00	02/09/91	00:00:00	23.61	22.63	23.12
6	02/11/91	07:00:00	02/11/91	18:00:00	23.61	22.94	23.28
7	02/12/91	07:00:00	02/12/91	18:00:00	23.61	23.99	23.80
8	02/14/91	01:00:00	02/14/91	12:00:00	23.61	23.44	23.53
9	02/15/91	07:00:00	02/15/91	18:00:00	23.61	23.29	23.45
10	02/16/91	20:00:00	02/17/91	07:00:00	23.61	23.47	23.54
11	02/17/91	20:00:00	02/18/91	07:00:00	23.61	23.04	23.33
12	02/19/91	07:00:00	02/19/91	18:00:00	23.21	22.97	23.09

^a Mountain standard time.

^b Release rate calculated from mass flow controllers (MFCs) that were calibrated at 760 mm Hg, 21.11 °C.

^c Release rate determined from cylinder weight loss (CWL).

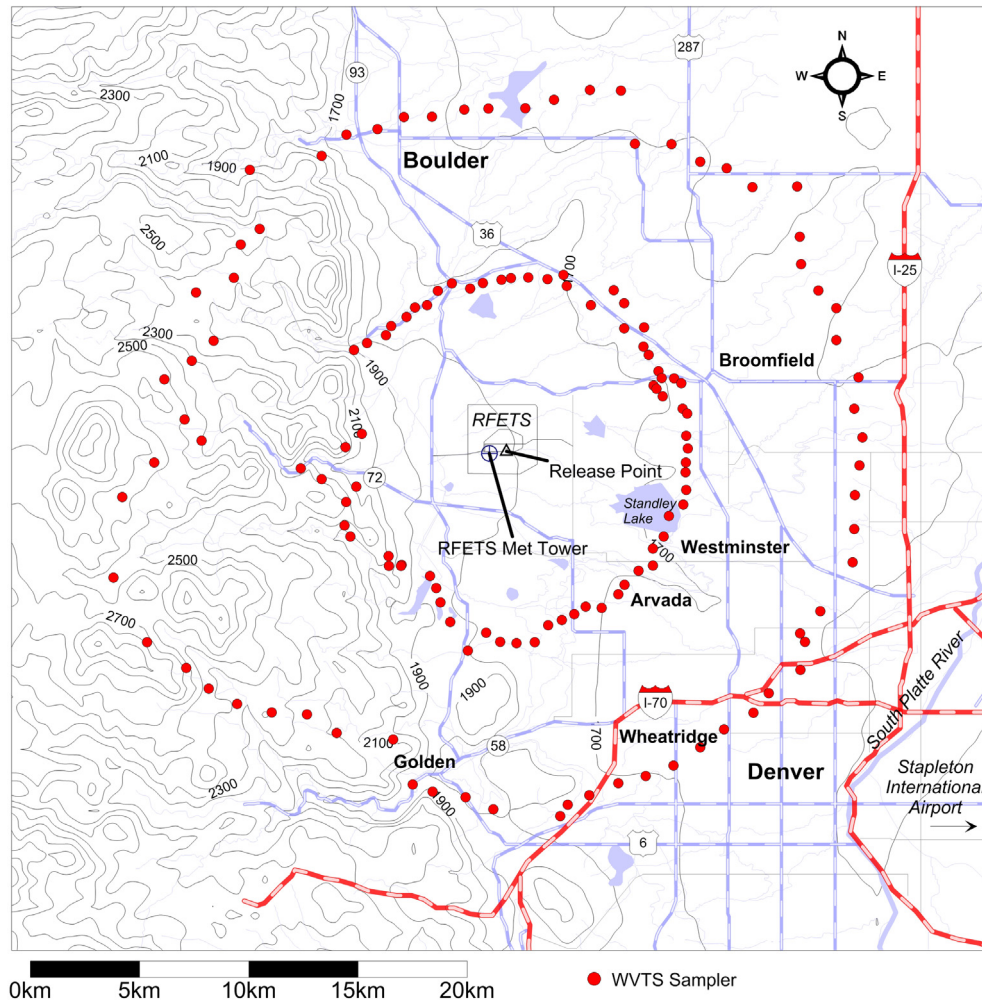


Fig. 1. CALPUFF model domain showing location of the WVTS samplers and terrain features of the Colorado Front Range.

Mixing depth estimates for the ISC2 simulations were derived from linear interpolation for each 15-min period from the rawinsonde data taken every 12 h at Denver Stapleton airport. No precipitation was measured during any of the 12 tests, and there was no snow cover during February 1991.

Additional surface and upper air meteorological data were obtained from Denver Stapleton airport located about 25 km southeast of the RFETS. Surface data included wind speed and direction, cloud cover, and ceiling height and were used with the RFETS data to calculate stability class. The RATCHET and CALPUFF models utilized the wind speed and direction measurements in their wind field interpolation.

Surface observations from Denver Stapleton are strongly influenced by air movement within the Platte River Valley, which flows to the northeast from the city center. By contrast, Rocky Flats is more strongly influenced by its proximity to the foothills. Both locations are influenced by the diurnal pattern of upslope-downslope conditions that characterize the general air movement on the Colorado Front Range environs. Downslope conditions typically occur during the evening hours and are characterized by drainage flow of cooler surface air from the foothills and upper reaches of the Platte River Valley northeastward to the plains. Airflow at Rocky Flats is typically from the west-northwest, and converges with the flow from the south within the Platte River Valley in a broad zone 20 km–30 km east–northeast of the RFETS (Lange, 1992). During daylight hours and after surface heating has

eliminated the cooler surface layer, the downslope conditions cease. This is followed by a brief period of relatively calm winds, which in turn is followed by return of air up the valley or upslope conditions. Upslope conditions were weak to non-existent during the WVTS.

2.3. Atmospheric transport models and protocol

A brief description of each of the models included in this study is presented along with the modeling protocol. Because the SF₆ tracer is an inert gas, all model simulations did not include deposition and plume depletion.

2.3.1. AERMOD

The American Meteorological Society and EPA developed the AERMOD modeling system (Cimorelli et al. 2004). Model development began in 1991 with the objective to incorporate current planetary boundary layer concepts into regulatory compliance models. Treatment of both surface and elevated point sources, area sources, and volume sources in a simple or complex terrain model domain are addressed in the model. It was intended as a replacement of the Industrial Source Complex Version 3 (ISC3) model. Currently, AERMOD is the EPA's preferred model for regulatory compliance demonstration for criteria pollutants in the near field (<50 km).

2.3.1.1. AERMOD modeling protocol. The modeling domain consisted of a 46.2-km × 49.8-km region centered on the RFETS. Meteorological data were the same used in the CALPUFF simulation and included surface and upper-air data from Denver Stapleton airport and onsite data from RFETS.

AERMOD and AERMET version 12345 were used in the model simulations. Special processing of AERMOD output was required because minimum model-simulation times are one-day, and nine-hour averaging times are not an option. Nine-hour average concentrations were calculated by inputting the tracer release rate for the last nine hours of the 11-h tracer test and setting the release rate to zero for the remaining hours in the simulation. The maximum one-hour, and 12-h average concentration at each of the samplers for a simulation period that encompassed each test was output. The nine-hour average concentration was calculated by multiplying the 12-h average concentration by the ratio of 12/9.

2.3.2. CALPUFF

The CALPUFF modeling system (Scire et al., 2002) is a non-steady-state Lagrangian puff model that simulates pollutant transport, transformation, and deposition in a three-dimensional spatially and temporally variable wind field. CALPUFF can be applied on local and regional scales. The modeling system is composed of three primary modules: CALMET, CALPUFF, and CALPOST and collectively these are referred to as the CALPUFF modeling system.

The CALMET module is a meteorological model that generates a three-dimensional hourly wind field within a three-dimensional gridded modeling domain. The CALPUFF module uses the CALMET-generated wind field and micrometeorological parameters to advect and disperse “puffs”. The CALPOST module reads the CALPUFF concentration and deposition flux files and produces time-averaged concentration and deposition output along with visibility impacts.

CALPUFF is currently the EPA preferred long-range (>50 km) dispersion model for demonstration of compliance with Prevention of Significant Deterioration increment levels and National Ambient Air Quality Standards in Class I areas.

2.3.2.1. CALPUFF modeling protocol. A 45.2-km × 43.6-km model domain having a grid spacing of 400 m (113 × 109 grid cells) was established (Fig. 1). It was centered approximately on the WVTS release point and included the Platte River Valley in the southeast corner. Vertical discretization consisted of eight layers 20 m, 40 m, 60 m, 100 m, 200 m, 400 m, 800 m, 1200 m, and 1800 m above land surface.

For the CALMET simulations, EPA-Federal-Land-Manager-recommended parameter values (Fox, 2009) or CALMET default values were generally used where applicable. The model parameters BIAS, RMAX1, RMAX2, TERRAD, R1, and R2 were chosen on a site-specific basis. The BIAS parameter assigns weights to the surface and upper-air stations data for each vertical layer. Surface data were given 100% of the weight (BIAS = 1) in the first layer with zero weight in the last two vertical layers (BIAS = 1). Equal weight was assigned to the fourth layer (BIAS = 0) with a gradation of weights between the lower and upper for the remaining layers.

The RMAX1 and RMAX2 parameters define the maximum radius of influence for surface and upper data, respectively, over land surfaces. To incorporate the influence of flow in the Platte River Valley as represented by the surface data at Denver Stapleton airport, a value of 32 km for RMAX1 was used. The RMAX2 value serves the same purpose as RMAX1 but is used for upper-air data. A value of 100 km was selected for the RMAX2 parameter.

The TERRAD parameter defines the radius of influence of terrain features. A TERRAD value of 7 km was used so that the terrain

influence of the foothills encompassed RFETS. The parameters R1 and R2 are the distance from an observation where the observation and the initial guess field are equally weighted for surface and layers aloft, respectively. A value of 17 km and 56 km were chosen for R1 and R2, respectively.

The CALPUFF runs were performed using dispersion coefficients calculated from micrometeorological variables (MDISP = 2), and the simple CALPUFF-type terrain adjustment algorithm (MCTADJ = 2). The remaining parameters were CALPUFF defaults. CALPUFF Version 5.8, Level 070623, and CALMET Version 5.8, Level 060811, were used in the model simulations.

2.3.3. Industrial Source Complex Short Term Version 2 (ISC2)

The ISC2 model is an augmented steady-state Gaussian plume model primarily used to demonstrate regulatory compliance with criteria pollutants emitted by industrial facilities. It was replaced by ISC Version 3 and was the EPA preferred model until the promulgation of AERMOD in December of 2005. The model was included in the evaluation because straight-line Gaussian plume models form the basis of the CAP88 (EPA, 2007) model for demonstration of compliance with the Clean Air Act, and of the MACCS2 code (Chanin et al., 1998) for reactor accident consequence analysis.

2.3.3.1. ISC2 modeling protocol. The ISC2 simulations were performed by Haugen and Fontino (1993) using 15-min meteorological data from the 10-m level taken at the RFETS and mixing depth estimated from the rawinsonde data at Denver Stapleton airport. Four ISC2 runs were performed for each hour of simulation using the four, 15-min average data from the Rocky Flats meteorological station. The results from the four simulations were averaged to provide hourly-average concentrations at each of the sampler locations. These hourly concentrations were then averaged across each test by Rood (1999) to provide nine-hour average concentrations at each sampler.

The performance evaluation of this model was originally reported in Rood (1999) and Rood et al. (1999). The results presented here are based on the original data using slightly different performance measures.

2.3.4. RATCHET

The Regional Atmospheric Transport Code for Hanford Emission Tracking (RATCHET) (Ramsdell et al., 1994) is a Lagrangian puff model developed by Pacific Northwest Laboratories for the Hanford Dose Reconstruction Project (Farris et al., 1994). Its primary purpose was to estimate transport and deposition of ¹³¹I released from the Hanford facility across a 194,250 km² model domain located in eastern Washington State. The model includes a surface wind field interpolator that allows incorporation of multiple surface meteorological stations into a model simulation. Upper-air data were not considered in the model. Terrain complexities were not explicitly treated, but are implicitly represented by using multiple meteorological surface stations that reflect major topographical features. Surface roughness features are spatially variable across the model domain. Diffusion coefficients are estimated from statistics of atmospheric turbulence that are inferred from estimates of atmospheric stability, surface roughness length, and the Monin–Obukhov length. The current radiological assessment models, RASCAL (Ramsdell et al., 2010) and GENII (Napier, 2009), employ the RATCHET air dispersion model.

2.3.4.1. RATCHET modeling protocol. Model simulations with RATCHET were performed by the author (Rood et al., 1999) as part of Phase II of the Historical Public Exposures at Rocky Flats (Till et al., 2002). Hourly-average meteorological data at the 10-m level from the Rocky Flats plant and Denver Stapleton airport

were used in the model simulations. A 37-km × 37-km model domain centered on the RFETS with 500-m grid spacing was established. RATCHET does not allow discrete receptors, and therefore, calculated concentrations were extracted from the grid node nearest the sampler. Surface roughness lengths (z_0) ranged from 2-m in the foothills to 0.05-m in the farmland east of the RFETS.

2.4. Performance objectives

Performance objectives consisted of four fundamental plume properties and a paired and unpaired comparison of individual samplers. The four fundamental plume properties were maximum concentration, location of the plume maximum, plume width, and arc-integrated concentration. An additional objective of the maximum one-hour average concentration unpaired in space and time was also included to provide insight into model performance for short-term maximum concentrations. Descriptions of each modeling objective follows.

2.4.1. Maximum hourly and nine-hour average concentration and plume maximum location

This modeling objective compared the predicted and observed maximum one-hour and nine-hour average concentration measured at a sampler during the nine-hour test period at either the 8-km or 16-km distance from the release point. The predicted maximum concentration was not paired in space, and also unpaired in time for the maximum-hourly average concentration. The nine-hour average concentration was determined by a simple arithmetic average of the nine, one-hour average concentrations. Sampler data that were missing were not included when computing the predicted or observed average concentration.

The plume maximum location was only computed for the nine-hour average concentration and was quantified in terms of the absolute value of angular difference between the predicted and observed location of the plume maximum.

2.4.2. Plume width

The plume width objective evaluated the predicted impact area of the plume. Each sampler was assigned an arc length equal to the arc length between the midpoints of the sampler and each of its adjacent samplers. The plume width was sum of the arc lengths of samplers that had a concentration greater than zero, or in the case of the observed values, a concentration greater than the minimum detectable concentration.

2.4.3. Arc-integrated concentration

The arc-integrated concentration evaluated the plume mass at the 8-km and 16-km distance. The arc-integrated concentration is the sum of the product of the sampler arc lengths as defined in Section 2.4.2 and the nine-hour average predicted or observed concentration.

2.4.4. Unpaired time-averaged concentration

This modeling objective compared the ranked predicted and observed time-averaged (nine-hour) concentrations. Only predicted and observed concentrations that met the selection criteria stated in Section 2.6 were included. Samples were blocked into those performed at night (Tests 1, 2, 3, 4, 10, and 11), those performed during the day (Tests 6, 7, 9, and 12), and those performed during transition periods (Tests 5 and 8). Sample blocking is used in bootstrap resampling to avoid block-to-block variance (Chang and Hanna, 2005).

2.4.5. Paired ensemble means (ASTM procedure)

The American Society for Testing and Materials (ASTM) proposed a procedure for evaluation of models, recognizing that model predictions are ensemble-mean predictions, while observations correspond to realizations of ensembles (ASTM, 2000). An ensemble is defined as a set of experiments having fixed external conditions, such as meteorological conditions and downwind distance. In the WVTS, fixed external conditions were the distance to the sampling arc and meteorological conditions. In general, repeatable diurnal flow and stability regimes are established during nighttime, daytime, and day–night transitional periods along the Colorado Front Range. Thus, averages across the tests representing these similar conditions would approximate ensemble means to compare with model predictions for the same period.

Predictions and observations were grouped into three blocks consisting of nighttime (six tests), daytime (four tests), and transition period (two tests). Average concentrations were calculated across all tests in the block for each sampler, and performance statistics were calculated separately for each block.

2.5. Performance measures

Several simplified measures were used to evaluate model performance (Cox and Tikvart, 1990; Weil et al., 1992). These measures were the fractional bias (FB) and normalized mean square error (NMSE). Fractional bias is given by

$$FB = \frac{2(\bar{C}_o - \bar{C}_p)}{\bar{C}_o + \bar{C}_p} \quad (1)$$

where C_p and C_o are the predicted and observed concentrations, respectively. Overbars indicate averages over the sample. The NMSE given by

$$NMSE = \frac{(\overline{C_o - C_p})^2}{\bar{C}_o \bar{C}_p} \quad (2)$$

The FB is a measure of mean bias. A FB of 0.6 is equivalent to model under-prediction by about a factor of two. A negative value indicates model over-prediction. The NMSE is a measure of variance, and a value of 1.0 indicates that a typical difference between predictions and observations is approximately equal to the mean. The NMSE and FB are appropriate when the typical difference between the predictions and observations are approximately a factor of two (Hanna et al., 1991) and the range of predictions and observations in the dataset is small (i.e., less than a factor of two). This was not the case in this study where ratios of model predictions to observations often ranged from 0.01 to 100, and within a data set, the predicted and observed concentrations ranged from the zero to $\sim 10,000 \text{ ng m}^{-3}$. In these cases a log-transformed measure of model bias and variance is more appropriate because it provides a more balanced approach (Hanna et al., 1991). The log-transformed measures described in Hanna et al. (1991) are the geometric mean bias (MG) and the geometric mean variance (VG) and are defined by

$$MG = \exp\left(\overline{\ln C_o} - \overline{\ln C_p}\right) = \exp\left(\overline{\ln \frac{C_o}{C_p}}\right) \quad (3)$$

$$VG = \exp\left[\overline{(\ln C_o - \ln C_p)^2}\right] \quad (4)$$

Geometric mean bias values of 0.5 and 2.0 indicate a factor of two over-prediction and under-prediction, respectively. A VG value

of 1.6 indicates about a factor of two difference between predicted and observed data pairs.

A more easily understood log-transformed quantity that is related to the *MG* and *VG* is the geometric mean (*GM*) and geometric standard deviation (*GSD*) of the predicted-to-observed ratio (C_p/C_o). The *GM* and *GSD* are given by

$$GM = \exp\left(\overline{\ln \frac{C_p}{C_o}}\right) \quad (5)$$

$$GSD = \exp\left[\sqrt{\frac{1}{n-1} \sum_{i=1}^n \left(\ln \frac{C_{pi}}{C_{oi}} - \overline{\ln \frac{C_p}{C_o}}\right)^2}\right] \quad (6)$$

where n = the sample size. Because the *MG* is simply the inverse of the *GM*, only the *GM* is reported. A perfect model would have *FB* and *NMSE* values of 0, and *GM*, *GSD*, and *VG* values of 1.0. With the exception of the plume width and location of plume maximum performance objectives, the log-transformed performance measures are considered more appropriate than the *FB* and *NMSE*, and thus only the log-transformed measures are reported. The location of plume maximum does not lend itself to the above performance measures, mainly because the objective considered the absolute angular difference between the predicted and observed location of maximum. For this performance objective, the mean difference, standard deviation of the mean (i.e., standard error), and the minimum and maximum differences are reported. Because differences between predicted and observed values and the range of predictions and observations were less than about a factor of two, the *FB* and *NMSE* were considered more appropriate for the plume width objective.

In addition to the above measures, the correlation coefficient (r) between predicted and observed values and the number of predictions within a factor of two of the observations were also reported. The correlation coefficient was determined using least-squares linear regression and log-transformed data except for the plume width performance objective. Scatter plots were also included as visual measures of performance for the paired ensemble means and unpaired time-averaged concentration modeling objectives.

Confidence intervals were estimated for each of the performance measures using the bootstrap methodology described in BOOT software (Hanna et al., 1991; Chang and Hanna, 2005). Confidence intervals were used to determine if the estimated performance measure was significantly different than its optimum value and whether a statistically significant difference existed between the performance measures for each model. Confidence interval estimates were based on the cumulative density function generated from 1000 bootstrap samples.

2.6. Selection criteria

The observed data set only reported nonzero hourly average concentrations greater than the minimum detectable sampler concentration (*mdc*) of 33 ng m⁻³. Measured concentrations below this value were reported as zero. A sampler that had only one hour of data (in the nine-hour measurement period) greater than the *mdc* would have a nine-hour average concentration of 3.7 ng m⁻³ (33 ng m⁻³/9). This value represents the nine-hour time-averaged *mdc* for a sampler.

For the paired ensemble means performance objective, the dataset was based on the union of the predicted and observed concentrations. The *mdc* was substituted for predicted

concentrations that were less than the *mdc* if the paired observed concentration was greater than zero. Likewise, the *mdc* was substituted for observed concentrations less than the *mdc* if the paired predicted concentration was greater than zero. Predicted and observed pairs that were both zero were omitted from the analysis.

For the unpaired analysis only predicted and observed concentration pairs greater than the *mdc* were considered. Samplers missing all nine hours of data were eliminated from the data set.

3. Results

The paired ensemble means and unpaired scatter plots are perhaps the most illustrative in terms of summarizing model performance qualitatively (Figs. 2–5). In general, the highest predicted and observed concentrations were during nighttime and transition period tests and the lowest during daytime tests.

The paired ensemble mean scatter plot at the 8-km distance (Fig. 2) showed the transition period tests as having the highest observed concentrations, some exceeding 8000 ng m⁻³. Nighttime tests had maximum observed concentrations between 3000 and 4000 ng m⁻³. As expected, daytime tests had the lowest observed maximum concentrations, the maximum being slightly less than 600 ng m⁻³. All models performed poorly for the transition period tests, underestimating observed concentrations that were >1000 ng m⁻³. In general, the puff models exhibited better correlation to the observations for daytime and nighttime tests and concentrations that were >100 ng m⁻³ compared to the steady-state models.

At the 16-km distance (Fig. 3) the nighttime period tests had the highest observed concentrations (~3500 ng m⁻³), followed by transition period tests (~1800 ng m⁻³). Daytime tests had maximum observed concentrations that were ~70 ng m⁻³. The puff models exhibited better correlation, less variability, and a greater number of points within a factor of two of the observations compared to the steady state models for nighttime tests and concentrations >100 ng m⁻³.

Scatter plots of the unpaired data at the 8-km distance (Fig. 4) showed that all models underestimated transition period observed concentrations that were greater than 1000 ng m⁻³. Predicted concentrations from RATCHET were within a factor of two of the observations for almost all the daytime tests and most of the nighttime tests for the entire concentration range. Most of the ISC2 concentrations for daytime and nighttime tests were within a factor of two of the observations for concentrations that were >100 ng m⁻³.

At the 16-km distance (Fig. 5), scatter plots of the unpaired data were similar to those at the 8-km distance, although CALPUFF underestimated almost all the concentrations for transition period tests by more than a factor of two. The three highest observed concentrations were within a factor of two of the corresponding AERMOD predicted concentrations. A similar result was found for ISC2, except the highest observed nighttime concentration was underestimated by more than a factor of two. Observed nighttime concentrations that were <100 ng m⁻³ were overestimated by more than a factor of two by RATCHET.

3.1. Maximum one-hour and nine-hour average concentration

Performance measure results for the maximum one-hour average concentration modeling objective (Table 2) indicate a strong positive bias for the steady-state models, especially AERMOD, and nearly no bias for puff models RATCHET and CALPUFF (GM confidence interval included 1.0). The positive bias for the steady-state models was greater at the 16-km distance. Ninety-two percent of the ISC2-estimated maximum one-hour average

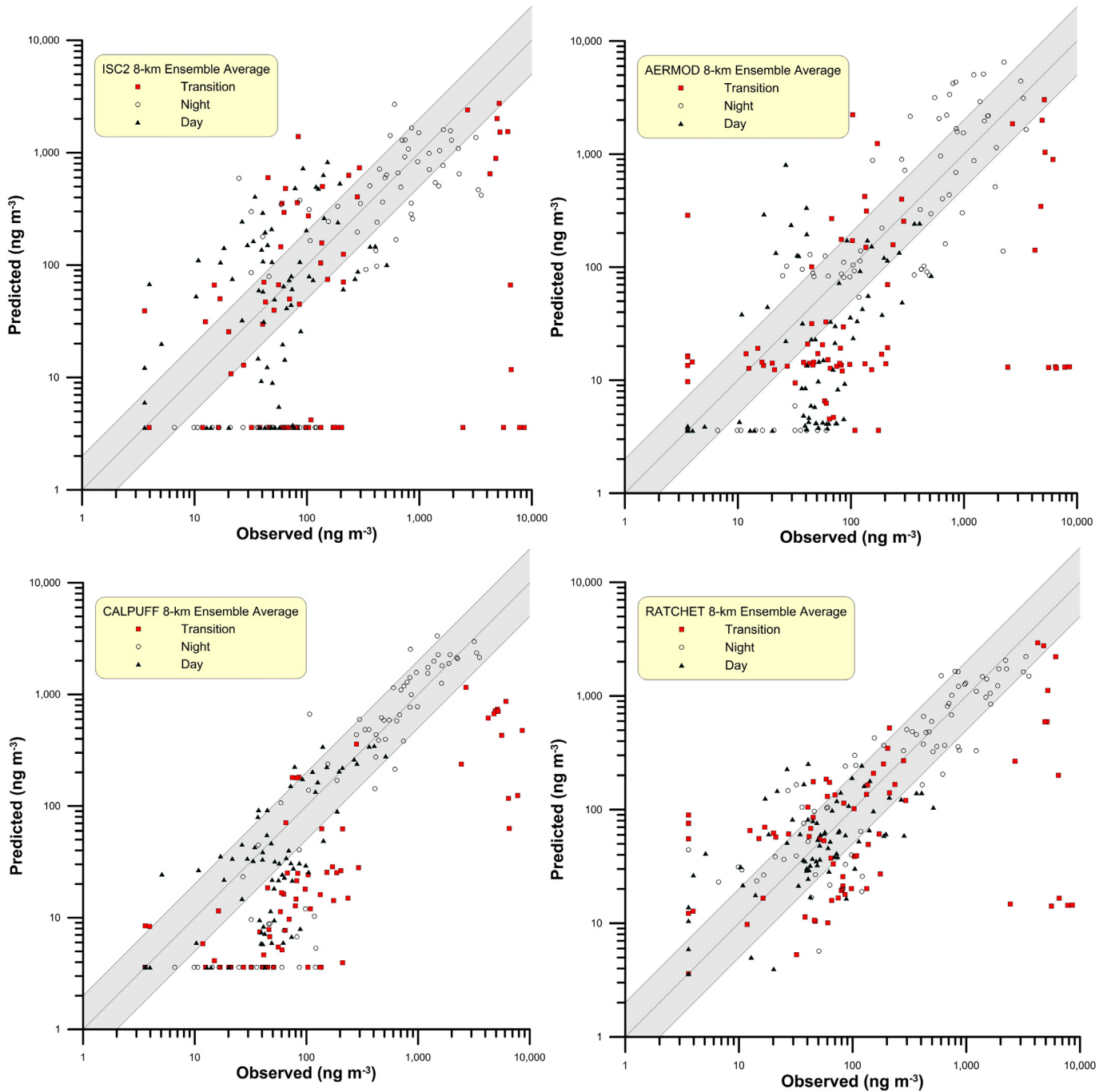


Fig. 2. Scatter plots of paired nine-hour average ensemble mean concentrations at the 8-km distance. Points that lie within the shaded region are within a factor of 2 of the observations.

concentrations and 83% of the AERMOD values had predicted-to-observed ratios of 0.95 or higher. In contrast, only 50% of the CALPUFF- and RATCHET-estimated maximum one-hour average concentrations had a predicted-to-observed ratio greater than 0.95.

Predicted maximum nine-hour average concentrations (Table 3) showed a similar trend to those of the maximum hourly-average concentrations. That is, the steady-state models exhibited positive bias, while the Lagrangian puff models exhibited negative bias. However, the GM confidence interval included 1.0 for all models. Measures of variance were generally lower for the puff models and correlation coefficients were higher compared to the steady state models.

Measures of bias among the steady state models were significantly different from those of the puff models (Table 4). None of the model performance measures for CALPUFF and RATCHET were significantly different from one another.

3.2. Plume maximum location, plume width, and arc-integrated concentration

Plume maximum location at the 8-km distance (Table 5) showed that the mean deviation was smallest for AERMOD and RATCHET (14°) and greatest for CALPUFF and ISC2 (26 and 24° respectively). Based on a *t*-test difference of the means, the

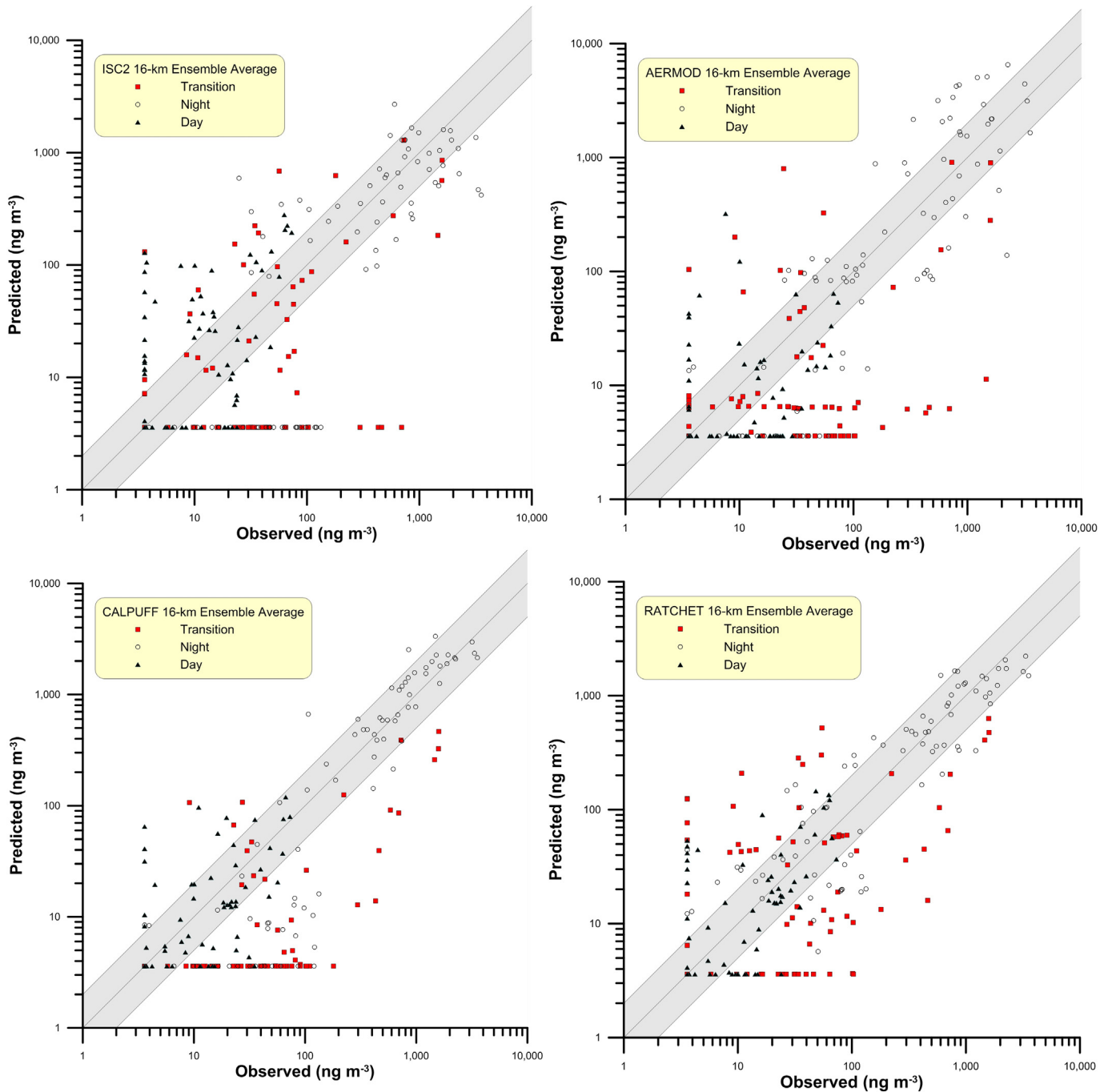


Fig. 3. Scatter plots of paired nine-hour average ensemble mean concentrations at the 16-km distance. Points that lie within the shaded region are within a factor of 2 of the observations.

mean deviation for CALPUFF and ISC2 was significantly different from the mean deviation for AERMOD and RATCHET ($P > 0.005$).

Plume width performance measures at the 8-km distance (Table 5) showed that ISC2 and CALPUFF underestimated plume width while RATCHET and AERMOD overestimated plume width. Although the FB confidence interval for CALPUFF included the optimum value of zero and CALPUFF had the smallest NMSE value.

Arc-integrated concentration at the 8-km distance showed little bias for the steady state models (GM confidence interval included 1.0) and a negative bias for the puff models. However, only 50% of

the predictions were within a factor of two for the steady-state models while over 90% of the predictions were within a factor of two for the puff models.

Plume maximum location at the 16-km distance (Table 6) showed that the mean deviation was smallest for CALPUFF and RATCHET (26 and 24 degrees respectively) and greatest for ISC2 and AERMOD (34 and 36 degrees respectively). Based on a t -test difference of the means, the differences between the steady state and puff models were significant at the 99% level ($0.01 < P < 0.005$).

Plume width performance measures at the 16-km distance (Table 6) showed that ISC2 underestimated plume width while

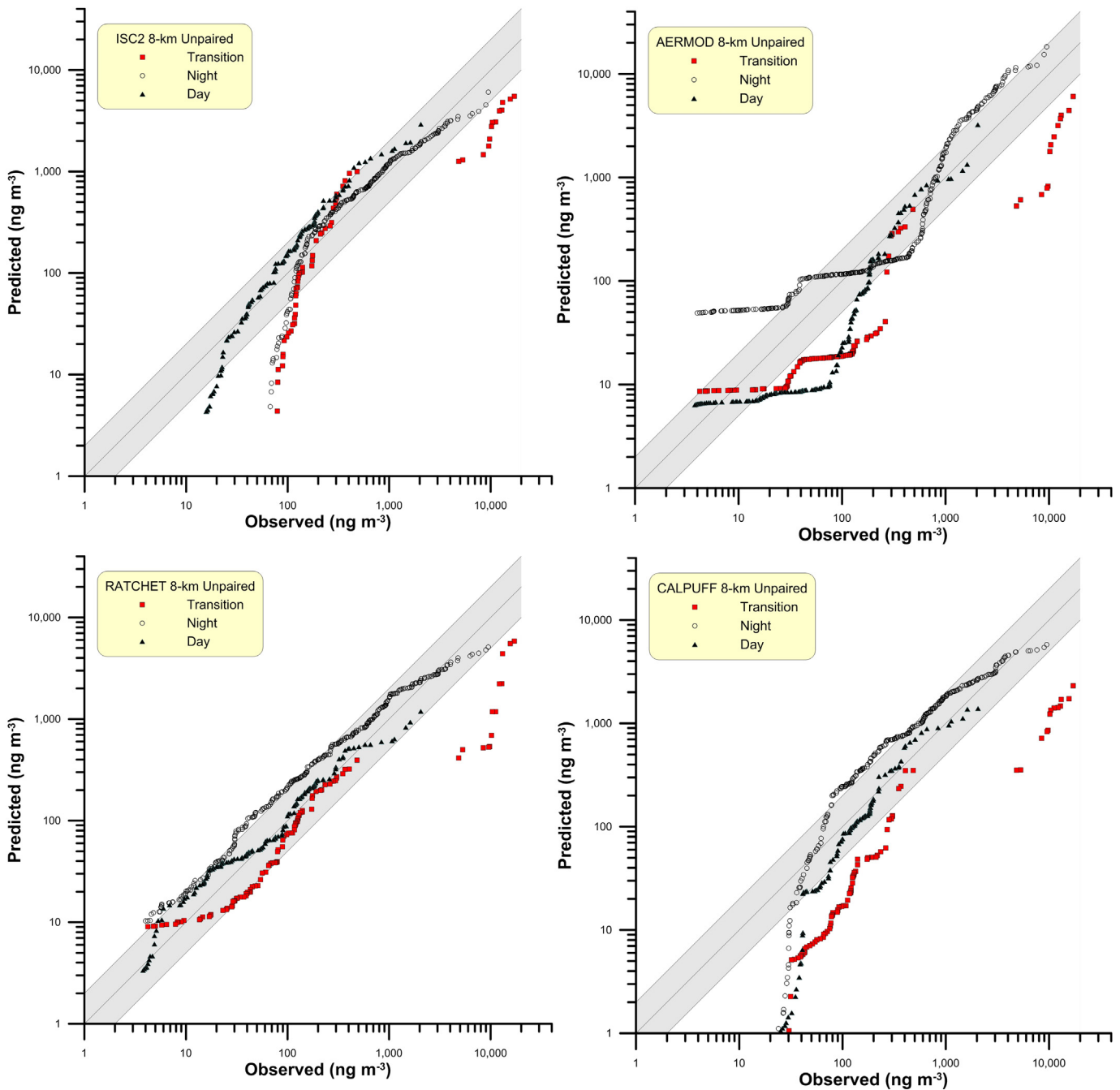


Fig. 4. Scatter plots of unpaired nine-hour average concentrations at the 8-km distance. Points that lie within the shaded region are within a factor of 2 of the observations.

RATCHET and AERMOD overestimated plume width. The CALPUFF *FB* was not significantly different from zero.

Arc-integrated concentration at the 16-km distance showed positive bias for ISC2. The GM confidence interval for the other models included the optimum value of 1.0. Puff models showed a greater percentage of predictions within a factor of two of the observations.

Significant differences among models (Table 7) were noted for the bias performance measures and the correlation coefficients.

3.3. Unpaired nine-hour average concentration

The performance measure results at the 8-km distance for the unpaired nine-hour average concentration (Table 8) indicated a

negative bias in predicted concentrations for AERMOD and CALPUFF, slight negative bias for ISC2, and positive bias for RATCHET. ISC2 and RATCHET also had the smallest variance, highest correlation coefficient, and highest percentage of predictions within a factor of two of the observations.

At the 16-km distance, ISC2 and RATCHET exhibited positive bias, AERMOD exhibited negative bias, and CALPUFF nearly no bias. RATCHET and ISC2 had the highest correlation coefficients and CALPUFF and RATCHET had the highest percentage of predictions within a factor of two of the observations.

Except for AERMOD and CALPUFF at the 8-km distance, and ISC2 and RATCHET at the 16-km distance, all bias performance measures among the models were significantly different from one another (Table 9).

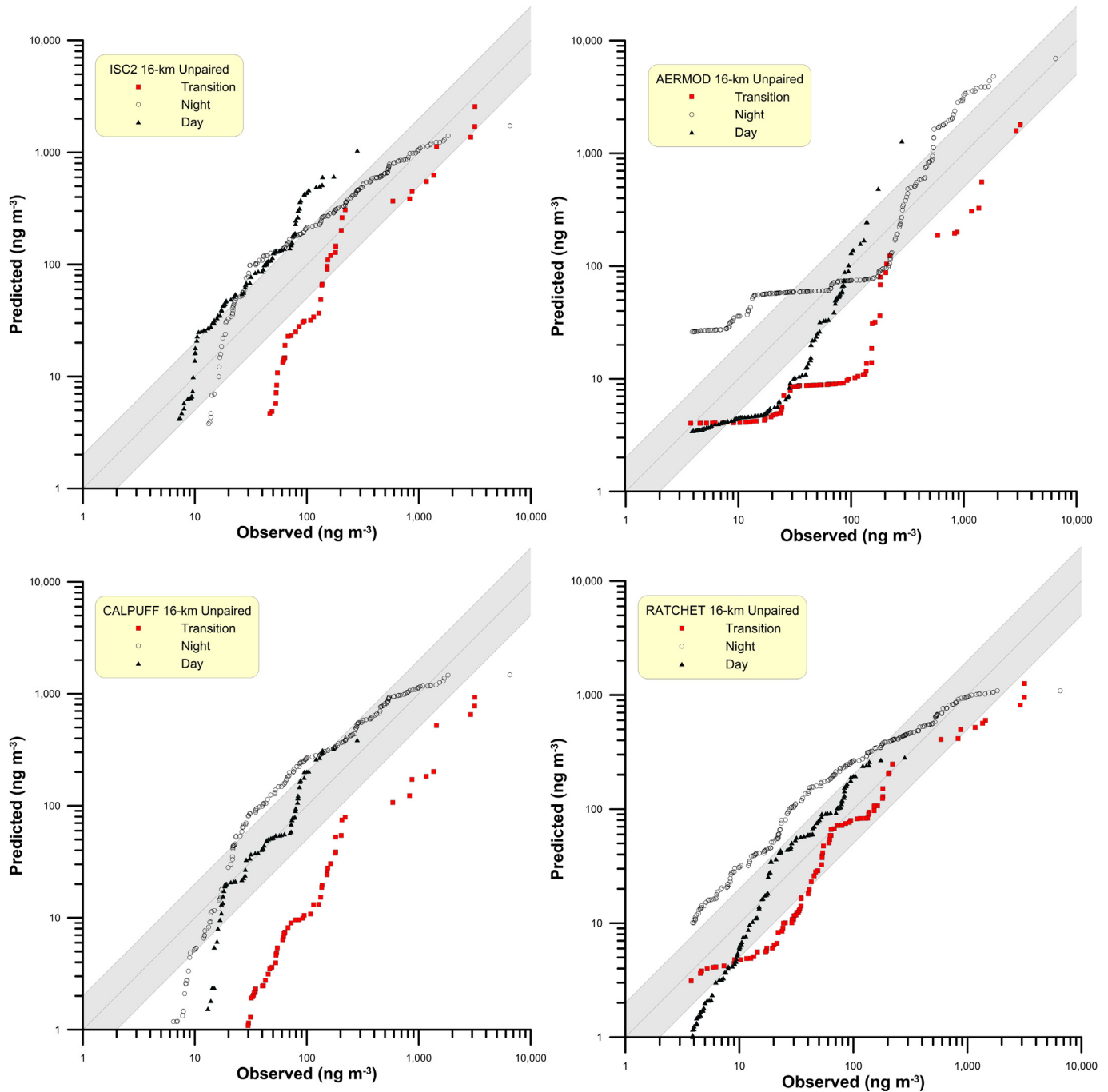


Fig. 5. Scatter plots of unpaired nine-hour average concentrations at the 16-km distance. Points that lie within the shaded region are within a factor of 2 of the observations.

3.4. Paired ensemble means

No one model showed overall better performance across all ensemble groups and all models performed poorly for the transition period ensemble means (Tables 10 and 11). However, excluding the transition ensemble means, RATCHET and CALPUFF had the highest percentage of predictions within a factor of two of the observations, the highest correlation coefficients, and generally the lowest variance compared to the steady-state models. For daytime and nighttime ensemble means, the GM confidence interval for RATCHET encompassed 1.0 at both the 8- and 16-km distances. AERMOD was biased low for daytime tests and showed little bias for nighttime tests (GM confidence interval encompassed 1.0). ISC2

exhibited no bias for daytime tests (GM = 1.0) at the 8-km distance but was biased high at the 16 km distance (GM confidence interval excluded 1.0). For nighttime tests, ISC2 was biased low at the 8-km distance but exhibited nearly zero bias at the 16 km distance. CALPUFF was biased low for daytime and nighttime tests at the 8-km distance (GM confidence interval excluded 1.0), but the GM confidence interval encompassed 1.0 at the 16-km distance.

All models were biased low for the transition period ensemble means at both the 8 and 16-km distances, and exhibited large variances, although the variance measures for CALPUFF and RATCHET were considerably smaller than those for ISC2 and AERMOD. Puff model VG and r values were significantly different than steady-state models for nighttime tests at the 16-km distance (Table 12).

Table 2
Performance measures for the maximum one-hour average concentration unpaired in time and space modeling objective.

	ISC2	AERMOD	CALPUFF	RATCHET
8-km results				
GM C_p/C_o	1.9	3.4	0.99	0.92
GM confidence interval	1.24–2.87	2.15–5.94	0.65–1.56	0.55–1.65
GSD C_p/C_o	2.2	3.4	2.2	2.8
VG	2.7	17.4	1.8	2.6
log (VG) confidence interval	0.40–1.59	1.78–4.15	0.26–0.92	0.48–1.35
<i>r</i>	0.748	0.742	0.76	0.612
<i>r</i> confidence interval	0.55–0.92	0.46–0.90	0.58–0.96	0.27–0.89
% within a factor of 2	33.3%	25.0%	58.3%	58.3%
16-km results				
GM C_p/C_o	2.7	4.9	0.98	0.93
GM confidence interval	1.71–3.94	2.40–9.34	0.59–1.62	0.57–1.47
GSD C_p/C_o	2.2	3.5	2.8	2.5
VG	4.7	54.8	2.7	2.2
log (VG) confidence interval	0.57–2.42	2.25–5.85	0.41–1.47	0.55–1.07
<i>r</i>	0.885	0.727	0.742	0.828
<i>r</i> confidence interval	0.78–0.97	0.55–0.92	0.58–0.93	0.69–0.95
% within a factor of 2	50.0%	16.7%	50.0%	58.3%

4. Discussion

Model performance is judged in terms of the assessment question that the model is intended to address. As stated in the introduction, the assessment questions are different for a prospective regulatory compliance calculation compared to a retrospective dose reconstruction.

In terms of the prospective assessment where it is important that regulatory limits are not exceeded (i.e., highest concentrations are not underestimated), the steady-state models were less likely to underestimate maximum one- and nine-hour average concentrations compared to the Lagrangian puff models. However, this result is not only due to differences in model formulation, but also the model parameters such as diffusion coefficients. The unpaired scatter plots (Figs. 4 and 5) showed that the *maximum* observed concentration across all tests was not underestimated by AERMOD at both the 8 and 16-km distance, although the time and place of the observed maximum was not the same as the predicted maximum.

In terms of the retrospective assessment where the objective is an unbiased estimate of the concentration in space and time, the

Table 3
Performance measures for the maximum nine-hour average concentration unpaired in time and space modeling objective.

	ISC2	AERMOD	CALPUFF	RATCHET
8-km results				
GM C_p/C_o	1.2	1.5	0.79	0.75
GM confidence interval	0.70–2.02	0.94–2.52	0.59–1.03	0.55–1.00
GSD C_p/C_o	2.9	3.0	1.9	1.8
VG	2.9	3.6	1.6	1.5
log (VG) confidence interval	0.78–1.39	0.69–1.88	0.08–0.82	0.13–0.68
<i>r</i>	0.56	0.73	0.86	0.90
<i>r</i> confidence interval	0.35–0.88	0.49–0.89	0.67–0.98	0.78–0.98
% within a factor of 2	33.3%	16.7%	91.7%	75.0%
16-km results				
GM C_p/C_o	1.4	1.8	0.90	0.85
GM confidence interval	0.96–1.99	0.94–3.14	0.59–1.30	0.56–1.23
GSD C_p/C_o	2.7	3.1	2.4	2.6
VG	2.9	4.4	2.0	2.4
log (VG) confidence interval	0.41–1.76	0.86–2.17	0.27–1.31	0.40–1.44
<i>r</i>	0.80	0.76	0.87	0.84
<i>r</i> confidence interval	0.66–0.96	0.63–0.90	0.81–0.94	0.68–0.97
% within a factor of 2	58.3%	16.7%	66.7%	41.7%

Table 4
Significant differences in model performance measures for the maximum one-hour and nine-hour-average concentration unpaired in space and time modeling objective. An “X” indicates a significant difference.

Model	8-km data			16-km data		
	GM	VG	<i>r</i>	GM	VG	<i>r</i>
Maximum one-hour						
ISC2-AERMOD	X	X		X	X	X
ISC2-CALPUFF	X			X		
ISC2-RATCHET	X			X		
AERMOD-CALPUFF	X	X		X	X	
AERMOD-RATCHET	X	X		X	X	
CALPUFF-RATCHET						
Maximum nine-hour						
ISC2-AERMOD						
ISC2-CALPUFF	X			X		
ISC2-RATCHET	X	X	X	X		
AERMOD-CALPUFF	X			X		
AERMOD-RATCHET	X	X	X	X		
CALPUFF-RATCHET						

Lagrangian puffs models showed overall better performance, especially at the 16-km distance. In most cases, the Lagrangian puff models for the paired ensemble means exhibited lower variance higher correlation to observed values and a higher percentage of observations within a factor of two of the observations compared to steady-state models.

In terms of the four fundamental plume properties, the steady-state models tended to overestimate maximum concentrations but provide unbiased estimates of the plume mass at the 8-km distance and the 16-km distance for ISC2. Puff models tended to slightly underestimate plume maximums, but were better at locating the

Table 5
Performance measures for plume maximum location, plume width, and the arc integrated concentration at the 8-km distance.

	ISC2	AERMOD	CALPUFF	RATCHET
Plume maximum location				
Mean deviation (degrees)	26	14	24	14
Standard error (degrees)	11	3.0	10	3.2
Minimum (degrees)	4.2	0.0	3.3	0.0
Maximum (degrees)	133	31	129	29
Plume width				
FB	0.42	–0.43	0.14	–0.34
FB confidence interval	0.31–0.54	–0.52 to –0.35	–0.06 to 0.37	–0.51 to –0.15
NMSE	0.25	0.22	0.15	0.25
NMSE confidence interval	0.13–0.38	0.15–0.32	0.07–0.31	0.15–0.36
<i>r</i>	0.57	0.19	0.71	–0.22
<i>r</i> confidence interval	0.00–0.88	–0.24 to 0.50	0.44–0.88	–0.79 to 1.00
% within a factor of 2	83.3%	91.7%	75.0%	91.7%
Arc-integrated concentration				
GM C_p/C_o	1.1	0.94	0.76	0.79
GM confidence interval	0.71–1.66	0.68–1.29	0.61–0.94	0.60–1.03
GSD C_p/C_o	2.4	2.3	2.0	1.8
VG	2.1	1.9	1.7	1.5
log (VG) confidence interval	0.52–0.93	0.29–0.94	0.07–0.98	0.05–0.70
<i>r</i>	0.81	0.86	0.86	0.89
<i>r</i> confidence interval	0.64–0.96	0.67–0.96	0.60–1.00	0.75–0.98
% within a factor of 2	50.0%	50.0%	91.7%	91.7%

Table 6

Performance measures for plume maximum location, plume width, and the arc integrated concentration at the 16-km distance.

	ISC2	AERMOD	CALPUFF	RATCHET
Plume maximum location				
Mean deviation (degrees)	34	36	26	23
Standard error (degrees)	9.4	9.0	8.0	7.2
Minimum (degrees)	0.0	0.0	3.8	0.0
Maximum (degrees)	95	98	86	74
Plume width				
FB	0.30	−0.57	0.081	−0.47
FB confidence interval	0.10–0.49	−0.71 to −0.44	−0.18 to 0.37	−0.66 to −0.27
NMSE	0.26	0.44	0.26	0.39
NMSE confidence interval	0.09–0.42	0.28–0.63	0.11–0.48	0.20–0.60
<i>r</i>	0.074	−0.022	0.49	0.065
<i>r</i> confidence interval	−0.36 to 0.51	−0.63 to 0.36	0.20–0.79	−0.57 to 0.54
% within a factor of 2	83.3%	50.0%	66.7%	58.3%
Arc-integrated concentration				
GM C_p/C_o	1.4	1.2	0.88	1.1
GM confidence interval	1.11–1.87	0.77–1.70	0.66–1.16	0.77–1.60
GSD C_p/C_o	2.0	2.4	1.9	2.1
VG	1.8	2.1	1.5	1.6
log (VG) confidence interval	0.28–0.85	0.36–1.15	0.13–0.71	0.40–0.58
<i>r</i>	0.92	0.85	0.87	0.82
<i>r</i> confidence interval	0.88–0.97	0.75–0.96	0.70–0.98	0.76–0.89
% within a factor of 2	66.7%	50.0%	75.0%	83.3%

plume maximum at the 16-km distance. CALPUFF appeared to more accurately estimate the plume impact region, whereas AERMOD and RATCHET tended to overestimate it and ISC2 underestimated it.

The WVTS consists of only 108 h of measurements taken during February 1991 and are not representative of annual average concentrations. However, the high sampler density resulted in the

Table 7

Significant differences in model performance measures for the plume width and arc integrated concentration modeling objective. An “X” indicates a significant difference.

Model	8-km data			16-km data		
	FB	NMSE	<i>r</i>	FB	NMSE	<i>r</i>
Plume width						
ISC2-AERMOD	X			X		
ISC2-CALPUFF						
ISC2-RATCHET	X			X		
AERMOD-CALPUFF	X		X	X		
AERMOD-RATCHET						
CALPUFF-RATCHET	X		X	X		
Model	8-km data			16-km data		
	GM	VG	<i>r</i>	GM	VG	<i>r</i>
Arc-integrated concentration						
ISC2-AERMOD						
ISC2-CALPUFF				X		
ISC2-RATCHET	X					X
AERMOD-CALPUFF						
AERMOD-RATCHET						
CALPUFF-RATCHET						

Table 8

Performance measures for the unpaired nine-hour averaged concentration modeling objective.

	ISC2	AERMOD	CALPUFF	RATCHET
8-km results				
GM C_p/C_o	0.93	0.82	0.89	1.3
GM confidence interval	0.90–1.00	0.77–0.87	0.84–0.92	1.22–1.31
GSD C_p/C_o	1.9	2.8	2.7	1.8
GSD confidence interval	1.77–1.96	2.62–2.88	2.56–2.76	1.66–1.90
<i>n</i>	392	564	430	560
VG	1.5	2.9	2.5	1.5
log (VG) confidence interval	0.33–0.46	0.97–1.16	0.89–1.04	0.32–0.46
<i>r</i>	0.92	0.87	0.87	0.95
<i>r</i> confidence interval	0.91–0.94	0.85–0.89	0.85–0.89	0.94–0.96
% within a factor of 2	85%	56%	58%	81%
16-km results				
GM C_p/C_o	1.4	0.86	1.1	1.4
GM confidence interval	1.35–1.50	0.81–0.92	1.08–1.19	1.32–1.45
GSD C_p/C_o	2.1	2.9	2.5	2.0
GSD confidence interval	1.93–2.17	2.75–3.04	2.43–2.62	1.94–2.08
<i>n</i>	316	410	299	399
VG	1.9	3.2	2.4	1.8
log (VG) confidence interval	0.57–0.71	1.04–1.25	0.80–0.94	0.54–0.63
<i>r</i>	0.88	0.82	0.82	0.90
<i>r</i> confidence interval	0.86–0.90	0.79–0.85	0.80–0.85	0.89–0.91
% within a factor of 2	51%	49%	62%	62%

likelihood that the maximum concentration was detected at either the 8-km or 16-km sampling distance. Moreover, the tests were conducted during the wintertime when stable dispersion conditions would likely result in the maximum one- or eight-hour average concentration over the course of a year. Achieving compliance with National Ambient Air Quality Standards typically is limited by the short-term average concentration limits. Therefore, these results have relevance in terms of model performance for short-term averages over the period of a year.

5. Conclusions

No one single model consistently out-performed the others in all performance objectives or measures and the state-of-the-art models (CALPUFF and AERMOD) did not exhibit superior performance in all performance objectives to the legacy models (ISC2 and RATCHET). Lagrangian puff models generally exhibited smaller variances, higher correlation, and higher percentage of predictions within a factor of two compared to the steady-state models at these distances. The conceptual framework of a Lagrangian puff model is better suited for long range transport where winds vary spatially across the model domain. Hence, Lagrangian puff models may be preferable for dose reconstruction where model domains can be large and where the assessment question is an unbiased estimate of concentration in time and space. However, model choice depends on site-specific considerations and the assessment questions to be addressed, and therefore no categorical statement can be made

Table 9

Significant differences in model performance measures for the unpaired nine-hour average concentration modeling objective. An “X” indicates a significant difference.

Model	8-km data			16-km data		
	GM	VG	<i>r</i>	GM	VG	<i>r</i>
ISC2-AERMOD	X	X	X	X	X	X
ISC2-CALPUFF	X	X	X	X	X	X
ISC2-RATCHET	X		X			
AERMOD-CALPUFF		X		X	X	
AERMOD-RATCHET	X	X	X	X	X	X
CALPUFF-RATCHET	X	X	X	X	X	X

Table 10
Performance measures for the daytime, transition, and nighttime period ensemble means modeling objective at the 8-km distance.

	ISC2	AERMOD	CALPUFF	RATCHET
Daytime tests				
GM C_p/C_o	1.0	0.43	0.61	1.05
GM confidence interval	0.71–1.46	0.31–0.59	0.49–0.76	0.87–1.30
GSD C_p/C_o	4.7	4.3	2.6	2.5
GSD confidence interval	3.87–5.60	3.25–5.36	2.29–2.92	2.16–2.87
VG	11	16	3.2	2.3
log (VG) confidence interval	1.83–2.97	2.12–3.45	0.81–1.52	0.59–1.11
r	0.45	0.46	0.74	0.63
r confidence interval	0.26–0.58	0.28–0.62	0.62–0.82	0.46–0.76
% within a factor of 2	32%	38%	61%	69%
Transition period tests				
GM C_p/C_o	0.3	0.31	0.19	0.56
GM confidence interval	0.15–0.48	0.19–0.51	0.15–0.25	0.36–0.90
GSD C_p/C_o	12.1	8.3	3.4	7.4
GSD confidence interval	8.06–19.6	5.30–12.5	2.70–4.07	4.44–11.0
VG	2024	326	68.2	71.2
log (VG) confidence interval	5.19–11.50	3.49–8.31	3.32–5.17	2.31–6.56
r	0.36	0.41	0.82	0.43
r confidence interval	0.01–0.51	0.17–0.61	0.73–0.88	0.18–0.66
% within a factor of 2	35%	38%	18%	40%
Nighttime period tests				
GM C_p/C_o	0.5	0.84	0.56	1.0
GM confidence interval	0.36–0.71	0.64–1.10	0.43–0.75	0.86–1.25
GSD C_p/C_o	4.3	3.4	3.3	2.4
GSD confidence interval	3.45–5.47	2.89–3.95	2.67–3.84	2.00–2.72
VG	12.9	4.6	5.6	2.1
log (VG) confidence interval	1.81–3.46	1.13–1.96	1.08–2.41	0.48–1.00
r	0.79	0.86	0.92	0.87
r confidence interval	0.68–0.86	0.79–0.90	0.88–0.95	0.82–0.91
% within a factor of 2	53%	47%	68%	72%

Table 11
Performance measures for the daytime, transition, and nighttime period ensemble means modeling objective at the 16-km distance.

	ISC2	AERMOD	CALPUFF	RATCHET
Daytime tests				
GM C_p/C_o	1.6	0.72	0.94	1.10
GM confidence interval	1.18–2.27	0.54–0.96	0.75–1.19	0.90–1.41
GSD C_p/C_o	3.7	3.4	2.6	2.7
GSD confidence interval	3.11–4.54	2.60–4.39	2.15–3.21	2.21–3.24
VG	6.81	5.04	2.54	2.73
log (VG) confidence interval	1.44–2.68	1.09–2.23	0.60–1.35	0.63–1.42
r	0.41	0.27	0.55	0.57
r confidence interval	0.11–0.57	0.02–0.53	0.33–0.72	0.34–0.74
% within a factor of 2	40%	56%	69%	72%
Transition period tests				
GM C_p/C_o	0.4	0.29	0.20	0.61
GM confidence interval	0.24–0.59	0.18–0.47	0.15–0.28	0.39–0.94
GSD C_p/C_o	6.3	6.8	3.8	6.2
GSD confidence interval	4.67–8.31	4.91–9.00	2.99–4.59	4.70–7.72
VG	72.31	169.10	69.42	33.82
log (VG) confidence interval	3.02–5.85	3.79–6.46	3.41–5.12	2.76–4.38
r	0.40	0.22	0.60	0.32
r confidence interval	0.11–0.60	–0.13 to 0.49	0.35–0.76	0.07–0.54
% within a factor of 2	37%	30%	30%	27%
Nighttime period tests				
GM C_p/C_o	1.2	1.2	0.90	1.1
GM confidence interval	0.89–1.72	0.86–1.51	0.73–1.09	0.93–1.33
GSD C_p/C_o	3.8	3.5	2.5	2.2
GSD confidence interval	2.82–5.07	2.84–4.08	2.11–2.83	1.80–2.62
VG	6.0	4.6	2.3	1.8
log (VG) confidence interval	1.07–2.79	1.09–2.02	0.57–1.10	0.35–0.95
r	0.74	0.82	0.91	0.92
r confidence interval	0.60–0.85	0.73–0.89	0.87–0.94	0.87–0.95
% within a factor of 2	54%	53%	68%	76%

Table 12
Significant differences in model performance measures for the day, transition, and nighttime ensemble means modeling objective. An “X” indicates a significant difference.

Model	8-km data			16-km data		
	GM	VG	r	GM	VG	r
Daytime						
ISC2-AERMOD	X			X		
ISC2-CALPUFF	X	X	X	X	X	
ISC2-RATCHET		X			X	
AERMOD-CALPUFF		X	X		X	
AERMOD-RATCHET	X	X		X		
CALPUFF-RATCHET	X			X		
Transition						
ISC2-AERMOD						
ISC2-CALPUFF		X	X	X		
ISC2-RATCHET		X				
AERMOD-CALPUFF			X			X
AERMOD-RATCHET				X		
CALPUFF-RATCHET	X		X	X		
Nighttime						
ISC2-AERMOD	X	X				
ISC2-CALPUFF			X		X	X
ISC2-RATCHET	X	X			X	X
AERMOD-CALPUFF			X		X	X
AERMOD-RATCHET		X			X	X
CALPUFF-RATCHET	X	X				

about the performance of one type of model over the other for a specific application.

The steady-state models generally did not underestimate the high-end concentrations at the distances studied, and therefore provide a sound basis for regulatory compliance modeling. Based on the overall performance of ISC2, assessment models that rely on the Gaussian plume model are not necessarily inferior to the current state-of-the-art models in terms of meeting regulatory performance objectives.

There was a general tendency for the steady-state models to predict relatively higher concentrations at the 16-km distance compared to the 8-km distance. This effect is important because it manifests itself at substantially shorter distances (16 km) than what is defined by the EPA as the near-field environment (≤ 50 km). The EPA requires AERMOD for the near-field environment for demonstration of regulatory compliance, unless compelling reasons are provided to justify the use of an alternative model. Thus, estimated maximum hourly-average concentrations at distances > 16 km are likely to be overestimated based on these results. Other investigators (Dresser and Huizer, 2011) found AERMOD to underestimate near-field maximum one- and three-hour average SO₂ concentrations based on data from the Martins Creek Power Plant. However, only eight samplers were used in the study and it is possible (if not likely) that the true maximum concentration in the model domain was not captured. In the WVTS, it was less likely that the maximum concentration within a sampling arc went undetected.

Finally, a compelling reason to use steady-state models for regulatory compliance demonstration is the fact that they are simpler to run, require less user judgment, and are less prone to error than Lagrangian puff models. The CALMET/CALPUFF model simulation in this paper required numerous iterations using different values of RMAX1, RMAX2, and other parameters so that the wind field matched what was expected. In a prospective analysis, it is unlikely tracer or other validation data would be available to test model performance and adjust model parameters accordingly to improve model performance. The need for consistency and assurance that estimated concentrations are not underestimated

are legitimate reasons for using steady-state models for regulatory compliance determination.

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Attachment N

Kentucky Energy and Environment Cabinet July 2017 Comments on the Corrective Action Plan



MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ENERGY AND ENVIRONMENT CABINET
Department for Environmental Protection

AARON B. KEATLEY
COMMISSIONER

300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601

July 21, 2017

Mr. Philip Comella, Esq.
Freeborn & Peters, LLP
311 S. Wacker Dr., STE 3000
Chicago, IL 60606

RE: Blue Ridge Landfill Corrective Action Plan-Cabinet Comments
Blue Ridge Landfill, Estill Co., Kentucky
Agreed Order Case No. DWM - 160048
Agency Interest No. 998, Estill County

Dear Mr. Comella:

The Energy and Environment Cabinet (Cabinet) has completed its review of the Corrective Action Plan (CAP) for the Blue Ridge Landfill, Estill County, Kentucky which was received in our offices on May 4, 2017. The CAP was prepared pursuant to paragraph 19 of the above-referenced agreed order. The cabinet is providing the attached comments on the CAP. As required by the agreed order, please provide a revised CAP addressing the comments pursuant to paragraph 20 within thirty (30) days of receipt of the comments.

We appreciate your cooperation in this matter. Should you have questions regarding the comments you may contact me at (502) 782-6956, or Tim Hubbard, Environmental Scientist Consultant Senior in the Division of Waste Management's Director's Office at (502) 782-6660.

Sincerely,

Jeffery A. Cummins, Director
Division of Enforcement

Attachment

cc: Jon Maybriar, DWM
Tim Hubbard, DWM
Philip Kejzlar, DENF
Daniel Cleveland, OGC



Cabinet Comments
Corrective Action Plan (CAP)
Blue Ridge Landfill, Estill County, Kentucky
July 21, 2017

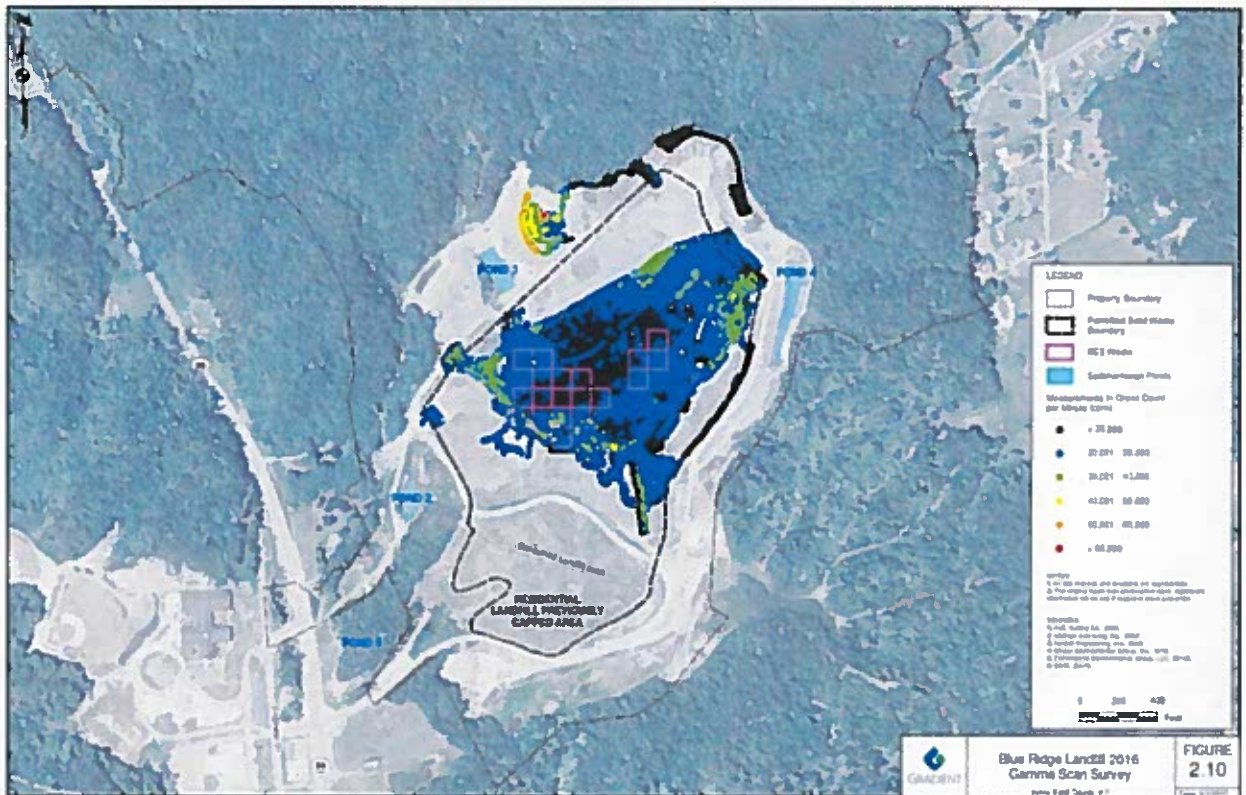
The Corrective Action Plan (CAP) for the Blue Ridge Landfill, Estill County, Kentucky, prepared for Advanced Disposal Services Blue Ridge Landfill, Inc. by Gradient Corporation, dated May 3, 2017 has been reviewed. Throughout the following comments, this document will be referred to as the CAP.

1. In the Executive Summary of the Corrective Action Plan (CAP), it is stated that "... Kentucky allows TENORM with "radiation levels" up to 2,000 pCi/g, generated within the State, to be disposed of in solid waste landfills, and therefore has implicitly determined that solid waste landfills can safely contain TENORM below this radioactivity level." Further **Sec. 2.5.1 State of Kentucky Landfill Requirements**, states "Since Kentucky allows TENORM up to 2,000 pCi/g generated within the state to be disposed of in solid waste landfills, the State has already determined that these landfills can safely contain whatever risk these materials may pose". These are misstatements of the Commonwealth's requirements for TENORM provided under the Central Midwest Interstate Low-Level Radioactive Waste Commission, which states that "TENORM with concentrations greater than 2,000 pCi/g shall be disposed of at the regional low-level radioactive waste disposal facility and TENORM waste with concentrations less than 2,000 pCi/g shall be disposed of in accordance with the method approved by the appropriate state regulatory agency." The Commonwealth has not concluded that municipal solid waste landfills can safely contain TENORM below 2,000 pCi/g. As page 14 of the CAP notes, regulations for TENORM waste are currently pending by the Cabinet for Health and Family Services (CHFS) and the Energy and Environment Cabinet (EEC) The regulations will include specific requirements for the operation and closure for contained landfills and other disposal facilities which accept TENORM waste in order to be protective of public health and the environment.
2. The Executive Summary of the CAP states that "sampling investigations indicate that radionuclide concentrations in areas of the landfill containing the BES Waste are below those of samples from naturally occurring radioactive material (NORM) inside and outside of the permitted solid waste boundary." This does not seem to be possible, considering the average radium concentrations in the wastes as described in the RAC reports. Please clarify this statement.
3. In accordance with the landfill operating permit, groundwater, storm water, surface water, and leachate are routinely monitored for a "suite of constituents" (Table 2.4 and

Remediation Alternative 1, page 25 of the Plan). The constituents currently monitored in these media do not include radionuclides. Due to the presence of TENORM wastes, the groundwater monitoring plan and surface water monitoring plan required pursuant to 401 KAR 48:300 and 48:090 for the solid waste contained landfill permit must be amended to include radionuclides (particularly radium-226, radium-228, gross alpha, and gross beta) as parameters for monitoring groundwater and surface water in addition to other parameters that are currently analyzed. For storm water and surface water discharges from the facility, the KPDES permit will also need to be amended to add these parameters. Leachate analysis should also include radionuclide parameters and appropriate heavy metals prior to discharge to the wastewater treatment plant (WWTP). The WWTP must be capable of treating and testing for the relevant parameters.

4. Remediation Alternative 2, as described in the Executive Summary, is to “excavate and transport the BES Waste from the BRL to another disposal facility, where it would be redispersed, subject to similar environmental controls.” The re-disposal site considered in the evaluation is the Mostoller Landfill, in Somerset, PA – a facility approved by the state of Pennsylvania to receive TENORM wastes. Are the environmental controls for the two landfills “similar” or are there more stringent design and operating requirements at the Mostoller landfill, based on its approval to receive TENORM waste?
5. The BRL and immediate surrounding area are described in Section 2 of the CAP. Some information that would be important to consider in the risk assessment which is not included in the Risk Assessment Corporation (RAC) documents is the estimated population, land use and groundwater usage in the vicinity of the landfill currently and projected into the future. Also, please provide information on the potentially exposed populations and estimated or modelled effects of radiation doses, if any, on these groups.
6. The landfill is estimated to operate approximately 40 more years, after which the approved closure plan will be implemented. Closure will include: capping of the landfill pursuant to the requirements of 401 KAR 48:080 and the landfill permit, recording of an environmental covenant which prevents disturbance of the cap and prevents residential and groundwater use, 30 year post-closure maintenance and groundwater monitoring, and a plan for long-term maintenance and monitoring. The lifetime of the landfill cap, used for the RAC evaluation, is 200 years. How do these expectations and closure practices compare with those of a landfill authorized to receive TENORM wastes, such as the Mostoller facility?
7. Original quarterly landfill waste reports submitted by the facility indicated that the TENORM waste was used as alternate daily cover. ADS later submitted revised reports to indicate that the material was not used as daily cover but was mixed with municipal

solid waste (MSW) and covered in place with soil and additional MSW. Due to uncertainty as to the disposition of the TENORM waste, it is recommended that the risk calculations for “maximum reasonable exposure” be revised by RAC to address possible use of the material as alternate daily cover. Figure 2.10 below indicates the highest levels measured in the Gamma Scan Survey are shown outside of the permitted solid waste boundary. A brine filtration sock was found in the material and ADS has stated the material originated from an oil and gas well located in eastern Kentucky that had been disposed of years earlier and resurfaced as part of constructing a new landfill cell. Please provide information as to how potential exposure resulting from incidental resurfacing of previously buried TENORM waste will be addressed.



8. Potential Additional Source

One other issue that should be considered is the likelihood of radon in the collected landfill gas that is extracted, transported, treated, and then used to generate electricity at the onsite 1600-kilowatt electrical generation plant. The method of “treatment” is not specified and radon from this potential source does not appear to have been modeled or measured.

From Section 2.1.3 of the CAP: The vertical gas extraction wells collect methane gas and transport it to an on-site treatment facility. A header system collects condensate as the landfill gas is cooled. This condensate is removed and disposed of, along with the landfill leachate. The remaining treated gas is used for electricity generation at the landfill.

9. **2.5.2 State of Kentucky Remediation Requirements**

This section states that identification of final remediation goals for the proposed remedy can be based on USEPA Region IX Preliminary Remediation Goals (PRGs) pending review by the cabinet of site-specific conditions.” Pursuant to KRS 224.1-530, the cabinet uses the Regional Screening Levels (RSL) Table published by USEPA Region 3 as screening levels in conformance with the Risk-Based Concentration Table Users Guide.

10. **Table 3-1 Site-Specific Factors for Remedial Action Objective Determination**

For groundwater use, it is stated that there is not potable water use at the site and that a 1992 well search identified 16 wells within one mile of the downgradient (northwest) site boundary. Updated information must be provided related to water use in the vicinity of the site.

11. **Figure 2-9** noted on page 23 could not be located in the CAP.

12. **4.2.1 Remediation Alternative 1: Closure-in-Place and Monitoring**

It is stated that “sampling will be conducted for the closure period of 2 years and the post-closure care period of at least 30 years.” Page 25 notes that long-term monitoring of surface water and groundwater beyond the ‘containment zone’ will be conducted to ensure protectiveness. Clarify what area is included in the containment zone.

Measures must be taken to ensure long-term protectiveness for Remediation Alternative 1: Closure in Place and Monitoring, due to the nature of long-term decay of the TENORM constituents. This section states that “prior to construction of the final cover system, a minimum of 30 feet of MSW will be placed on top of the BES waste”, with the final cap to be constructed in phases upon closure of the landfill. It should be noted that the closure and final cap requirements for facilities disposing of TENORM wastes may be amended by the pending regulations. Following closure of the site under the solid waste contained landfill permit requirements, 401 KAR 48:080 and 48:090, and the pending amended regulations for TENORM disposal, the site should be subject to regular inspections, a long-term monitoring program, and an operations and maintenance (O&M) Plan to ensure overall stability and performance of the cap and an environmental covenant pursuant to KRS 224.80 should be filed to restrict future use of the property. A Five Year Review and annual certification is also required under 401 KAR 100:030 Section 8 (3) (b).

13. **4.2.2 Remediation Alternative 2, Excavate and Redispose BES Waste**

Please describe measures that would be employed to control storm water run-on and runoff while the TENORM material is excavated during the estimated 90-day construction period. Explain the procedures for handling and disposal of water in the excavation.

14. 4.2.2 Remediation Alternative 2, Excavate and Redispose BES Waste

A typo is noted in "...amount of soil and overlying MSW to be excavated is approximately 16,300 cubic yards (45,575 cubic yards) assuming a "fluff factor" of 15%. It should be 18,745 cubic yards assuming a 15% fluff factor.

15. 6.5.1 Short-Term Radiological Risks

It is unclear as to whether the RAC report includes the potential risk incurred by the receiving landfill facility workers including the Landfill Laborer, Supervisor and Other Landfill Customers. Please clarify.

16. Table 6-3 Cancer Morbidity Risk Estimates for the Remediation Alternatives During Excavation

The excess cancer risk for the Landfill Laborer (1.8×10^{-5}) and Supervisor (2.2×10^{-6}) is within the USEPA risk range of 1×10^{-4} to 1×10^{-6} but it exceeds Kentucky's target risk level of 1×10^{-6} .

17. 6.5.3 Green and Sustainable Remediation (GSR)

For Remediation Alternative 2, hauling the TENORM and associated wastes from the landfill over county and state roads to another disposal location could damage the roadways which would need to be repaired. This would increase the cost for labor, materials and fuel, and would also increase air emissions from heavy equipment for road repair.

18. 6.6 Implementability

Decontamination of the trucks after each shipment will generate additional waste which would have to be properly disposed.

19. 6.7 Cost

Additional costs will be incurred for laboratory analytical analyses to add radionuclides to the surface water, groundwater and leachate samples. There could also be additional costs for leachate disposal if the levels are elevated above levels accepted by the Irvine Municipal Utility Wastewater Treatment Plant. Additional radiation safety procedures may be necessary when collecting and handling these media during sampling.

20. Table 6.6 Summary of Incremental Remediation Alternative Costs

There would be some increased costs for monitoring long-term for radionuclides at the landfill which would be in addition to the other constituents that are monitored.

21. Although some of the exposure factors used by RAC will need to be recalculated as noted in further comments on the risk assessment reports, it is evident that radiation doses received by individual workers and members of the public, during the placement of the wastes in the landfill are low and within regulatory limits. The modeling of potential groundwater exposure and dose into the future does appear to be reasonably conservative. Estimated future radiation doses to a worker and maximally exposed member of the public from wastes left in the landfill will also be quite low. The adverse impacts of excavating and relocating the wastes will likely be greater than those of leaving them in place, due in large part to the potential for accidents during the physical actions to excavate, transport, and redispense of the wastes.

Therefore it seems clear that "Remediation Alternative 2: Excavate and Redispense the BES Waste" would present a higher potential risk than "Remediation Alternative 1: Closure-in-place and Monitoring." However, for the purposes of ensuring safety of the landfill workers, it is recommended that ADS develop a landfill worker training and safety program to meet the requirements of 902 KAR 100:019 including the use of personnel radiation badges (dosimeters) to measure potential doses in real time.

RAC 2016 Dose and Risk Assessment Attachment A1 and RAC 2017 Radiological Risk Assessment Attachment A2

22. The original 2016 Risk Assessment was reviewed by the KY Department of Public Health, whose comments were used to revise the RA in 2017. If we assume that these parameters are representative of reasonable maximum exposure (RME), the result of the revised risk assessment is that the dose calculated for the most exposed receptor (landfill worker) results in a potential risk of 2.0E-05, which is within the USEPA risk range, but above our *de minimis* value of 1.0E-06. As with all risk assessments, there were many assumptions made, some of which seem to err on the side of conservatism, with some notable exceptions, shown below.

The risk assessment parameters that were used for the most exposed receptor include:

- **Soil ingestion rate – 330 mg/day over an 8 hour workday.** This is less conservative than the KDEP recommended rate of 480 mg/day, but it is in line with USEPA and is a reasonable value for an outdoor worker
- **Exposure Time – 20 minutes per disposal** for the most exposed receptor). (The landfill worker). This leads to a soil ingestion rate per disposal of only 13.75 mg. This is particularly important for external exposure, which drives the risk for these workers.

- **Inhalation rate – 1.8 m³/hour.** This is less conservative than the KDEP recommended rate of 2.5 m³/hour, but is probably reasonable for the level of activity for a landfill worker.

Additional issues and assumptions were made in the risk assessment that may need to be considered and re-evaluated including:

- ➔ The fact that **TENORM waste from in-state** was also disposed of at the site, but the areas of the site that received these wastes are **not included** in the risk assessment.
- ➔ The assumption that the heavy-equipment operator is inside an air-conditioned cab exposed only to filtered air.
- ➔ The assumption that the TENORM waste in question was covered within an hour of receipt, since there is uncertainty as whether the TENORM may have been used as alternate daily cover or placed in disposal cells. Due to the uncertainty of the disposition of the TENORM, it is recommended that the risk calculations for the most exposed receptor be recalculated to account for the increased time of exposure as the worker would grade the cover material over the entire working face at the end of the day and would also remove it at the beginning of the next work day.

23. Comparison to North Dakota TENORM Risk Assessment

The volume of BES waste was compared with proposed allowable TENORM disposal regulations in other states. As an example, Argonne National Laboratory produced a document for the North Dakota Department of Health, in which they propose allowing TENORM wastes containing an average concentration of less than or equal to 50 pCi/g of total radium (independent of background radium levels) to be disposed of in either Industrial Landfills or Special Wastes Landfills, provided the following conditions are met:

- No more than 25,000 tons of TENORM wastes are disposed of in a single year
- The average thorium activity concentration in the waste does not exceed 24 pCi/g (assuming a thorium to radium ratio of 49% at 50 pCi/g total radium)
- TENORM wastes must be covered by at least 2 m (6 ft) of a combination of the landfill cover materials and clean wastes that do not contain radionuclides

If we calculate the inventory in Ci for a year's worth of TENORM that would be allowed based on this assessment, the annual result is approximately 0.59 Ci from Radium and 0.55 Ci from Thorium, for a total of 1.14 Ci.

Comparing that to BES waste at BRLF (which is neither an Industrial Landfill nor a Special Waste Landfill), approximately 1157 tons of out-of-state TENORM wastes were disposed of at BRLF, with an average concentration of total radium of approximately 700 pCi/g. If we assume the same thorium to radium ratio of 49%, the result is 673 pCi/g for thorium (NOTE: The thorium to radium activity ratios in the RA/CAP, which were derived from the filter sock found at the landfill, would result in even higher thorium levels). If we calculate the inventory in Ci for the 92 loads of out-of-state TENORM, the result is approximately 0.73 Ci from Radium and 0.66 Ci from Thorium, for a total of 1.4 Ci. This not only exceeds what would be allowed in a ND industrial or special waste

landfill, but only accounts for out-of-state TENORM. In addition, the average concentration of each load is 14 times that allowed in ND (with at least one load above 2000 pCi/g).

Argonne National Laboratory, Environmental Science Division. 2014, November. Radiological Dose and Risk Assessment of Landfill Disposal of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in North Dakota
https://www.ndhealth.gov/EHS/TENORM/ArgonneStudy/ANL-NDDH%20TENORM%20Landfill%20Study%20%28ANL%20EVS-14_13%29%20Final%20Report.pdf

24. Attachment A1 Waste Handling Procedure, Page 5

It is mentioned that ADS added sawdust to absorb the excess liquid to seven of the 92 loads. Based on information received, L. R. Daniels also solidified some of the waste. Eleven (11) unsealed truckloads of waste mixed with absorbent were trucked from the Ashland area to the Blue Ridge Landfill. Some of the waste from Fairmont Brine Processing appears to have been hauled in an uncovered trailer instead of being sealed. Given the nature of the waste and its small particle size, fugitive dust emissions from the trucks must be considered.

25. Attachment A1 Fracking Waste and Treatment, Page 11

The waste from Fairmont Brine was described as “Exploration and production soil and debris”. However the physical nature of the Fairmont Brine waste is not that of a soil; rather it is a chemical precipitate resulting from Fairmont’s operations which extract radionuclides, recycle salts and water and concentrate the radionuclides through a chemical precipitation process. The resulting Fairmont Brine material is different from the soils and debris generated directly from the exploration and production facilities, as it is made up of much smaller particulates which should be considered for fugitive emissions.

26. Attachment A1 Particulate Emissions and Inhalation and Ingestion Doses During Disposal, Page 34

It is stated that “Radionuclide emissions during disposal are based on EPA emission model for aggregate handling and storage piles during drop loading operations as described in AP-42 Compilation of Air Pollutant Emission Factors (EPA 1995). Aggregate material is typically much drier and particulate aggregate is more easily dispersed in air than the solidified brines that comprise most of the TENORM material disposed in the Blue Ridge Landfill.” Therefore the AP-42 emission factor for aggregate may not be the most appropriate factor.

27. Attachment A1 Equation 2, Page 35

What was the value of “k” used in the calculations for the “particle size multiplier”?

28. Attachment A1, Page 36

Please describe if the wind speed used in the air emission model was representative. The standard meteorological for wind speed measurements is 10 meters. Often the actual wind speed in the vicinity of the emission source is significantly different due to the surface of the local terrain and boundary layer effects.

29. Attachment A1, Page 38

The inhalation dose to off-site receptors was calculated using the "classic Gaussian plume model" as described in the second edition of *Workbook of Atmospheric Diffusion Estimates* (Turner 1994) and is shown as Equation 10. The basic Gaussian equation model and dispersion coefficients were first published by Turner in the 1968-1969 time period (the report dated their reference to 1995). The model/equation is somewhat dated and has a high margin of error, and there are better approaches to modeling downwind transport today in the peer reviewed published literature. Also the model does not consider particulate deposition and re-suspension and treats the behavior of any particles entrained in the emission plume as following the streamlines of air flow (modeled as behaving as gas molecules where the momentum and inertia and mass differences between the gas molecules and entrained particles are not accounted for.) Also the model equation is a point source model and a more accurate approach would have been to use an area source model to accurately capture the receptor concentrations close to the source. The dispersion coefficients developed by Turner were based on very different terrain than is present at Blue Ridge Landfill. Also the model assumes a statistical Gaussian plume (concentration profile) and works better for elevated point sources instead of ground-level area sources.

30. Attachment A1 Table 11. Parameters for Emission Model during Disposal and Transport in Air, Page 39

The emission factor indicates that 2.01 grams of particulate matter is being released to the atmosphere per load. This emission factor was developed for soil placement at a construction site and is not representative of the particle size distribution for Blue Ridge which affects its transport and inhalation properties. Also the waste from Ohio and West Virginia should have emission factors representative of their respective waste characteristics.

31. Attachment A1 Uncertainty in Dose Estimates, Source Term, Pages 50-51

It is stated that "the bulk of TENORM activity received was from Fairmont Brine. Based on mean exposure readings taken on the shipments and the conversion factor developed by PADEP, the Ra-226/228 concentrations were estimated. Concentrations of the remaining radionuclides were estimated based on activity ratios from a single sock sample that maximized thorium isotope concentrations." Please clarify this statement as

no brine filtration socks were disposed of by Fairmont Brine. Filter socks are typically generated on-site at oil and gas exploration/production facilities.

32. Dose Estimates Page 53

The exposure times for the landfill workers should be recalculated to address their day-to-day work activities. The dose estimates were calculated “assuming a laborer spends 0.25 hours per disposal at a distance of 1.0 m from the TENORM container, and 0.083 hours 1 meter from the waste pile.” A landfill equipment operator spends much of the work day at the working face, spreading incoming waste and is still in the vicinity of the TENORM waste and can be exposed to additional inhalation hazards as the operator works around the disposal area with incoming waste loads.

33. The risk assessment does not consider air scouring at the atmosphere/soil-waste interface and the generation of airborne inhalable particulate matter being generated from the equipment activity during placement of waste and its use and management as ADC.

34. The risk assessment should include calculations for incidental residential exposure as it was reported that local citizens were allowed to drive up to the working face to dump their loads in their personal vehicles during the time span for receipt of the TENORM waste.

Cornerstone Environmental 2017 BES Waste Depth Memo, Attachment B

35. As a point of clarification the CAP prepared by Gradient notes that 92 separate loads of TENORM waste (1,157 tons) were disposed at the landfill, which the cabinet has confirmed. However, the Cornerstone memorandum in Attachment B and the Agreed Order indicates 47 sealed boxes of TENORM waste were disposed at the landfill. The RAC reports indicate that the TENORM wastes of concern have been covered with a minimum of 30 feet of municipal waste, while the Cornerstone memorandum indicates that there may be as little as 0 feet of cover in 8 of the 17 affected landfill grids. Please clarify these statements.

Weaver 2017 Radioactive Material Screening Plan, Attachment C

36. Page 45. Procedures to detect radioactive materials should include: Profiling in-state generated waste and drilling mud waste.

37. The Ludlum Model 375P-1000 with dual plastic scintillation detectors as described in the Screening Plan is an instrument typically used by landfills to screen incoming waste for radioactive material content. Paragraph 19 c of the agreed order requires ADS to submit “A plan for detecting and preventing the disposal of unpermitted TENORM wastes at the Facility that shall be incorporated into the Permit as a condition.” For purposes of this agreement “unpermitted TENORM waste” means out-of-state generated TENORM waste material with combined concentrations of Radium 226 and 228 greater

than 5 pCi per dry weight gram of waste material over background.” At 10 $\mu\text{R/h}$ the acceptable background variation of $\pm 20\%$ would be equivalent to 2 $\mu\text{R/h}$. Based on the average radiation level on the BES Wastes of 0.377 $\mu\text{R/h}$ per pCi/g of total Ra-226 and Ra-228 determined by RAC, the screening process would therefore not be able to determine TENORM concentrations less than approximately 5 to 6 pCi/g of TENORM. Section 3.1.2 of the Screening Plan recommends setting the instrument to alarm at 5 times background. If the background is 10 $\mu\text{R/h}$, the alarm would be at 50 $\mu\text{R/h}$. This would be a net of 40 $\mu\text{R/h}$ above background, which, based on 0.377 $\mu\text{R/h}$ per pCi/g of total Ra-226 and Ra-228, would be equivalent to alarming at a TENORM concentration of slightly over 100 pCi/g. Therefore, ADS should consider setting the instrument to trigger an alarm at a lower total radium concentration threshold of 5 to 10 pCi/g in order to provide a “go/no go” signal with possible further evaluation by other instrumentation to quantify the levels. It is recommended that ADS consult with the Cabinet for Health and Family Services (CHFS) to determine overall acceptability of the radiation portal monitor.

38. The Screening Plan for the Ludlum monitor does not include a detailed description of the installation and operation of such an instrument. For example, the distance between the detectors, the distance from the centerline of the waste container to the detectors, the speed at which the container would pass through the sensitive detection region (or length of counting time, if a static measurement), and, finally, the minimum detection sensitivity (e.g., exposure rate [$\mu\text{R/h}$] and activity concentration [pCi/g] of the system for a typical container of waste) should be estimated for TENORM and other potential radioactive contents when operating the system in a screening mode. Note that the instruments may be set to display in exposure rate, count rate, or integrated counts over a preset monitoring period. Please provide the additional information for the monitor.
39. 10 $\mu\text{R/h}$ is a typical background exposure rate to be expected. The background recorded by the screening instrument may be lower, depending on the effect of shielding around the detectors. It should not be necessary to collect 100 individual background measurements to determine an accurate and reproducible average; 20 individual determinations are usually adequate to determine the average. The average background and source response level should be determined, along with the acceptable variability ($\pm 20\%$ or $\pm 3\sigma$) should be recorded and the instrument performance compared with those values by completing a “control chart” for each day of use (more often if the background is found to be highly variable).
40. Ideally, after triggering an alarm setting, additional evaluations could be used to identify the radioactive source, estimate the activity or concentration in the waste, and determine whether contamination and radiation levels are compliant with Department of

Transportation regulations. These actions typically require a level of technical training and experience associated with professional radiation protection personnel. The level of sophistication described in the Screening Plan is beyond what needs to be readily available "in-house" at the landfill. Without extensive training and experience, use of gamma spectrometers and radiation contamination survey instruments and procedures, interpretation of the results, and actions based on the findings, relative to Federal and State regulations may easily cause greater "harm" than they prevent. If an alarm is triggered and a recheck confirms that level, the vehicle should be rejected and impounded, and notification made to CHFS Dept. for Public Health, Radiation Health Branch. Actions beyond Step 2 of Section 5 of the Screening Plan, raise the necessary knowledge, training, and experience to a completely different level. It is recommended that ADS consider contracting with radiation safety professionals for any activities related to the assessment and detailed screening for suspect waste shipments. At a minimum, such a firm could assist in developing a worker safety program, a comprehensive Screening Plan and providing appropriate training and oversight in its implementation.

41. A radiation level greater than 50 mR/h in the vehicle cab (screening step 5.C.3) could be indicative of a major problem. Please clarify.

42. Page 4 typo. Should be Screening

43. It is unclear as to the training requirements for the Supervisor who has been given responsibility for implementing the screening plan. It is recommended that a radiation safety professional handle portable hand-held screening of suspected TENORM materials.

44. Section 6.2 Action Level 2, Paragraph A

It states that workers should stop leakage of material leaking from the vehicle and "try to catch material leaking from the vehicle" in a container or absorbent material. Only specially equipped, trained radiation professionals should attempt to address leaks, contain or handle potentially radioactive materials utilizing appropriate personnel protective equipment.

45. Section 7 Characterization, Page 15

It states that it may be necessary to unload waste from a vehicle to remove a radiation source if it is determined to be a medical radionuclide, consumer product, NORM, TENORM or potassium-40 to obtain a sample for characterization. This work should only be done by trained radiation safety professionals.

46. Comments from the Community

The cabinet received comments from members of the community that obtained the CAP through an Open Records request. The comments requested information on potential future safeguards that could be implemented to make the landfill more protective should the waste be left in place as proposed under the preferred remedial alternative including whether the landfill or the portion of the landfill which received the TENORM waste be closed under the requirements for a hazardous waste landfill including a RCRA Subtitle C cap and whether additional bonding should be required due to the presence of the TENORM waste? Other comments on the Weaver 2017 Radioactive Material Screening Plan (Attachment C) noted that the Emergency Contact List does not include any local contacts (i.e., the Solid Waste Coordinator and the County Health Department) and also noted that the document contains grammatical errors and should be written in layman's language.

Attachment O

**Advanced Disposal Services, Inc. May, August 2017
Corrective Action Plan Submittal Letters**



FREEBORN & PETERS LLP

PHILIP L. COMELLA
Partner

Freeborn & Peters LLP
Attorneys at Law
311 South Wacker Drive
Suite 3000
Chicago, IL 60606

(312) 360-6935 direct
(312) 360-6520 fax

pcomella@freeborn.com

www.freeborn.com

May 3, 2017

Division of Enforcement
Attn: Director
300 Sower Boulevard, 3rd Floor
Frankfort, Kentucky 40601

**Re: Submission of Corrective Action Plan Per Agreed Order
Blue Ridge Landfill, Inc.**

Dear Mr. Cummins:

In accordance with Paragraph 19 of the Agreed Order dated January 3, 2017 and your letter dated March 27, 2017, we hereby submit, on behalf of Advanced Disposal Services Blue Ridge Landfill, Inc., the attached *Corrective Action Plan (CAP) for the Blue Ridge Landfill, Estill County, Kentucky*.

If you have any questions, please contact either Dave Rettell or me.

Very truly yours,

Philip L. Comella

PLC/mk
Enclosure

cc: Daniel Cleveland
Dave Rettell
Jay Warzinski
Michael Slattery



August 28, 2017

Jeffrey A. Cummins, Director
Division of Enforcement
Energy and Environment Cabinet
Department for Environmental Protection
300 Sower Boulevard
Frankfort, Kentucky 40601

Re: Blue Ridge Landfill Corrective Action Plan
Blue Ridge Landfill, Estill Co., Kentucky
Agreed Order Case No. DWM - 160048

Dear Mr. Cummins:

In accordance with Paragraph 20 of the above-referenced Agreed Order, Advanced Disposal Services Blue Ridge Landfill, Inc. is hereby submitting the attached response to comments (received in hard copy on July 28, 2017) and revised Corrective Action Plan.

If you have any questions, please call me at 248-755-9306.

Very truly yours,

A handwritten signature in blue ink, appearing to read 'David Rettell', is written over a light blue horizontal line.

David Rettell

GT
Enclosure

cc: Philip L. Comella
Emily Caffrey
Daniel Cleveland
Helen Grogan
Kurt Herman
John Till

Attachment P

**Advanced Disposal Services, Inc. and
Kentucky Energy and Environment Cabinet March 2017
Corrective Action Plan Extension Requests and Approval**



FREEBORN & PETERS LLP

PHILIP L. COMELLA
Partner

Freeborn & Peters LLP
Attorneys at Law
311 South Wacker Drive
Suite 3000
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(312) 360-6935 direct
(312) 360-6520 fax

pcomella@freeborn.com

www.freeborn.com

March 23, 2017

Jeffrey A. Cummins
Division of Enforcement
300 Sower Boulevard, 3rd Floor
Frankfort, KY 40601

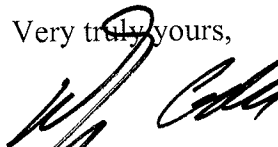
**Re: Agreed Order
Advanced Disposal Services Blue Ridge Landfill, Inc.**

Dear Mr. Cummins:

In accordance with Section 22 of the above Agreed Order, Advanced Disposal Services Blue Ridge Landfill, Inc. hereby requests a 30-day extension, until May 3, 2017, to submit the Corrective Action Plan due under the Order. Although significant progress has been made in preparing the Plan, Advanced Disposal and its consultants can use the extra time to refine the submittal.

We appreciate your consideration of this request.

Very truly yours,



Philip L. Comella

PLC/mk

cc: Daniel Cleveland



FREEBORN & PETERS LLP

PHILIP L. COMELLA
Partner

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March 24, 2017

Jeffrey A. Cummins
Division of Enforcement
300 Sower Boulevard, 3rd Floor
Frankfort, KY 40601

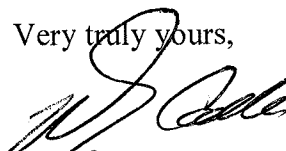
**Re: Agreed Order
Advanced Disposal Services Blue Ridge Landfill, Inc.**

Dear Mr. Cummins:

As a follow-up to my prior letter and in accordance with Section 22 of the above Agreed Order, Advanced Disposal Services Blue Ridge Landfill, Inc. hereby respectfully requests a 30-day extension, until May 3, 2017, to submit the Corrective Action Plan due under the Order. Although Advanced Disposal has made significant progress on this project, the preparation of the CAP is a complex undertaking as it requires the coordination not only of experts located across the country, but also requires the interplay of radiation principles with corrective action assessments, something that is unique for solid waste landfills. Because of scheduling issues, we have also not yet been able to schedule a site visit for the lead consultant and would like to arrange such a visit before submitting the CAP. Last, the additional time will allow the consultants to further verify the modeling results, calculations, and conclusions contained in the CAP. For these reasons, we respectfully request a 30-day extension to submit the CAP.

We appreciate your consideration of this request.

Very truly yours,



Philip L. Comella

PLC/mk

cc: Daniel Cleveland



MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

AARON B. KEATLEY
COMMISSIONER

300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601

March 27, 2017

Philip L. Comella
Freeborn & Peters LLP
311 South Wacker Drive
Suite 3000
Chicago, IL 60606

Re: AI Name Advanced Disposal Services Blue
Ridge Landfill Inc
AI No. 998
Case No. DWM 160048
Activity No. ERF20160001
Estill County

Dear Mr. Comella:

The Energy & Environment Cabinet is in receipt of your letters dated March 23 and March 24, 2017 requesting an extension for the submittal of the CAP in the above-referenced case. Having considered the reasons cited in your March 24 letter, the Cabinet agrees to extend the deadline for submittal of the CAP by 30 days, making the new due date May 3, 2017. Please contact either Daniel Cleveland at 502.782.6921 or me at 502.782.6848 if you have questions or concerns regarding this extension.

Sincerely,

Jeffrey A. Cummins, Director
Division of Enforcement

JAC/jac

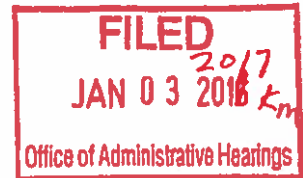
C: Daniel Cleveland



Attachment Q

**Kentucky Energy and Environment Cabinet and
Advanced Disposal Service, Inc.
January 2017 Agreed Order**

COMMONWEALTH OF KENTUCKY
ENERGY AND ENVIRONMENT CABINET
DIVISION OF ENFORCEMENT
CASE NO. DWM 160048



IN RE: Advanced Disposal Services Blue Ridge Landfill, Inc.
 2700 Winchester RD.
 Irvine, KY 40336
 AI No. 998
 Activity ID No. ERF20160001

AGREED ORDER

WHEREAS, the parties to this Agreed Order, the Energy and Environment Cabinet (hereinafter "the Cabinet"), and Advanced Disposal Services Blue Ridge Landfill, Inc. (hereinafter, "Blue Ridge"), state:

STATEMENT OF FACTS

1. The Cabinet is charged with the statutory duty of enforcing KRS Chapter 224 and the regulations promulgated pursuant thereto.
2. Blue Ridge is a Kentucky Corporation registered with the Kentucky Secretary of State to do business in the Commonwealth of Kentucky, and owns and operates the Blue Ridge Landfill (hereinafter "the Facility") located at 2700 Winchester Road, Irvine, Estill County, Kentucky.
3. Blue Ridge operates the Facility under the Cabinet's Division of Waste Management (hereinafter "DWM") Solid Waste Permit SW030004 (hereinafter "the Permit"), during all times relevant to the alleged violations described in this Agreed Order.

4. Between July 2015 and November 2015, BES, L.L.C. (hereinafter “BES”), an affiliate of Advanced TENORM Services, arranged for the disposal of approximately 47 loads of oil and gas production and exploration waste from the West Virginia company, Fairmont Brine Processors, at the Facility. BES also arranged for the shipment of other oil production waste from other generators in Ohio. Collectively, this waste is hereinafter referred to as the “BES Waste”.

5. For each shipment of BES Waste, BES’s managing member executed the waste profile sheets certifying, on behalf of Fairmont Brine and the other generators, that the material:

- (a) was not a hazardous waste as defined by federal, state, or local laws and regulations and exempt under 40 CFR 261.4(b)(5); and
- (b) did not contain Radioactive waste as defined by State and Federal Regulations.

6. Blue Ridge asserts it acted consistently with industry practice when it relied upon the representations of the generators before accepting the material and Blue Ridge also retained a third party technical consultant to review all such generator waste profile sheets for conformance with Blue Ridge’s permit. Blue Ridge asserts it relied upon the judgment of the third party technical consultant to determine that the BES material could be disposed of at the Blue Ridge Landfill.

7. Blue Ridge asserts that at no time prior to the receipt and disposal of the BES material did it have knowledge that the material might be “TENORM” or otherwise consist of materials not acceptable at the Blue Ridge Landfill.

8. On February 10, 2016, representatives of the Cabinet and the Cabinet for Health and Family Services (hereinafter “CHFS”) conducted an unannounced inspection of the Facility, to investigate allegations that Technologically Enhanced Naturally Occurring Radioactive

Material (hereinafter "TENORM") from outside of the Commonwealth of Kentucky was being disposed of at the Facility.

9. On February 22, 2016 the Cabinet sent a notice to all permitted solid and special waste facility owners in Kentucky advising that TENORM waste from oil and gas drilling activities in Ohio, West Virginia, and Pennsylvania had been transported to Kentucky and disposed at certain solid waste landfills in the state. The notice reminded permittees of their duty to conform with KRS Chapter 211 and Title 902, Chapter 100 of the Kentucky Administrative Regulations.

10. On February 27, 2016, CHFS took general area radiation surveys and contamination surveys at the Facility and two public school buildings located across from the Facility's entrance (hereinafter "Estill County Schools"). The results showed no evidence that the BES Waste had impacted the Estill County Schools. There was no evidence of radiation above federal and state safety limits.

11. On March 2, 2016, Ameriphysics, on behalf of Estill County, reported on the results of its airborne and sediment pond radiological sampling at the locations within the Estill County School buildings and the Blue Ridge Landfill. Ameriphysics reported that the samples contained naturally occurring radionuclides at levels below allowable airborne and water concentrations under federal law.

12. Between March 2 and March 4, 2016, Blue Ridge carried out the following environmental investigations to characterize the nature and extent of any alleged TENORM at the Facility:

- (a) Blue Ridge's consultant, Chase Environmental (hereinafter "Chase"), performed the first of several gamma scan surveys of the ground surface to measure gamma exposure rates. The results were correlated with GPS

coordinates to produce a color-coded image of the Facility's surface exposure rates.

- (b) Chase conducted a gamma ray survey of a portion of the BES burial area and four areas representative of background: a distal burial area; an area of New Albany Shale; an area of Nancy Shale; and an area representative of the natural topography of the area. The scans did not identify any elevated areas of radioactivity above background at the surface of the BES Waste Disposal Area.

13. On March 8, 2016, the Cabinet issued Blue Ridge a Notice of Violation for the following alleged violations:

- (a) 401 KAR 47:190 Section 8(1)(b): Blue Ridge's quarterly Waste Quantity Reports reflected that 47 loads of oil production waste, which the Cabinet alleged to be TENORM, were disposed as alternate daily cover. The NOV alleged that Blue Ridge was not authorized for such alternate daily cover.
- (b) KRS 224.1-400(18): The NOV alleged Blue Ridge failed to comply with the provisions of KRS 224.1-400(18) by failing to characterize a release/potential release of TENORM to the environment.
- (c) 401 KAR 47:120 Section 1(1): The NOV alleged that Blue Ridge accepted and disposed of 47 loads of unpermitted TENORM waste from outside the Commonwealth of Kentucky from July 2015 through November 2015. The NOV alleged that neither Blue Ridge's permit nor KRS Chapter 224 authorize TENORM from out-of-state to be disposed of in a contained landfill in Kentucky.

- (d) 401 KAR 47:190 Section 8(5): The NOV alleged that a request to provide all waste disposal manifests from January 1, 2015 through January 30, 2016 to DWM was made during the inspection referenced in paragraph 8 above, but only manifests pertaining to particular TENORM-related entities were submitted to DWM.

14. On March 12, 2016, the U.S. Army National Guard 41st Civil Support Team took air and soil samples, and conducted a contamination survey at the Estill County Schools and tested the samples for radionuclides. The samples all showed concentrations below state and federal standards and consistent with natural background radiation in the area.

15. On March 18, 2016, Blue Ridge responded to the March 8, 2016 Notice of Violation and provided the Cabinet with a Comprehensive Compliance Plan.

16. From May 23 to May 25, 2016, Chase scanned the remaining areas where BES waste was buried, and the remainder of the operational part of the Facility (outside areas where BES waste was buried). The scans did not identify any elevated areas of radioactivity above background at the surface of the BES Waste Disposal Area.

17. Between March and May 2016, Chase collected numerous samples of soil, groundwater, sediment, and other environmental media, which will be evaluated, per the terms of paragraph 19 below.

18. On or about March 23, 2016, Blue Ridge delivered all of the requested waste manifests to the Cabinet's Division of Enforcement (hereinafter "DENF").

WHEREAS Blue Ridge does not admit to the allegations as listed in the NOV, but agrees to the terms and conditions of this Agreed Order to resolve the above allegations.

NOW THEREFORE, in the interest of settling all civil claims and controversies involving

the alleged violations described above, the parties hereby consent to the entry of this Agreed Order and agree as follows:

REMEDIAL MEASURES

19. Within ninety (90) days of execution of this Agreed Order by the Cabinet's Secretary, Blue Ridge shall submit a Corrective Action Plan (hereinafter "CAP"), detailing the steps Blue Ridge has taken and will take to address the matters raised in this Agreed Order. The CAP shall include, but not be limited to:

- (a) A remedial plan in accordance with KRS 224.1-400 and 401 KAR 100:030 with adequate analytical or modeling data to demonstrate the proposed remedy will be protective of human health and the environment. This plan may include plans and reports previously submitted in response to the Notice of Violation referenced in paragraph 13 above. If Blue Ridge proposes a remedy pursuant to KRS 224.1-400(18)(a)(b) or (d), Blue Ridge's remedial plan shall address the following factors, where applicable:
 - i. The overall protection of human health and the environment;
 - ii. The compliance with any other applicable requirements;
 - iii. The long-term effectiveness and permanence of the remedial option;
 - iv. The reduction of toxicity, mobility, or volume through the use of treatment;
 - v. The short-term effectiveness of the remedy; and
 - vi. The reasonable ability to implement the remedy;
- (b) In evaluating the remedy, the Cabinet will also consider the cost of the remedy, and the community acceptance of the remedy;

- (c) A plan for detecting and preventing the disposal of unpermitted TENORM waste at the Facility that shall be incorporated into the Permit as a condition. For purposes of this agreement “unpermitted TENORM waste” means out-of-state generated TENORM waste material with combined concentrations of Radium 226 and 228 greater than 5 p/Ci per dry weight gram of waste material over background;
- (d) A timeline for the completion of specific corrective actions to be taken; and
- (e) An estimated final compliance date by which Blue Ridge anticipates completing all remedial items listed in the abovementioned CAP.

20. Upon review of the CAP, the Cabinet shall, in whole or in part, either (1) approve the CAP or (2) disapprove it and provide comments to Blue Ridge identifying any deficiencies. Upon receipt of the Cabinet’s comments, Blue Ridge shall take the Cabinet’s comments into consideration and revise and resubmit the CAP to the Cabinet within thirty (30) days for review and acceptance. Upon resubmittal by Blue Ridge, the Cabinet may, in whole or in part, (1) approve or (2) disapprove and provide comments to Blue Ridge identifying any deficiencies of the revised CAP. Upon receipt of the Cabinet’s additional comments, Blue Ridge shall take the Cabinet’s comments into consideration and revise and resubmit the CAP to the Cabinet within thirty (30) days for review and acceptance. If Blue Ridge does not timely or in good faith respond to the Cabinet’s comments, the Cabinet reserves its rights to deem Blue Ridge out of compliance with this Agreed Order.

21. If at any time any party determines it is necessary to amend the CAP in order to meet the goals or deadlines of this Agreed Order, the following will occur:

- (a) If the Cabinet requests an amendment to the CAP, the Cabinet shall notify Blue Ridge in writing that an amendment is necessary and will outline the reasons for the request. The Cabinet shall give Blue Ridge thirty (30) days from receipt of written notification to amend the CAP and submit the Amended CAP to the Cabinet. Upon review, the Cabinet may, in whole or in part, (1) approve or (2) disapprove and provide comments to Blue Ridge identifying any deficiencies of the Amended CAP. Upon receipt of the Cabinet's comments, Blue Ridge shall revise and resubmit the Amended CAP to the Cabinet within thirty (30) days for review and acceptance. Upon review, the Cabinet shall, in whole or in part, either (1) approve the Amended CAP or (2) disapprove it and provide comments to Blue Ridge identifying any deficiencies of the revised Amended CAP. Upon receipt of the Cabinet's additional comments, Blue Ridge shall take the Cabinet's comments into consideration and revise and resubmit the Amended CAP to the Cabinet within thirty (30) days for review and acceptance. If Blue Ridge does not timely or in good faith respond to the Cabinet's comments, the Cabinet reserves its rights to deem Blue Ridge out of compliance with this Agreed Order.
- (b) If Blue Ridge requests an amendment to the CAP, Blue Ridge shall notify the Cabinet in writing that an amendment request is forthcoming and shall outline the reasons why the amendment is necessary. Blue Ridge shall then submit an Amended CAP within thirty (30) days to the Cabinet. Upon review of the Amended CAP, the Cabinet may, in whole or in part, either

(1) approve the Amended CAP or (2) disapprove it and provide comments to Blue Ridge identifying any deficiencies of the Amended CAP. Upon receipt of the Cabinet's comments, Blue Ridge shall revise and resubmit the Amended CAP within thirty (30) days for review and acceptance. Nothing in this provision shall require the Cabinet to accept Blue Ridge's request to amend the CAP.

22. Blue Ridge may request an extension of time within which to submit a CAP or revised CAP pursuant to paragraphs 19 and 20 of this Agreed Order or an Amended CAP pursuant to paragraph 21 of this Agreed Order, or to carry out the Supplemental Environmental Project set forth in paragraph 27 below. Approval of any request for an extension of time shall be at the reasonable discretion of the Director of the Division of Enforcement.

23. By the final compliance date established in the CAP or Amended CAP, Blue Ridge shall complete all remedial actions outlined in the CAP.

24. Nothing in this Agreed Order prohibits the Cabinet from seeking comments from CHFS when reviewing the CAP or Amended CAP pursuant to paragraphs 19, 20, and 21 of this Agreed Order.

25. All submittals required by the terms of this Agreed Order shall be sent to:

Division of Enforcement
Attn: Director
300 Sower Boulevard, 3rd Floor
Frankfort, Kentucky 40601

PENALTIES & SUPPLEMENTAL ENVIRONMENTAL PROJECT

26. Blue Ridge is assessed a civil penalty in the amount of ninety-five thousand dollars (\$95,000). The entire civil penalty balance shall be offset by the Supplemental Environmental Projects (hereinafter "SEPs") described below.

27. Blue Ridge shall implement SEPs that will result in:
- (a) The installation of devices to detect radioactivity of waste materials at the Facility and the Morehead landfill before disposal occurs, provided that,
 - i. The device installed at the Facility is included in the plan submitted to the Cabinet pursuant to paragraph 19 of this Agreed Order,
 - ii. Blue Ridge maintains monitoring records for the devices which shall be provided to the Cabinet for inspection upon request, and
 - iii. Both devices are maintained, calibrated, and quality control is performed consistent with manufacturer specifications; and
 - (b) After appropriate consultation, contribute sixty-thousand dollars (\$60,000) to the Estill County School District to assist it in
 - i. detecting and mitigating naturally occurring radon within the Estill County School District;
 - ii. paying costs associated with the radiation surveys; and/or
 - iii. establishing educational programs related to environmental sciences

28. Actions associated with the SEP are scheduled to begin within thirty (30) days after execution of this Agreed Order. Blue Ridge shall install the devices described in paragraph 27(a) within 120 days after the execution of this Agreed Order. Blue Ridge shall complete the SEP described in paragraph 27(b) within 120 days after the execution of this Agreed Order.

29. Upon completion of each SEP, Blue Ridge shall submit to the Cabinet documentation certifying the completion of and invoices verifying the total expenditures by Blue Ridge for the completion of the SEP. Information regarding the certification of completion of the

SEP shall be sent to the Director of the Division of Enforcement, 300 Sower Boulevard, Frankfort, Kentucky 40601.

30. The Cabinet may assess a stipulated penalty in an amount not to exceed two thousand five hundred dollars (\$2500), for failure to timely submit the CAP or Amended CAP described in paragraphs 19 and 21(a) above. Payment of the stipulated penalty shall be tendered by Blue Ridge to the Cabinet within thirty (30) days of receipt of written notification from DENF. This penalty is in addition to, and not in lieu of, any other penalty that is or could be assessed. The Cabinet may, at its discretion, waive stipulated penalties that would otherwise be due.

31. The Cabinet may assess a stipulated penalty in an amount of twenty-five thousand dollars (\$25,000) should Blue Ridge accept and dispose of unpermitted TENORM waste prior to the termination of this Agreed Order. No such penalty shall be due, however, if the appropriate cabinet within the Commonwealth of Kentucky approves of the disposal in writing. Blue Ridge reserves all defenses to a request for stipulated penalty including those based upon misrepresentation and the Permit. Payment of the stipulated penalty shall be tendered by Blue Ridge to the Cabinet within thirty (30) days of receipt of written notification from DENF. This penalty is in addition to, and not in lieu of, any other penalty that is or could be assessed. The Cabinet may, at its discretion, waive stipulated penalties that would otherwise be due.

32. If Blue Ridge believes the request for payments of a stipulated penalty is erroneous or contrary to law, Blue Ridge may request a hearing in accordance with KRS 224.10-420(2). The request for hearing does not excuse timely payment of the penalty. If an order is entered pursuant to KRS 224.10-440 that excuses payment, the Cabinet will refund the payment. Failure to make a timely payment shall constitute an additional violation of this Agreed Order.

33. Payment of penalties shall be by cashier's check, certified check, or money order, made payable to "Kentucky State Treasurer" and sent to the attention of the Director, Division of Enforcement, Department for Environmental Protection, 300 Sower Boulevard, Frankfort, Kentucky 40601; note "Case Number DWM 160048" on the instrument of payment.

MISCELLANEOUS PROVISIONS

34. This Agreed Order addresses only the allegations specifically described above. Other than those matters resolved by entry of this Agreed Order nothing contained herein shall be construed to waive or to limit any remedy or cause of action by the Cabinet based on statutes or regulations under its jurisdiction and Blue Ridge reserves its defenses thereto. The Cabinet expressly reserves its rights at any time to issue administrative orders and to take any other action they deem necessary that is not inconsistent with this Agreed Order, including the right to order all necessary remedial measures, assess penalties for violations, or recover all response costs incurred, and Blue Ridge reserves its defenses thereto.

35. This Agreed Order shall not prevent the Cabinet from issuing, reissuing, renewing, modifying, revoking, suspending, denying, terminating, or reopening any permit to Blue Ridge. Blue Ridge reserves its defenses thereto, except that Blue Ridge shall not use this Agreed Order as a defense.

36. Blue Ridge waives its right to any hearing on the matters alleged herein. However, failure by Blue Ridge to comply strictly with any or all of the terms of this Agreed Order shall be grounds for the Cabinet to seek enforcement of this Agreed Order in Franklin Circuit Court and to pursue any other appropriate administrative or judicial action under KRS Chapter 224, and the regulations promulgated pursuant thereto.

37. The Agreed Order may not be amended except by a written order of the Cabinet Secretary or his designee. Blue Ridge may request an amendment by writing the Director of the Division of Enforcement at 300 Sower Boulevard, 3rd Floor, Frankfort, Kentucky 40601, and stating the reasons for the request. If granted, the amended Agreed Order shall not affect any provision of this Agreed Order unless expressly provided in the amended Agreed Order.

38. The Cabinet does not, by its consent to the entry of this Agreed Order, warrant or aver in any manner that Blue Ridge's complete compliance with this Agreed Order will result in compliance with the provisions of KRS Chapter 224, and the regulations promulgated pursuant thereto. Notwithstanding the Cabinet's review and approval of any plans formulated pursuant to this Agreed Order, Blue Ridge shall remain solely responsible for compliance with the terms of KRS Chapter 224, and the regulations promulgated pursuant thereto, this Agreed Order and any permit and compliance schedule requirements.

39. Blue Ridge shall give notice of this Agreed Order to any purchaser, lessee or successor in interest prior to the transfer of ownership and/or operation of any part of its now-existing facility occurring prior to termination of this Agreed Order, shall notify the Cabinet that such notice has been given, and shall follow all statutory and regulatory requirements for a transfer. Whether or not a transfer takes place, Blue Ridge shall remain fully responsible for payment of all civil penalties and response costs and for performance of all remedial measures identified in this Agreed Order.

40. The Cabinet agrees to allow the performance of the above-listed remedial measures completion of the SEP by Blue Ridge to satisfy Blue Ridge's obligations to the Cabinet generated by the allegations described above.

41. The Cabinet and Blue Ridge agree that the remedial measures agreed to herein are facility-specific and designed to comply with the statutes and regulations cited herein. This Agreed Order applies specifically and exclusively to the unique facility referenced herein and is inapplicable to any other facility.

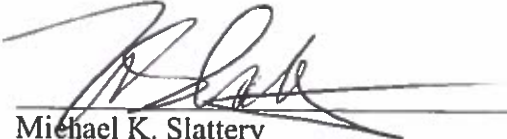
42. This Agreed Order shall be of no force and effect unless and until it is entered by the Cabinet's Secretary or his designee as evidenced by their signature thereon. If this Agreed Order contains any date by which Blue Ridge is to take any action or cease any activity, and the Secretary enters the Agreed Order after that date, then Blue Ridge is nonetheless obligated to have taken the action or ceased the activity by the date contained in this Agreed Order.

TERMINATION

43. This Agreed Order shall terminate upon the Blue Ridge's completion of all requirements described in this Agreed Order. Blue Ridge may submit written notice to the Cabinet when they believe all requirements have been performed. The Cabinet will notify Blue Ridge in writing of whether it intends to agree with or object to termination. The Cabinet reserves its rights to enforce this Agreed Order, and Blue Ridge reserves its right to file a petition for hearing pursuant to KRS 224.10-420(2) contesting the Cabinet's determinations.


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AGREED TO BY:



Michael K. Slattery
Senior Vice President and General Counsel
Advanced Disposal Services, Inc.

12/22/2016
Date



Philip L. Comella, Counsel for
Advanced Disposal Services Blue Ridge Landfill, Inc.

12/27/2016
Date

CASE NO. DWM 160048

APPROVAL RECOMMENDED BY:



Jeffrey A. Cummins, Director
Division of Enforcement, EEC

12/28/2016
Date



John G. Horne, II, Executive Director
Office of General Counsel, EEC

1/3/2017
Date

ORDER

Wherefore, the foregoing Agreed Order is entered as the final Order of the Energy and Environment Cabinet This the 3RD day of January, 2018⁷.

ENERGY AND ENVIRONMENT CABINET



R. BRUCE SCOTT, DEPUTY SECRETARY

CERTIFICATE OF SERVICE

I hereby certify that a true and accurate copy of the foregoing **AGREED ORDER** was mailed, postage prepaid, to the following this 3rd day of January, 2016.

Advanced Disposal Services Blue Ridge Landfill, Inc.
Attn: Mr. Dave Rettell, Regional Manager
10690 West Six Mile Road
Northville, Michigan 48168

Hon. Philip L. Comella
Freeborn & Peters, LLP
311 South Wacker Drive
Suite 3000
Chicago, IL 60606

And mailed messenger to:

Jeffrey A. Cummins, Director
Division of Enforcement
300 Sower Boulevard, 3rd Floor
Frankfort, Kentucky 40601

John G. Horne, II, Executive Director
Office of General Counsel
300 Sower Boulevard, 3rd Floor
Frankfort, Kentucky 40601



DOCKET COORDINATOR

SH