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Responses to EPA Solicitation for Comments on: Enhancing Public Access to Information; Reconsideration of Beneficial Use Criteria and Piles

Docket Number: EPA-HQ-OLEM-2018-0524

Prepared for:
Earthjustice

October 11, 2019

The United States Environmental Protection Agency (EPA) recently published a Solicitation for Comments on, among other topics, Reconsideration of Coal Combustion Residual (CCR) piles. At the request of Earthjustice I have reviewed the subject request for information and prepared this report that describes my responses to EPA questions pertaining to CCR piles.

1. Background

CCR is managed at electric generating stations in several ways including storage of wet ash in surface impoundments, disposal of dry ash in landfills, collection and sale for beneficial use, and unfortunately, by creating ash piles. Unlike other forms of solid waste such as municipal solid waste (MSW), inorganic coal combustion residuals and the metals they contain do not biodegrade. Coal ash that is present in waste piles, lined landfills, or ash basins will be capable of leaching toxic metals into the environment at any time in the present, or the near or distant future for as long as soluble metals contained in ash are allowed to come into contact with water. Therefore, effective management of coal ash requires that the waste be isolated from water: including precipitation, surface water, and groundwater.

Failure to isolate coal ash waste from water will result in leaching of contaminants, i.e. formation of leachate. "Leachate" "includes liquid, including any suspended or dissolved constituents in the liquid, that has percolated through or drained from waste or other materials placed in a landfill, or that passes through the containment structure (e.g., bottom, dikes, berms) of a surface impoundment."[1] If released to soils, groundwater, or surface water, coal ash leachate impairs and degrades soil and/or water quality and the environment.

Piles of CCR have the potential to impact environmental quality similarly to the well-known and documented impacts from lined and unlined CCR landfills and impoundments. Precipitation that falls on the pile can cause erosion of CCR sediments which can then be transported to adjacent areas. Precipitation can infiltrate into the waste causing generation of leachate. Leachate can run-off and transport contaminants off-site and/or can infiltrate into underlying soils and/or groundwater. In addition to impacts to soils, groundwater and surface water, storage of CCR in waste piles carries an additional elevated risk related to dispersal of CCR dust from the pile and subsequent exposure to nearby receptors.

Dust emissions from CCR piles are generated by various processes including loading CCR onto the pile, loading CCR out of the pile, and wind erosion of the CCR while in the pile. Transport of CCR to the pile through the use of trucks, conveyors, or other equipment, involve one or more "drop operations" that generate dust emissions at uncontained CCR piles. At a number of generating stations with CCR piles the CCR is transported onto the pile via conveyors. At these locations emissions result from the release of CCR onto the piles, particularly, when the drop height from the conveyor and the moisture content are not properly controlled.[2] Unloading CCR from a conveyor onto a CCR pile is an example of a continuous drop operation. Depending on

[1] EPA, 2015, at 67,838 and 67,847

[2] Pless Environmental, 2010, Appendix A

the transport system employed, drop operations may occur several times for each load of CCR removed from the pile. Loading waste onto the pile, redistributing waste in the pile, and loading waste off the pile could all be emission points for one load of CCR eventually removed from the pile.

CCR that is dropped onto an outside pile unprotected from wind and precipitation is subject to higher erosion and resultant transport as particulate matter than is a similar volume of CCR placed in an impoundment or landfill. Increased wing erosion is related to both increased surface area and impinging wind velocity. The elevated portions of a CCR pile present a considerably larger surface area that is subject to wind erosion than the footprint of a similarly sized landfill or impoundment. For example, a circular active working face of a coal ash landfill that is 10 meters (m) across has an exposed surface of 78.5 square meters (m^2).[3] A cone-shaped storage pile of the same diameter (10 m) and a height of 3 m has the same footprint (78.5 m^2) but an exposed surface area of 91.6 m^2, a 17% increase.[4,5] In addition, landfilled ash is generally compacted and covered on a regular basis to minimize dust releases and surface water transport. These operational procedures are not applicable to waste stored in piles.

Exposed CCR placed in a pile is subject to higher wind speeds than is contained waste or waste placed in a landfill or impoundment. Wind speed is known to increase with elevation above the surrounding ground surface. Increasing wind velocity with elevation above ground surface causes ash piled high on a waste pile to be subject to increased wind erosion. The erosion potential for most materials tends to decay however during a high wind event as easily erodible materials material is removed from the pile, leaving larger particle sizes to armor the surface. The small size of CCR, however, provides an unending supply[6] of erodible material that can sustain dust emissions for substantial periods without decreasing emission rates. In addition, CCR is continuously added to many piles so there is a constant supply of readily erodible source materials.

Dispersal of CCR dust with the wind can transport CCR in different directions than that transported through surface or groundwater transport. Wind dispersed dust can be inhaled or ingested, contaminate the top of the soil layer, and be incorporated into topsoil soil to contaminate plants and animals.

USEPA makes several specific requests for information including;

- Are there cases where it is acceptable to manage releases retroactively?
- Are there situations where piles are placed for a short period of time, are then removed, and that present no reasonable probability of adverse effects?

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[3] Area of a circle: $A = \pi r^2$

[4] Pless Environmental, 2010, Appendix A

[5] Footprint of cone: $\pi * r^2 = \pi (5m^2)^2 = 78.5 m^2$;
exposed surface area of cone: $\pi * r \times \sqrt{(r^2 + h^2)} = \pi\sqrt{(5m^2 + 3m^2)} = 91.6 m^2$

[6] The supply can be thought of as unending as new CCR is continuously being placed on the pile to replace what has been removed

- Is a requirement that a pile be temporary a key element of controlling risks of releases from piles of CCR?
- Is there data documenting instances in which releases from temporary CCR piles have caused adverse effects?
- EPA solicits comments on whether to retain a mass-based threshold.

My comments on each of these requests are provided in Section 3 of this report.

2. Qualifications

I express the opinions in this letter based on my formal education in geology and over thirty-nine years of experience on a wide range of environmental characterization and remediation sites. My education includes Bachelor of Science and Masters of Science degrees in geology from Northern Illinois University and the University of Illinois at Chicago, respectively. I am a registered Professional Geologist (PG) in Kansas, Nebraska, Indiana, Wisconsin, and North Carolina, a Certified Professional Geologist by the American Institute of Professional Geologists, and am a Past President of the Colorado Ground Water Association.

My entire professional career has been focused on regulatory, site characterization, and remediation issues related to waste handling and disposal practices and facilities, for regulatory agencies and in private practice. I have worked on contaminated sites in over 35 states and the Caribbean. My site characterization and remediation experience includes activities at sites located in a full range of geologic conditions, including soil and groundwater contamination in both consolidated and consolidated geologic media, and a wide range of contaminants. I have served in various technical and managerial roles in conducting all aspects of site characterization and remediation including definition of the nature and extent of contamination (including developing and implementing monitoring plans to accurately characterize groundwater contamination), directing human health and ecological risk assessments, conducting feasibility studies for selection of appropriate remedies to meet remediation goals, and implementing remedial strategies. Much of my consulting activity over the last 13 years has been related to groundwater contamination and permitting issues at coal ash storage and disposal sites in numerous states, including Alabama, Arizona, Colorado, North Carolina, Illinois, Indiana, Kansas, Maryland, Minnesota, Mississippi, Montana, New Mexico, Nevada, North Carolina, South Carolina, Pennsylvania, Virginia, Wisconsin.

3. Discussion of Requested Items

The following are my responses to requests for information from USEPA:

3.1 Are there cases where it is acceptable to manage releases retroactively?

The EPA asks if in some cases, it is acceptable to manage releases retroactively. For example, are there situations in which CCR will only enter the topmost layer of soil over the time the CCR is in place at the site, in which retroactive management of these *releases combined with an active management of releases to air and water, could avoid all reasonable probability of adverse effects on human health and the environment. For example, commenters may have information to show that the placement of CCR at a construction site, which typically occurs over a brief, one- time period, is precisely one such situation in which releases to soil and groundwater can retroactively be managed by removing the CCR and the contaminated soil beneath it, at the completion of the project.*

A central tenet of responsible waste management is that it be prevention-based. The EPA articulated this tenet in its 1993 guidance for owners and operators of solid waste disposal facilities stating: "Ground water is … used extensively for agricultural, industrial, and recreational purposes. Landfills can contribute to the contamination of this valuable resource if they are not designed to prevent waste releases into ground water … Cleaning up contaminated ground water is a long and costly process and in some cases may not be totally successful."[7]

Unfortunately, environmental and human health impacts from placing CCR on a property, even temporarily, are not restricted to contamination of localized on-site materials. Wind-blown dust from temporarily placed CCR is readily transported from the site and creates opportunities for off-site exposures. Once dust leaves the property, it may enter homes, lungs, etc., producing harm that cannot be remedied.

The Illinois Pollution Control Board recently found that a temporary CCR pile contributed to exceedances of state groundwater standards for arsenic, boron, sulfate, and total dissolved solids, as well as boron and sulfate pollution in excess of state background levels.[8] The extent of soil, groundwater, and particulate dust contamination resulting from even temporary storage of CCR in an uncontained pile would be unknown until testing was completed and may prove to be irreversible. The operator would not be able to assume that removal of, for instance, the top six-inches of soil would retroactively manage the waste. Remediation of groundwater contamination is often a long-term commitment of time, effort and money that often continues for decades. Even once closure is achieved, some residual groundwater impacts remain. A more cost-effective regulatory strategy is to prevent releases to the environment and avoid potential exposures to local human and biological populations. Also, see response to section 3.2, below.

3.2 <u>Are there situations where piles are placed for a short period of time, are then removed, and that present no reasonable probability of adverse effects?</u>

The EPA also seeks comment and data on whether there are additional situations where piles are commonly in place for a short period of time (e.g., 90 days or less), at the end of

[7] EPA, 1993, p.3

[8] Illinois Pollution Control Board, 2019, Sierra Club et al v. Midwest Generation, LLC, PCB No. 2013-15, at 42, 48-51, 86 (Illinois Pollution Control Board June 20, 2019)

> *which the CCR is fully removed and presents no reasonable probability of adverse effects on human health or the environment, thus supporting an exemption from having to meet the requirement to control releases. The EPA also asks for information about key characteristics of such piles that would make them readily identifiable in practice.*

There are no CCR pile characteristics or situations that would dependably render a CCR waste pile safe to leave exposed to the environment for even a short period of time. In fact, the Illinois Pollution Control Board recently found that a temporary ash pile – in existence for a mere "two to three" months – contributed to exceedances of state groundwater standards for arsenic, boron, sulfate, and total dissolved solids, as well as boron and sulfate pollution in excess of state background levels.[9]

In practice, the ability to pile CCR on the ground surface for a "short" period of time and remove said pile and contaminated underlying soils without leaving lasting environmental effects is highly contingent on a variety of factors including:

- The type and amount of CCR as well as the type and concentrations of environmental contaminants contained within the waste.
- Leaching of some contaminants such as boron from CCR can be highest as the first few pore volumes of water pass through the waste. A pile of CCR that contains rapidly leaching contaminants could conceivably lose a considerable volume of contaminants during even very short-term storage in a waste pile, especially if a period of significant precipitation occurs before the CCR is removed.
- The physical characteristics of the ground surface upon which the waste would be placed. Waste piled on a substantial naturally occurring clay bed would be much less likely to spread subsurface contamination than would a pile placed on a sandy surface.
- Weather and environmental factors would also play an important part in determining the extent of redistribution of piled CCR. A significant rain or wind event that occurred while CCR was piled on the ground surface could cause significant mobilization and transport of waste from the original location.

The above bullets provide examples of just a few of the many site–specific variables that impact the potential for adverse effects from CCR piles. These examples should provide an indication of the folly of proposing a blanket authorization to store CCR in an uncontained pile on the ground and why such an authorization would not be protective of the environment. Requiring an Environmental Determination[10], at the very least, causes operators to think about and plan to avoid potential problems with short-term storage of CCR in waste piles and should continue to be required.

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[9] Illinois Pollution Control Board, 2019, p. 42.
[10] Campbell, 2019

3.3 *<u>Is a requirement that a pile be temporary a key element of controlling risks of releases from piles of CCR?</u>*

EPA requests comment on whether requiring that a pile must be temporary is a key element of controlling risks associated with the potential releases from piles of CCR; for example, do commenters have information to show that the size of a pile is sufficiently controlled by the ability to use pollution control measures to control releases of CCR and that the temporary element is not needed.

“Temporary” piles of CCR are constant or nearly-constant features at sites that manage their CCR in waste piles. In practice CCR stored in piles is routinely added-to and taken-from as new waste is added to the pile and other waste is loaded out. Releases of CCR contaminants are nearly inevitable at sites where a large uncontained accumulation of CCR is allowed; whether or not there are records available indicating that each cubic yard of ash has been present in a pile for a defined period of time. Examples of sites that handle CCR in “temporary’ CCR piles and have documented groundwater contamination as a result of these waste handling practices include the AES –Puerto Rico Guayama Plant, the Southwestern Electric Power Company Pirkey Plant, and the Powerton Coal Ash Pile. Descriptions of environmental impacts from CCR piles at these facilities are provided in my response to item 3.4, below.

3.4 *<u>Is there data documenting instances in which releases from temporary CCR piles have caused adverse effects?</u>*

The EPA also solicits comment on the existence of any data documenting instances in which releases from temporary placement of CCR on the land caused adverse effects even though releases had been managed consistently with current regulatory standards.

There are numerous sites that store, or have stored, CCR in uncontained piles. Unfortunately the environmental monitoring practices required by EPA are commonly insufficient to definitively attribute detected environmental contaminants to waste piles rather than adjacent or nearby CCR landfills or waste impoundments that are monitored together as one unit. In effect, EPA has allowed monitoring systems to collect data covering multiple CCR units and is now asking for waste pile specific data, data that EPA has not generally required be collected. Despite the difficulty of attributing environmental contamination solely to CCR piles, there are examples of CCR waste piles that do show documented impacts to groundwater. Short descriptions of documented environmental impacts from CCR stored in temporary piles are provided below.

<u>AES Puerto Rico - Guayama, Puerto Rico</u>
AES-PR has stored a mixture of fly ash and bottom ash formed into a material called AGREMAX in piles on the plant site since approximately 2005. According to AES inspection reports posted in 2016, 2017 and 2018, the volume of the CCR pile maintained at the power plant site and regulated under the CCR rule was 120,000, 430,000 and 400,000 tons,

respectively. The height of the pile was approximately 120 feet. Air pollution and groundwater contamination has been documented in required groundwater monitoring reports and annual site inspection reports.

Groundwater monitoring required by the federal CCR rule at the AES-PR Power Plant indicates statistically significant increases of several coal ash constituents including boron, chloride, fluoride, sulfate, pH, and TDS in downgradient groundwater. In addition, the 2017 Site Inspection Report posted to the CCR compliance website documents the presence of fugitive dust on the west slope of the CCR stockpile. The report indicates that the water truck that is reportedly used to moisten CCR and control dust was not operational at the time of the inspection. Both the statistically significant increases in CCR-related groundwater contamination and observable blowing dust issues documented on the AES-PR CCR compliance website directly result from uncontained storage of CCR in piles on the site.

<u>H.W. Pirkey Power Station, Hallsville, TX</u>

Southwest Electric Power Company operates an approximately 7-acre Flue Gas Desulfurization (FGD) sludge storage area to collect and temporarily store CCR materials in piles. The FGD Stackout area is utilized as a temporary staging area for CCR material, including fly ash and FGD Sludge.[11] Reports of inspections conducted on the Stack-Out Pad in 2016, 2017, and 2018 indicate that the waste volume in storage at the time of the inspections were 30,000 cubic yards; 10,000 cubic yards; and 500 cubic yards, respectively. A photograph of CCR piles at the Pirkey stakeout area taken during the 2016 CCR inspection[12] is provided below.

Photograph #13	September 28, 2016
Direction:	Facing south southwest
Description:	Typical CCR material pile staged on FGD Stackout Area.

[11] Braun Intertec, 2016
[12] Braun Intertec, 2016

Runoff from the Stackout Area drains by gravity to surge ponds where the runoff is supposedly collected and recirculated back to the plant. A photograph of the Stackout Area Surge Pond taken during the 2016 CCR inspection[13] is provided below.

Photograph #9	September 28, 2016
Direction:	Facing northwest
Description:	Discharge pipe in Surge pond north of FGD Stackout Area.

The Annual Groundwater Monitoring Report for the Pirkey FGD Stackout Area[14] showed statistically significant increases in concentrations of the Appendix III constituents boron, chloride, and sulfate in downgradient groundwater. In addition, Southwestern Electric Power Company recently placed a notice of Statistically Significant Levels above the Groundwater Protection Standards for the Appendix IV constituent Beryllium in groundwater at the FGD Stackout Area. These results provide documentation of impacts to groundwater quality from a CCR waste pile.

Powerton Coal Ash Pile

Even very short-duration coal ash piles are sources of contamination. In June 2019, the Illinois Pollution Control Board found that a temporary ash pile – in existence for a mere "two to three" months – contributed to exceedances of state groundwater standards for arsenic, boron, sulfate, and total dissolved solids, as well as boron and sulfate pollution in excess of state background levels.[15] The Board likewise concluded that the temporary coal ash pile constituted a "water pollution hazard."[16]

Examples of sites where the monitoring systems are or were insufficient to distinguish between contamination from CCR waste piles and other CCR units include the Prairie Creek Generating Station in Cedar Rapids, IA; the Lewis & Clark Station located near Sidney, MT; and the Healey

[13] Braun Intertec, 2016

[14] American Electric Power Service Corporation, 2019

[1515] See In the Matter of: Sierra Club et al v. Midwest Generation, LLC, PCB No. 2013-15, at 42, 48-51, 86 (Illinois Pollution Control Board June 20, 2019)

[16] Id. at 86

Power Plant, in Healy, AK. Short descriptions of these sites coal ash piles for which current monitoring is ineffective are provided below.

Prairie Creek Generating Station

CCR piles at the Prairie Creek Generating Station originally included a Fly Ash Stockpile, Bottom Ash Pile, and a Beneficial Use Storage Area. The fly ash stockpile has not received CCR since October 19, 2015 and is therefore not counted as a CCR unit. The PCS Bottom Ash Pile was located immediately east of the where the sluiced CCR entered Pond 1. After the CCR was dewatered at the Bottom Ash Pile, the CCR was either hauled directly offsite or transported to the Beneficial Use Storage Area. The Closure Plan[17] for these waste piles estimated quantity of CCR in the inactive fly ash stockpile as 58,000 cubic yards. The estimated quantity of CCR in the Bottom Ash Pile and Beneficial Use Storage Area were estimated as 2,500 cubic yards and 7,000 cubic yards, respectively. The closure footprint likely does not theoretically include the former waste pile footprints, but the waste piles could have contributed to contamination. Notification of Closure Completion for the Bottom Ash Pile and Beneficial Use Storage Area was posted to the site operating record in December, 2018.

The Prairie Creek Generating Station posted a notification of concentrations of arsenic and molybdenum groundwater at statistically significant levels above Groundwater Protection Standards (GWPS).[18] The Bottom Ash Pile was located outside of the monitoring network, but the Fly Ash Pile and Beneficial Use Storage Area were located between the upgradient and downgradient wells along with other closure units, so contaminants from the units may have been detected along with overall site contamination.

Lewis & Clark Station

CCR from two scrubber ponds at the Lewis & Clark Station was stockpiled, until 2018, on a temporary CCR storage pad located adjacent to the scrubber ponds until it could be transported to the permanent ash disposal facility. As operations permit, the stockpiled CCR was loaded into trucks and transported offsite for disposal at an abandoned coal mine. The Lewis & Clark station posted a notification of concentrations of lithium and selenium in groundwater at statistically significant levels above Groundwater Protection Standards (GWPS).[19] Other groundwater contaminants detected at concentrations above background included boron, cobalt, molybdenum, and sulfate. Attribution of the detected groundwater contamination to either the scrubber ponds or the temporary storage pad has not been made since the ponds and pad are located within the same groundwater monitoring network.

Healy Power Plant

CCR handling and storage at the Healy Power Plant consisted of dredging settled ash from the Ash Pond and its subsequent placement in piles on the Ash Drying Area where excess water

[17] Alliant Energy 2018
[18] Alliant Energy, 2019
[19] BARR, 2019

infiltrated to the subsurface and evaporated. Once dry, the ash was then transported for disposal in the mine that supplied the coal. A photograph of the of the groundwater monitoring results reported in 2019[20] showed that seven appendix IV constituents (antimony, arsenic, chromium, fluoride, lithium, molybdenum, and selenium) were detected in at least on monitoring well at concentrations above the GWPS. The exceedances in groundwater appeared to originate from suspected source areas including the Ash Pond, Recirculating Pond, and Ash Drying Area. Attribution of the detected groundwater contaminants to a specific source location has not been made since the ponds and Ash Drying Area are located within the same groundwater monitoring network.

3.5 EPA solicits comments on whether to retain a mass-based threshold.

> EPA is proposing to eliminate *the mass-based numerical threshold and replace it with specific location-based criteria, derived from the existing location criteria for CCR disposal units, to trigger an environmental demonstration. As discussed further below the available information does not appear to provide strong support for a single numerical mass-based threshold as a general matter; however, EPA solicits comments on whether to retain a mass-based threshold. Assuming EPA determines a threshold to be appropriate, EPA also solicits comments on whether an appropriate value for a mass threshold to trigger and environmental demonstration should be based on the state beneficial use programs' lower tonnage thresholds, discussed above, or to retain the current 12,400-ton numerical criterion.*

Placement and storage of CCR in piles should trigger an environmental demonstration regardless of the size of the pile or duration of the planned storage. The requirement for an environmental demonstration causes CCR users to actively consider their plans and procedures for containment of CCR prior to potential impacts to human health or the environment. I hold this opinion based on my previous experience as a technical advisor for the citizen's group at the Town of Pines Groundwater Plume Alternative Superfund Site in Town of Pines, IN. Sampling conducted during a Remedial Investigation in Town of Pines identified that fly ash was used as landscaping fill in and around the town. Concentrations of CCR constituents that presented and unacceptable exposure risk to human health were found on at least 45 properties. CCR used as fill on residential and public properties had created risks for residents who unknowingly lived with waste at or very near the surface of their properties.

Residents of the Town of Pines were exposed to elevated risks from CCR through direct exposure to soils, CCR-contaminated groundwater in their wells, and exposure to CCR dust. Laboratory analysis of surficial soil samples collected at the Pines Town Hall playground showed arsenic concentrations of up to 430 milligrams per kilogram (mg/kg), nearly an order of magnitude above the 67 mg/kg USEPA Removal Management Level for arsenic. In some cases residents had consumed vegetables produced in gardens, and allowed children to play and dig in

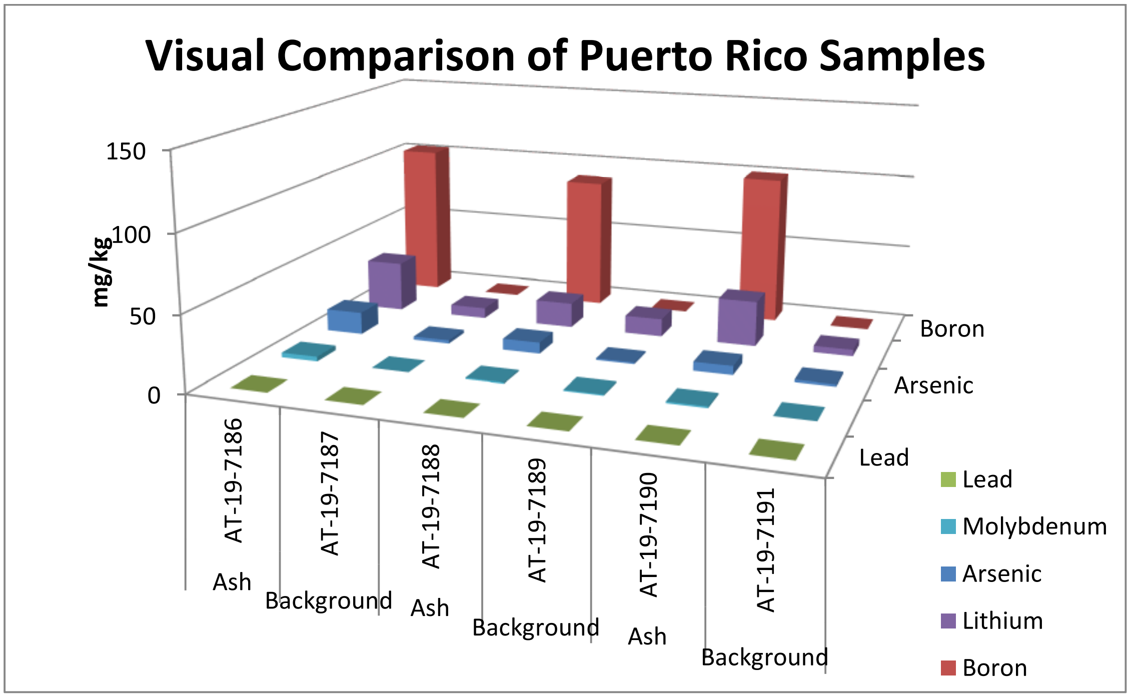
[20] Golden Valley Electric Association, 2019

CCR contaminated areas. None of the residential properties would likely have triggered the 12,400-ton numerical criterion to trigger a demonstration, yet the risk posed by these wastes was sufficient to trigger an EPA removal action. Soil removal in progress at the Town of Pines Park is shown in the photograph below.[21]

A current example human health and environmental exposures through small volume use of CCR as fill material can be found in Puerto Rico, near the AES-PR plant in Guayama, PR. Materials reported by residents to be CCR obtained from the AES-PR plant have been spread as fill in many public areas, including roadways, and remain on the surface where human and animal receptors are directly exposed, and contaminants are spread by wind and precipitation. I have examined and reviewed chemical analyses of these materials. The tested samples are amorphous solids that are enriched in arsenic, boron, and lithium (see below) as compared to local background soils, consistent with CCR from a fluidized bed generating station.

The concentration of arsenic detected in samples of CCR exposed on the ground surface were found to exceed the USEPA Regional Screening Level and thus, would pose a human health hazard in residential areas, where some of the materials are in fact located. None of the many dispersed areas where CCR has been spread on the surface around Guayama, PR would likely trigger the need for a demonstration at the current 12,400-ton trigger volume. Maintaining and strengthening a requirement for an environmental demonstration before CCR can be used as fill, in any volume, would drive at least a minimum amount of forethought, perhaps enough that these types of exposures can be avoided in the future.

[21] Picture from South Bend Tribune, June 27, 2016



Photographs of reported CCR deposits located around the Guayama area are shown in the following photographs.

The above findings are based on my review of the USEPA request for information, available sources including, previous USEPA policies and guidance, available information and data about example sites, and my education, qualifications, experience, and expertise.

I would be happy to discuss my thoughts on these of other CCR–related issues with USEPA at any time.

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References

Data and information sources reviewed included the following documents:

Akron Consulting, 2016, Initial CCR Inspection, H.W. Pirkey FGD Stackout Area, Hallsville, Harrison County, Texas, January 19, 2016

Alliant Energy, 2018, Closure Plan for Existing CCR Surface Impoundments and CCR Landfills, August 28, 2018

Alliant Energy, 2019, Notification of Groundwater Protection Standard Exceedance pursuant to 40 CFR 257.95, February 13, 2019

American Electric Power Service Corporation, 2019, Annual Groundwater Monitoring Report, Southwestern Electric Power Company, H.W. Pirkey Power Plant, FGD Stackout Area cCR Management Unit, Hallsville, TX, January 2019

BARR, 2019, Lewis & Clark Station, Notification of Statistically Significant Levels Above Ground Water Protection Standards, January 2, 2019

Braun Intertec, 2016, Annual Coal Combustion Residuals (CCR) Flue Gas desulfurization (FGD) Stackout Area Inspection Report, December 30, 2016

Campbell, 2019, Technical Memo Evaluating Aspects of Three Environmental Demonstrations Coal Combustion Residuals (CCRs), USA

DNA-Environment, LLC (2017), Groundwater Monitoring System and Sampling and Analysis Program, AES Puerto Rico LP, Guayama, Puerto Rico, August 2017

DNA-Environment, LLC (2017), Statistical Analysis Report, AES Puerto Rico LP, Guayama, Puerto Rico

DNA-Environment, LLC (2018), 2017 Annual Groundwater Monitoring Report, AES Puerto Rico LP, Guayama, Puerto Rico, January 2018

EPA, 1993, *Criteria for Solid Waste Disposal Facilities, A Guide for Owners/Operators*, EPA/530-SW-91-089, March 1993, *available at* https://www.epa.gov/sites/production/files/2016-03/documents/landbig.pdf

EPA, 2015, Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category, 80 Fed. Reg. (November 3, 2015) (40 C.F.R. Part 423), available at https://www.govinfo.gov/content/pkg/FR-2015-11-03/pdf/2015-25663.pdf

Golden Valley Electric Association Inc., 2019, 2018 Groundwater Monitoring and Corrective Action Report, January 2019

Illinois Pollution Control Board, 2019, Sierra Club et al v. Midwest Generation, LLC, PCB No. 2013-15, at 42, 48-51, 86 (Illinois Pollution Control Board June 20, 2019)

Pless Environmental, 2010, Review of EPA's Inhalation of Fugitive Dust: A Screening Assessment of Risks Posed by Coal Combustion Waste Landfills, prepared for Environmental Integrity Project.

APPENDICES

Pless Report

Pless Environmental, Inc.
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BY EMAIL

November 16, 2010

Eric Schaeffer
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Re: Review of EPA's Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills

Dear Mr. Schaeffer,

Per your request, I have reviewed *Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills* (hereafter "Screening Assessment") published by the U.S. Environmental Protection Agency ("EPA") for review in September 2009.[1] My review concentrates on EPA's assumptions for the development of emission factors for airborne particulate emissions from coal combustion waste ("CCW") landfills.

My qualifications as an environmental expert include a doctorate in Environmental Science and Engineering ("D. Env.") from the University of California Los Angeles. My résumé is attached to this letter.

Background

In 2009, EPA published the *Human and Ecological Risk Assessment of Coal Combustion Wastes* ("2009 Risk Assessment"). During the peer review and notice of data availability to the public for the draft of this document, EPA received comments pointing out that health risks from fugitive dust particulate matter emissions during operation of a CCW landfill via the inhalation pathway were not addressed. In response, the EPA prepared the Screening Assessment as a companion document to the 2009 Risk Assessment intended to examine the potential for uncontrolled fugitive dust emissions from dry handling of CCW to lead to significant human health risks.[2]

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[1] U.S. Environmental Protection Agency, Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion Waste Landfills, Draft, September 2009.

[2] *Ibid*, p. 2.

The stated purpose of the Screening Assessment is "to assess whether the national ambient air quality standards … for particulate matter could be violated through CCW landfilling operations without fugitive dust controls ... via a conservative screening analysis."[3]

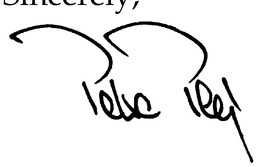
Executive Summary

After reviewing the Screening Assessment, I find that the methodology employed is overly simplistic, not sufficiently conservative and contains several errors. As a result, the Screening Assessment generally underestimates risks to receptors. For example, it is nonsensical to analyze the percentiles of landfill sizes and distances to receptors without acknowledging the extreme variability of emission factors for wind erosion, drop operations, and entrained road dust from equipment travel on unpaved landfill roads and their considerable contribution to total emissions of airborne particulates from a CCW landfill.

My comments should be viewed as suggestions regarding how the Screening Assessment could be improved and best used by the EPA in developing recommendations for CCW landfill management. Revision of the Screening Assessment taking into account the issues in my following comments would considerably improve the reliability of its results and conclusions. However, since the Screening Assessment for the most part underestimates risks to receptors, its conclusion to require daily controls as a safeguard for not causing excess levels of particulates at CCW landfills can be upheld without further review. In particular, daily landfill cover, rather than watering, is recommended for the best control, as watering alone is not sufficiently effective.

In addition, because of the substantial risks for residents living near CCW landfills, I recommend that the EPA conduct a full-scale health risk assessment that addresses both toxic constituents of fugitive dust emissions from landfills and emissions of diesel particulate matter from haul trucks, on-site heavy-duty landfill equipment, and diesel-powered pumps and generators.

Sincerely,



Petra Pless, D.Env.

[3] *Ibid*, p. 3.

Comments

The following table of contents summarizes the organization of this letter:

I. Summary of Screening Assessment Methodology and Results

The Screening Assessment includes the following steps to determine whether airborne particulate matter from CCW landfills would potentially exceed the national ambient air quality standards ("NAAQS") for particulate matter smaller than or equal to 10 micrometers ("PM10") and smaller than or equal to 2.5 micrometers ("PM2.5"):

Initial Scenario (Uncontrolled Landfill)

1. Determined the receptors with the highest exposure to CCW particulate emissions as residents living near CCW landfills and the most important source of particulate matter at the CCW landfill as wind erosion. Emissions from unloading of CCW at the landfill were excluded assuming they would have an increasingly lower contribution relative to total emissions from the entire landfill area exposed to wind erosion as the landfill approaches capacity over its useful life. (Section 2.1.)
2. Determined an emission factor for particulates resulting from wind erosion of CCW landfills based on the equation for "Continuous Fugitive/Windblown Dust Emissions" in EPA's 1992 *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*. Calculation of the emission factor is based on the assumption that the CCW consists of fly ash and the landfill is not covered does not have any controls to reduce wind erosion. (Section 2.2.)
3. As conservative assumptions for modeling, determined the 50th through 90th percentiles of landfill sizes and side length assuming that the landfills were square; determined the 10th through 50th percentiles of landfill distances to residential receptors based on available data on the distance of residential wells to landfills. The maximum size of landfills and minimum distance from landfill to receptor were excluded as being too conservative to be considered reasonable. Taken together, the combination of sizes and distances do be modeled were assumed to provide both a true median (50th/50th) and upper tail (90th/10th) of the input distribution that would be modeled in a probabilistic assessment. (Section 2.3.)
4. Determined other input parameters for SCREEN3, a single-source Gaussian plume screening model which provides maximum ground-level concentrations for point, area, flare, and volume sources. (Section 2.4.)
5. SCREEN3 modeling for both 50th percentile values for landfill side length and distance to receptors found that uncontrolled particulate matter emissions from wind erosion of CCW landfills (13,390 $\mu g/m^3$) would exceed the 24-hour NAAQS for PM10 (150 $\mu g/m^3$) by almost two orders of magnitude. Thus, risks posed by fugitive dust cannot be screened out if no dust controls are applied to the landfill before closure. (Section 2.5.)

Secondary Scenarios (Controlled Landfill)

6. Assumed that only a fraction of the CCW landfill would be exposed to wind erosion and the other remaining portion of the landfill would be controlled 100% assuming yearly, monthly, weekly, or daily control via spraying or covering over the landfill's useful life of 40 years. It was assumed that the exposed fraction of the landfill would be square and located in the center of the landfill. (Section 3.0.)
7. SCREEN3 modeling for both 50th percentile values for landfill side length and distance to receptors found that fugitive dust emissions with yearly and monthly controls of the landfill

would exceed the 24-hour NAAQS for PM10. Since emission estimates for weekly and daily controls for fugitive dust were below the 24-hour NAAQS for PM10, further permutations of inputs were entered into the model to determine the likelihood that operating with those frequencies of controls would be adequate to protect human health. (Section 3.1.)

8. The Screening Assessment concludes that only daily controls of landfills would guarantee particulate matter concentrations below the NAAQS for PM10 and PM2.5. (Sections 4.0 and 5.0.)

II. Discussion of Screening Assessment Methodology

In general, the Screening Assessment's approach to evaluating the potential of airborne particulate matter from CCW landfills exceeding the NAAQS is reasonable. However, the methodology relies on several overly simplistic or not sufficiently conservative assumptions and contains a number of errors. A revision of the Screening Assessment to address these issues would greatly improve the reliability of its conclusions and any recommendations for CCW landfill management that can be derived from them.

II.A Assumption of Wind Erosion of CCW Landfill as Sole Source of Particulate Matter Emissions Is Not Adequate

Total fugitive dust emissions into the air from dry-handling CCW result from several distinct source activities: loading onto trucks, conveyors, railcars, or barges; emissions during transport from the power plant to a landfill; direct unloading from trucks or conveyors or unloading of railcars or barges via mobile equipment; wind erosion of piles in open trucks, railcars or conveyors; wind erosion from a landfill; and entrained road dust from truck and heavy-duty equipment traffic on paved and unpaved roads to and at a landfill. Potential receptors of airborne emissions include residents near the power plant, along the transportation route and at the landfill.

The Screening Assessment concludes that residents living near a CCW landfill would be exposed to higher emissions and for longer periods of time than residents living near power plants where CCW is handled or near roads where CCW is transported because residents near landfills would be exposed to emissions from both unloading and windblown emissions of CCWs. The Screening Assessment therefore only further considers residents near landfills as a highly exposed receptor population. The Screening Assessment further reasons that, the closer an uncovered landfill gets to capacity towards the end of its operating life, the less relative influence unloading emissions would have on total (uncontrolled) emissions. Consequently, the Screening Assessment considers windblown emissions as representative for its preliminary scenarios because they would dominate and, thus, only quantifies windblown emissions.[4] This assumption is overly simplistic and not supported by evidence as discussed in the following comments.

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[4] Screening Assessment, p. 4.

First, the Screening Assessment fails to provide even a preliminary estimate for sources of fugitive dust emissions other than windblown erosion and their relative contribution to total emissions from the landfill to verify that its assumption that wind erosion is the dominating emission source and other sources of emissions are negligible is defensible.

These other sources, *e.g.*, fugitive dust emissions associated with unloading of fly ash[5] at a CCW landfill, entrained road dust from equipment travel on unpaved roads at the landfill, and unloading can be substantial.

The Screening Assessment fails to even recognize entrained road dust emissions from equipment travel on unpaved roads at the landfill as a potential source of airborne particulates. Equipment at the landfill includes both haul trucks and mobile equipment such as dozers or scrapers. At CCW landfills the temporary roads frequently consist of the deposited material, *i.e.*, flyash, and are therefore, without proper management, prone to releasing clouds of dust when equipment travels over them. Entrained road dust emissions can be a major contributor to airborne fugitive dust, as shown in the photographs below. (Note plumes of dust emanating from vehicle tires.)

Figure 1: Dust clouds from vehicle travel on unpaved road at CCW landfill in Bokoshe, OK

Photo courtesy of Linda Evans, EarthJustice

[5] Fly ash is fine powder with a mean particle size of 50 micrometers ("µm"); between 60 and 90 percent of fly ash particles are finer than 75 µm.

Figure 2: Dust clouds from vehicle travel on unpaved road at a surface mine

From: Reed WR, Organiscak JA, Haul Road Dust Control Fugitive Dust Characteristics from Surface Mine Haul Roads and Methods of Control; http://www.cdc.gov/Niosh/mining/pubs/pdfs/hrdcf.pdf

The following photograph shows clouds of dust released during unloading of fly ash at a CCW landfill.

Figure 3: Fly ash dumping at CCW landfill in Bokoshe, OK

Source: Fly Ash in the Air We Breathe; http://www.intheairwebreathe.com/html/what_is_fly_ash_.html

In addition, dust is released when on-site equipment such as dozers and scrapers move, compact and contour the deposited fly ash. The following photographs show the variety of heavy-duty equipment operating simultaneously at a CCW landfill.

Figure 4: Fly ash management at Arrowhead Landfill, AL
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 5: Fly ash management at Arrowhead Landfill, AL,
From: New York Times, Clash in Alabama Over Tennessee Coal Ash, August 29, 2009;
http://www.nytimes.com/2009/08/30/us/30ash.html?_r=2&ref=earth

Clearly, emissions of entrained road dust from equipment travel on unpaved roads, unloading, and compacting and contouring the landfill can be substantial and should not be excluded from the Screening Assessment without a quantitative demonstration that these emissions are indeed negligible compared to the total emissions from wind erosion. This is particularly important for the daily and weekly control scenarios evaluated in the Screening Assessment's Section 3.0 when emissions associated with wind erosion are restricted to a small active portion of the landfill and entrained road dust emissions and emissions from unloading and entrained road dust from vehicle travel on unpaved roads will contribute a larger percentage to total emissions.

At a number of coal-fired power plants, the landfill is directly adjacent and CCW is transported via conveyor belts to the landfill. At such landfills, emissions result from the release of fly ash onto the piles at the landfill, particularly, when the drop height from the conveyor and the moisture content of the material are not properly controlled. Railcar transport results in emissions at the landfill from unloading railcars into dozers or other landfill equipment and unloading of that equipment.

The following sections provide estimates of particulate matter emission factors for equipment traffic on unpaved roads and drop operations and compare them to the emission factor developed by the Screening Assessment for particulate matter emissions from wind erosion.

1. Entrained Road Dust from Equipment Traffic on Unpaved Roads

Emission Factors Based on Vehicle Distance Traveled

Emission factors for entrained road dust from equipment traffic (trucks, front-end loaders, dozers, etc.) on unpaved roads to the active section of the landfill can be estimated using an equation in EPA's *Compilation of Air Pollutant Emission Factors* ("AP-42") for *Unpaved Roads* at industrial sites, *i.e.*, sites that are not publicly accessible:

$$E_{VMT} = k\,(s/12)^{a}\,(W/3)^{b} \qquad \textbf{Equation 1}$$

where:

E_{VMT} = particle size-specific emission factor (lb/VMT)
k = particle size-specific empirical constant (lb/VMT)
s = surface material silt content (%)
a = particle size-specific empirical constant (dimensionless)
W = mean vehicle weight (tons)
b = particle size-specific empirical constant (dimensionless)[6]

Because many landfills build their internal temporary roads out of the deposited material itself, the silt content of the fly ash can be assumed as a worst-case estimate for the unpaved road surface material silt content at a CCW landfill. For the following estimate, a

[6] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.2 Unpaved Roads, updated November 2006.

lower-end value for the surface material silt content, 20%, was chosen based on the silt content determined for various roads in western surface coal mining, including haul roads to/from pit, plant road, scraper route, and freshly graded haul road (range 2.8%-29%; mean 5.1%-24%).[7] An upper-end value for the surface material silt content, 80%, was based on the silt content of fly ash as assumed by the Screening Assessment. Thus, based on Equation 1 and assuming a surface material silt content of 20% or 80% and a mean vehicle weight of 30 or 40 tons (average of vehicle weight full/vehicle weight empty) as lower and upper end variables, and the respective particle size-specific constants k, a, and b[8] for particulate matter equal to or smaller than 30 micrometers ("PM30")[9], PM10 and PM2.5, emission factors ("E_{VMT}") for the respective particle sizes in pounds per vehicle mile traveled ("lb/VMT") and grams per vehicle kilometer traveled ("g/VKmT") can be estimated as shown in Table 1 and Table 2 below.

Table 1: Particle size-specific emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads (mean vehicle weight 30 tons)

Particulate Size	A Surface material silt content 20% E_{VMT} (lb/VMT)	(g/VKmT)[a]	B Surface material silt content 80% E_{VMT} (lb/VMT)	(g/VKmT)[a]
PM30	19.7	5,567	52.1	14,690
PM10	6.7	1,887	23.3	6,572
PM2.5	0.7	189	2.3	657

a 1 lb/VMT = 281.9 g/VKmT

Table 2: Particle size-specific emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads (mean vehicle weight 40 tons)

Particulate Size	C Surface material silt content 20% E_{VMT} (lb/VMT)	(g/VKmT)[a]	D Surface material silt content 80% E_{VMT} (lb/VMT)	(g/VKmT)[a]
PM30	22.5	6,336	59.3	16,721
PM10	7.6	2,148	26.5	7,480
PM2.5	0.8	215	2.7	748

a 1 lb/VMT = 281.9 g/VKmT

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[7] *Ibid*, Table 13.2.2-1.

[8] *Ibid*, Table 13.2.2-2:

Constant	PM30	PM10	PM2.5
k	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

[9] Particulate matter with an aerodynamic diameter less than or equal to 30 micrometers is sometimes termed "suspendable particulate" and is often used as a surrogate for total suspended particulate matter ("TSP").

As shown in Table 1 and Table 2, emissions per vehicle mile traveled increase proportionally with silt content. As shown, the surface material silt content of the road has greatly influences the emission factors: from 20% to 80% silt content, emission factors rise by a factor of 2.6 for PM10 and 3.5 for PM10 and PM2.5. (*See* Table 1, Columns A and B, and Table 2, Columns C and D.)

A higher mean vehicle weight also increases emission factors: at 20% silt content, the emission factors rise by 43% for PM30 and 33% for PM10 and PM2.5 with increasing mean vehicle weight from 30 to 40 tons. (*See* Table 1, Column A, and Table 2, Column C.) At higher silt contents, the influence of mean vehicle weight on emission factors is not as pronounced: at 80% silt content, an increase in mean vehicle weight increases emission factors by 14%. (*See* Table 1, Column B, and Table 2, Column D.)

Area-specific Emission Factors

The following provides estimates for area-specific emission factors for fugitive dust emissions from unpaved roads that can be compared to the area-specific emission factor determined by the Screening Assessment for wind erosion:

On an area (unit square meter)-basis, it depends how many vehicles travel over the same road on a given day. Conservatively assuming that each vehicle travels twice over the same portion of the road while driving to and from the active portion of the landfill as landfill roads are often narrow, *i.e.*, traveling a distance of two meters ("m") on each square meter unit road, and assuming that vehicles would access the landfill over the entire 24-hour day, the unit emission factors ("E"), in grams per second and square meter ("g s^{-1} m^{-2}") for the respective particle sizes for 1, 10, 20, and 50 vehicles per day can be estimated as shown in Table 3 for a road surface material silt content of 20% and assuming the landfill operates 24 hours per day and in Table 4, as a worst-case assumption, for a road surface material silt content of 80% and assuming the landfill operates 8 hours per day.

Table 3: Particle size-specific unit emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads based on 20% silt content, mean vehicle weight of 30 tons, and 24 hours/day landfill operation

Particulate Size	E[a]			
	1 vehicle/day (g s^{-1} m^{-2})	10 vehicles/day (g s^{-1} m^{-2})	20 vehicles/day (g s^{-1} m^{-2})	50 vehicles/day (g s^{-1} m^{-2})
PM30	1.29E-04	1.29E-03	2.58E-03	6.44E-03
PM10	4.37E-05	4.37E-04	8.74E-04	2.18E-03
PM2.5	4.37E-06	4.37E-05	8.74E-05	2.18E-04

a E = (E_{VMT} in g/VKmT) x (2 m traveled/vehicle) x (number of vehicles/day) x (Km/1,000 m) x (day/24 hours) x (hours/28,800 seconds) x (m^{-2})

Table 4: Particle size-specific unit emission factors for PM30, PM10, and PM2.5 for entrained road dust from unpaved roads based on 80% silt content, mean vehicle weight of 40 tons, and 8 hours/day landfill operation

Particulate Size	E[a] 1 vehicle/day ($g\ s^{-1}\ m^{-2}$)	10 vehicles/day ($g\ s^{-1}\ m^{-2}$)	20 vehicles/day ($g\ s^{-1}\ m^{-2}$)	50 vehicles/day ($g\ s^{-1}\ m^{-2}$)
PM30	1.16E-03	1.16E-02	2.32E-02	5.81E-02
PM10	5.19E-04	5.19E-03	1.04E-02	2.60E-02
PM2.5	5.19E-05	5.19E-04	1.04E-03	2.60E-03

a E = (E_{VMT} in g/VKmT) x (2 m traveled/vehicle) x (number of vehicles/day) x (Km/1,000 m) x (day/8 hours) x (hours/28,800 seconds) x (m^{-2})

As the results in Table 3 and Table 4 show, the fugitive dust emission factors for PM30 for a unit square meter of road range from the same order of magnitude (1.29E-04 $g\ s^{-1}\ m^{-2}$ for one vehicle per day, a silt content of 20%, and 24-hours of landfill operation per day; *see* shaded cell in Table 3) to being two orders of magnitude higher (5.10E-02 $g\ s^{-1}\ m^{-2}$ for 50 vehicles per day, a silt content of 80%, and 8-hours of landfill operation per day compared to the Screening Assessment's unit emission factor (2.43E-04 $g\ s^{-1}\ m^{-2}$) for wind erosion; *see* shaded cell in Table 4). These emission factors are based on the mean vehicle weight of haul trucks only and do not take into account that the mean vehicle weight could be considerably higher due to operation of heavy-duty equipment on those roads, which would further increase emission factors.

Based on a three meter wide road leading to the active portion of a landfill (conservatively assumed at the opposite end of the landfill) and assuming a) 20% surface material silt content, a mean vehicle weight of 30 tons, and 24 hours of landfill operations per day as the lower bound variables and b) 80% surface material silt content, a mean vehicle weight of 40 tons, and 8 hours of landfill operation per day as the upper bound variables for one or 50 vehicles traveling the unpaved road per day, uncontrolled entrained road dust emissions in grams per second ("g/s") for the 50th and 90th percentile size landfills for PM30, PM10 and PM2.5 can be estimated as shown in Table 5.

Table 5: Uncontrolled entrained dust emissions from unpaved road assuming daily cover of landfill

	Landfill		**Road**		**Emissions (g/s)**					
					PM30		**PM10**		**PM2.5**	
Percentile	Total Side (m)	Active portion Side (m)	Length (m)	Area (m^2)	20% 30 tons 24 hours 1 vehicle	80% 40 tons 8 hours 50 vehicles	20% 30 tons 24 hours 1 vehicle	80% 40 tons 8 hours 50 vehicles	20% 30 tons 24 hours 1 vehicle	80% 40 tons 8 hours 50 vehicles
50th	518.8	4.3	515	1,544	1.99E-01	2.99E+01	6.74E-02	1.34E+01	6.74E-03	1.34E+00
90th	1097.4	9.1	1,088	3,265	4.21E-01	6.32E+01	1.43E-01	2.83E+01	1.43E-02	2.83E+00

Based on the Screening Assessment's assumptions, airborne particulate emissions due to wind erosion of the active portions of landfill with daily cover for the 50th and 90th percentile can be estimated at 4.37E-03 to 1.99E-02 g/s.[10] Compared to these estimates for wind erosion from active portions of a landfill with daily cover, entrained road dust PM30 emissions are orders of magnitude higher for both the 50th and 90th percentile size landfills and assuming either one or 50 vehicles traveling the unpaved road. (*See* shaded cells in Table 5).

This comparison illustrates the necessity of including fugitive emissions from unpaved roads in the estimates of fugitive dust emissions from CCW landfills and providing sound management requirements for their control. For further discussion of wind erosion from the active portion of a landfill, *see* Comment II.E.

These emission estimates do not account for trackout and re-entrainment of particulates through vehicle travel on paved roads. These emissions should be estimated separately with EPA's AP-42, Section 13.2.1, for *Paved Roads*.

2. Emissions Associated with Drop Operations

Unloading of CCW from trucks, conveyors, railcars, or barges at a landfill involves one or more so-called "drop operations," *i.e.*, dropping materials onto receiving surfaces. For example, truck dumping onto a pile is an example of a batch drop operation. Barge and railcar unloading requires loadout via on-site mobile equipment which then unload the materials at the active portion of the landfill in a batch drop operation. Unloading materials from a conveyor is an example of a continuous drop operation. Drop operations occur more or less instantaneously, often resulting in large clouds of dust released into the atmosphere, particularly, if the fly ash is uncontrolled, as shown in Figure 3.

The quantity of particulate emissions generated by a drop operation (*e.g.*, unloading of truck at landfill), in kilogram per metric ton ("kg/metric ton") of material transferred, may be estimated using the following empirical expression:

$$E = k\,(0.0016)\,(U/2.2)^{1.3} / (M/2)^{1.4}$$ **Equation 2**

where:

E = particle size-specific emission factor (kg/metric ton)
k = particle size-specific multiplier (dimensionless)
U = mean wind speed, meters per second (m/s)
M = material moisture content (%)

[10] Emissions from 50th percentile landfill area with daily cover: (2.43E-04 g s^{-1} m^{-2}) × (18 m^2 active landfill area) = 4.37E-03 g/s;
emissions from 90th percentile landfill area with daily cover: (2.43E-04 g s^{-1} m^{-2}) × (82 m^2 active landfill area) = 1.99E-02 g/s.

Equation 2 requires the assumption of wind speed for determining the emission factor. Table 6 shows the Beaufort wind force scale including a description of various wind speeds in meters per second ("m/s") and the resulting conditions on land.

Table 6: Beaufort wind force scale

Beaufort number	Wind speed (m/s)	Description	Land conditions
0	<0.3	Calm	Calm. Smoke rises vertically.
1	0.3-1.5	Light air	Smoke drift indicates wind direction, still wind vanes.
2	1.6-3.4	Light breeze	Wind felt on exposed skin. Leaves rustle, vanes begin to move.
3	3.4-5.4	Gentle breeze	Leaves and small twigs constantly moving, light flags extended.
4	5.5-7.9	Moderate breeze	Dust and loose paper raised. Small branches begin to move.
5	8.0-10.7	Fresh breeze	Branches of a moderate size move. Small trees in leaf begin to sway.
6	10.8-13.8	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	13.6-17.1	High wind, moderate gale, near gale	Whole trees in motion. Effort needed to walk against the wind.
8	17.2-20.7	Gale, fresh gale	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	20.9-24.4	Strong gale	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10	24.5-28.4	Storm, whole gale	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	28.5-32.6	Violent storm	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	≥32.7	Hurricane force	Very widespread damage to vegetation. Some windows may break; mobile homes and poorly constructed sheds and barns are damaged. Debris may be hurled about.

Adapted from Wikipedia; http://en.wikipedia.org/wiki/Beaufort_scale

For purposes of establishing emission factors for drop operations, wind speeds of 5, 10, 20, and 30 m/s were chosen to demonstrate the influence of wind speed on emissions at the landfill. Based on these wind speeds and assuming a fly ash moisture content of 27%[11] and the particle size-specific multipliers k[12], the particle size-specific emission factors E can be estimated as shown in Table 7.

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[11] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.4 Aggregate Handling and Storage Piles, updated November 2006: mean moisture content for fly ash from four samples.

[12] *Ibid*, p. 13.2.4-4: k = 0.74 for PM30, 0.35 for PM10 and 0.053 for PM2.5.

Table 7: Particle size-specific emission factors for PM30, PM10, and PM2.5 for drop operations at various wind speeds

Particulate Size	E (kg/metric ton) at wind speed 5 m/s	10 m/s	20 m/s	30 m/s
PM30	9.00E-05	2.22E-04	5.46E-04	9.25E-04
PM10	4.26E-05	1.05E-04	2.58E-04	4.37E-04
PM2.5	6.45E-06	1.59E-05	3.91E-05	6.62E-05

As shown in Table 7, particulate matter emission factors increase by an order of magnitude for wind speeds between 5 m/s and 30 m/s. The wind speeds of interest for determining whether fugitive dust emissions from the landfill would potentially exceed the short-term NAAQS for PM10 and PM2.5 are those that provide a worst-case scenario, *i.e.*, windy or stormy conditions above 10 m/s.

Based on the emission factors Table 7 particulate matter emissions for one drop operation can be estimated assuming a 20 ton[13] load of CCW per truck as shown in Table 8.

Table 8: Particle size-specific emissions for PM30, PM10, and PM2.5 for 1 drop operation (20 tons) at various wind speeds

Particulate Size	Emissions (kg) at wind speed 5 m/s	10 m/s	20 m/s	30 m/s
PM30	1.63E-03	4.02E-03	9.90E-03	1.68E-02
PM10	7.73E-04	1.90E-03	4.68E-03	7.94E-03
PM2.5	1.17E-04	2.88E-04	7.09E-04	1.20E-03

As an example of the magnitude of drop operation emissions: A 1,000 Megawatt ("MWe") power plant with an average daily consumption of 12,000 tons of sub-bituminous coal produces about 2,400 tons of fly ash per day.[14] Since capture efficiencies range from 95% to 99.95%, most of this fly ash is captured for either landfilling (or reuse). Thus, assuming 2,300 tons of fly ash would be disposed of per day and assuming a 20-ton load for each truck, about 115 drop operations would occur every day at a landfill to dispose of the fly ash from one 1,000-MWe power plant (in addition, the power plant generates bottom ash and other CCW wastes).[15] Some landfills receive CCW from several facilities; some of the largest commercial landfills receiving industrial waste are permitted to receive up to 15,000 tons of

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[13] 1 ton = 0.907 metric tons; 20 tons = 18.1 metric tons.

[14] Chen Y, Shah N, Huggins EE, Huffman GP, and Dozier A, Characterization of Ultrafine Coal Fly Ash Particles by Energy-filtered TEM, Journal of Microscopy, Vol. 217, Pt. 3, March 2005, pp. 225-234.

[15] (2,300 tons fly ash) / (20 ton load/truck) = 115 trucks/day.

waste per day.[16] Table 9 summarizes particulate emissions in kilogram per day ("kg/day") for drop operations of 2,300 tons of fly ash per day via 20 ton loads.

Table 9: Particle size-specific emissions for PM30, PM10, and PM2.5 for drop operation of 2,300 tons* of fly ash per day via 20 ton loads at various wind speeds

Particulate Size	Emissions (kg/day) at wind speed			
	5 m/s	10 m/s	20 m/s	30 m/s
PM30	1.88E-01	4.63E-01	1.14E+00	1.93E+00
PM10	8.88E-02	2.19E-01	5.39E-01	9.13E-01
PM2.5	1.35E-02	3.31E-02	8.16E-02	1.38E-01

* (2,300 tons) × (0.907 metric tons/ton) = 2,087 metric tons

As Table 9 shows, at wind speeds of 5 to 30 m/s, PM30 emissions attributable to truck drop operations at a landfill to dispose of fly ash from one 1000-MW coal-fired power plant range from 0.2 to 1.9 kg/day; PM10 emissions range from 0.09 kg/day to 0.9 kg/day. These emissions, which occur only during the operating hours of the landfill, must be added to the emission factors from wind erosion and entrained road dust from vehicle travel on unpaved roads.

Drop operations may occur several times for disposal of one load of fly ash: for example, if delivered via railcar or barge, the material will be dumped into a transfer vehicle (*see* Figure 4), moved to the active portion of the landfill and dropped off there. Thus, there will be two emission points (loading and unloading) for one load of CCW.

Figure 6: Fly ash unloading from rail cars at Arrowhead Landfill, AL
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

[16] *See*, for example, the Arrowhead Landfill in Alabama: http://www.arrowheadlandfill.com/.

3. Emissions Associated with Landfill Equipment

Typically at a landfill, trucks dump their loads onto piles and then large off-road equipment, such as scrapers or dozers, move and compact the materials and smooth and contour the landfill. (*See* Figure 4, Figure 5, and Figure 7.)

Figure 7: Heavy-duty equipment at fly ash landfills

Left: from Center for Environment, Commerce and Energy;
http://cenvironment.blogspot.com/2010/03/constellation-energy-proposing-fly-ash.html

Right: from The Star Online: Grappling with Garbage, May 27, 2008;
http://snipurl.com/1fci88 [thestar_com_my]

Fugitive dust emissions from material handling with off-road equipment can be substantial and must be included in the estimates of total emissions from disposal of CCW at landfills. Emissions can be estimated following the instructions in EPA's AP-42, Section 11.9, for *Western Surface Coal Mining*.

II.B Assumptions for Estimating Particulate Emissions due to Wind Erosion Are Not Sufficiently Conservative

The Screening Assessment determined the emission factor for windblown particulate emissions from a CCW landfill using the equation for "Continuous Fugitive/Windblown Dust Emissions" in EPA's 1992 *Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants*:[17]

[17] Screening Assessment, pp. 4-5.

$E = 1.9 (s/1.5) (365-p) / (235) (w/15)$ **Equation 3**

where:

E = emission factor (kg day^{-1} $hectare^{-1}$)
s = material silt content (%)
p = number of days per year with more than 25 mm of precipitation (dimensionless)
w = percent of time wind speed exceeds 5.4 m/s (%)

The Screening Assessment assumed a material silt content for fly ash of 80% and the default values in EPA's workbook of 0 for p and 20% for w to determine an emission factor of 2.43E-04 g s^{-1} m^{-2}.[18] Neither the Screening Assessment's assumptions nor the equation used provide a sufficiently conservative estimate for emissions from fly ash landfills.

Equation Is Only of Limited Value for Determining Worst-Case Emissions from CCW Landfills

First, the equation used by the Screening Assessment is of limited value for determining worst-case emissions from large-scale wind erosion of a CCW landfill. The equation had been developed to determine fugitive dust releases from "process losses, generated by mechanical action in material handling or windblown dust" originating "from a surface or a collection of small, poorly defined point sources," as shown in the following Figure.[19]

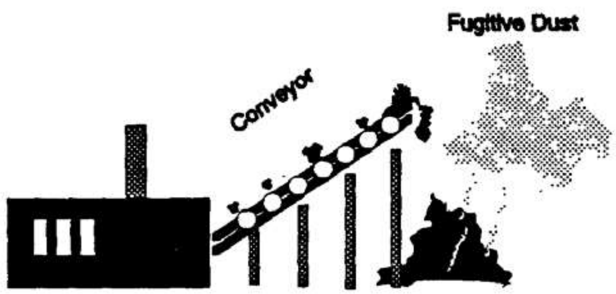

Figure 8: Fugitive dust from material handling or windblown dust
from: EPA, Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants, 1992, p. 4-11

The equation developed for this purpose is independent of wind speed (*see* Equation 3), assuming only a threshold wind speed at which particulates become airborne (5.4 m/s). Erosion potential has been found to increase rapidly with higher wind speeds resulting in considerably more airborne dust. Therefore, emissions should be related to wind gusts of highest magnitude.[20]

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[18] *Ibid*.

[19] U.S. Environmental Protection Agency, Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants, 1992, p. 4-11.

[20] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.5 Industrial Wind Erosion, updated November 2006, p. 13.2.5-1.

While for most materials the erosion potential, *i.e.*, the finite availability of erodible material (mass/area), tends to decay during an erosion event, fly ash due to its small size can act as an *unlimited reservoir of erodible material* and can sustain emissions for periods of hours without substantial decreases in emission rates. Some natural crusting of the surface may bind available erodible material, thereby reducing the erosion potential when fly ash is stored without disturbance. However, at most landfills, the piles of fly ash are continuously added to, moved, compacted, etc.

Percentage of Wind Speed Exceeding 5.4 m/s Is Not Sufficiently Conservative

Second, while the Screening Assessment's assumptions may be acceptable for determining whether airborne particulate matter emissions through wind erosion of CCW landfills may lead to a violation of the *annual* NAAQS for PM10; the assumption for w of 20%, *i.e.*, the percent of time wind speed exceeds 5.4 m/s, is not acceptable for determining whether emissions would exceed short-term NAAQS, *i.e.*, the *24-hour* standards for PM10 and PM2.5. As shown in Table 6, a wind speed of 5.4 m/s is only a gentle breeze. A conservative screening assessment for this purpose must therefore assume that the wind speed exceeds 5.4 m/s for the entire 24-hour period of a day, *i.e.*, 100%. Thus, the Screening Assessment underestimated potential emissions from wind erosion at a CCW landfill by a factor of five.[21]

Terrain Assumptions for Wind Erosion from Landfill Are Not Representative

The Screening Assessment calculates emissions and models dispersion of fugitive dust based on the emission factor of 2.43E-04 g s^{-1} m^{-2} and based on the 50^{th} through as 90^{th} percentiles of landfill sizes. The Screening Assessment calculates these emissions as if the landfill were a flat, even grade area, *i.e.*, it assumes the footprint of the landfill for emission estimates.

In reality, a landfill is rarely a flat, even grade area but typically consists of elevated areas with piles of recently dumped material that are then moved, compacted, and contoured by off-road equipment, as shown in Figure 4 through Figure 5 and Figure 7.

The elevated portions of the landfill and the piles of fly ash present a considerably larger surface area subject to wind erosion than the footprint of the landfill alone. For example, a cone-shaped storage pile with a diameter of 10 meters and a height of 3 meters has a footprint of 78.5 square meters ("m^2")[22] but an exposed surface area of 91.6 m^2, a 17% increase.[23]

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[21] (100%) / (20%) = 5.

[22] Footprint of cone: $\pi \times r^2 = \pi \times (5\ m^2)^2 = 78.5\ m^2$;
exposed surface area of cone: $\pi \times r \times \sqrt{(r^2 + h^2)} = \pi \times (5\ m) \times \sqrt{(5\ m^2 + 3\ m^2)} = 91.6\ m^2$.

[23] $(91.6\ m^2) \times (78.5\ m^2) = 1.17$.

Use of AP-42, Industrial Wind Erosion, Appears to Be More Representative for Estimating Wind Erosion from Fly Ash Storage Piles

The EPA's AP-42, Section 13.2.5, provides a methodology to estimate emissions from frequently disturbed storage piles and exposed areas within an industrial facility. This section takes into account the shapes of the piles (conical and oval with flattop), the surface area created by piles, and the frequency of disturbance of piles, amongst other variables. This methodology appears to be more representative to determine worst-case emissions for particulate emissions due to wind erosion from CCW landfill than the equation used by the Screening Assessment.

The Screening Assessment's Conclusion that Elevated Landfills Result in Fewer Fugitive Particulate Emissions Is Incorrect

The Screening Assessment determines maximum emissions from the landfill for two scenarios: a) at zero meters height and b) at 10 meters height. The Screening Assessment finds "that landfills that are built up, as opposed to dug into the ground, would actually lead to lower particulates nearby."[24] As explained above, the Screening Assessment's assumptions and calculations are not representative of actual landfill conditions and, thus, the modeling fails to provide accurate results. If emissions are calculated as detailed above, ambient concentrations of particulate matter resulting from wind erosion of CCW landfills will be higher for elevated rather than for at-grade landfills.

II.C The Choice of 10th Percentile of Landfill Distance to Nearest Receptor Is Not Acceptable

The Screening Assessment determined distances of landfills to residential receptors based on available data on the distance of residential wells to landfills. The Screening Assessment determined that the closest recorded distance between a resident (well) and the landfill is 0.6 meters (2 feet) and recognizes that some residences may be even closer.[25] Yet, the Screening Assessment excluded the minimum distance from landfills to receptors as being too conservative to be considered reasonable.[26] In my opinion, excluding the potential receptors who reside directly adjacent to a landfill from a risk assessment is unconscionable. These receptors exist and their risk from exposure to airborne dust from the landfill should therefore be evaluated.

The conventional way of evaluating potential violations of NAAQS for industrial facilities is to determine pollutant concentrations in ambient air at the fence line. This convention should be used here as well.

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[24] Screening Assessment, p. 10.

[25] Screening Assessment, p. B-1.

[26] Screening Assessment, p. 5.

II.D Assumed Control Efficiency for Wind Erosion via Cover or Spraying of Active Portion of Landfill Is Unrealistic

For its secondary scenarios, the Screening Assessment estimated emissions due to wind erosion from a landfill assuming that only a portion of the landfill would be active and the inactive portion would be controlled by covering or spraying on a regular basis. The Screening Assessment calculates emissions from the active portion of the landfill assuming a 40-year operating life of the landfill and daily, weekly, monthly, or annual control via covering or spraying of the inactive portions assuming 100% control. These assumptions are overly simplistic and fail to provide a worst-case scenario of fugitive dust emissions from wind erosion of fly ash at a landfill.

Covering the inactive portions of the landfill or spraying on a regular basis does not result in 100% control of fugitive dust emissions. For example, continuous chemical treating of material loaded onto piles, coupled with watering or treatment of roadways, has been estimated to reduce total particulate emissions by up to 90 percent.[27] The control efficiency of watering an exposed area before high winds has been estimated at 90%. Further, spraying with water is only effective as long as the surface material is sufficiently wetted: in dry climates or high wind conditions, watering during the operating hours of the landfill may be insufficient to control fugitive dust during the night and result in increasing emissions as the surface material dries out again. The efficiency of using dust suppressants or gravel has been estimated at 84%. For landfill covers, depending on the type and the timing of its application, control efficiencies may also be far lower than 100%. For example, the effect of revegetation on wind erosion has been estimated at only 90%.[28] Thus, the Screening Assessment underestimates emissions from the active portion of the landfill for its daily, weekly, monthly, and annual scenarios.

II.E Assumed Sizes of Active Portions of Landfill Are Unrealistic

For its controlled exposure scenarios, the Screening Assessment assumed that only a fraction of the CCW landfill would be exposed to wind erosion and the other remaining portion of the landfill would be controlled 100% assuming yearly, monthly, weekly, or daily control via spraying or covering over the landfill's useful life of 40 years. It was assumed that the exposed fraction of the landfill would be square and located in the center of the landfill. The Screening Assessment determined the following distributions of areas in square meters (m^2) and sides in meters (m) for the active portions of landfills:

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[27] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.4 Aggregate Handling and Storage Piles, updated November 2006, p. 13.2.4-5.

[28] Western Governors' Association, WRAP Fugitive Dust Handbook, September 7, 2006, p. 3; http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf.

	Yearly		Monthly		Weekly		Daily	
%ile	Area	Side	Area	Side	Area	Side	Area	Side
50th	6,728	82.0	561	23.7	129	11.4	18	4.3
60th	8,600	92.7	717	26.8	165	12.9	24	4.9
70th	12,282	110.8	1024	32.0	236	15.4	34	5.8
80th	21,084	145.2	1757	41.9	405	20.1	58	7.6
90th	30,109	173.5	2509	50.1	579	24.1	82	9.1

[29]

Review of these estimates shows that at least some of the exposure scenarios evaluated in the Screening Assessment are unrealistic. For example, the 50th and 90th percentiles for the sides of an active portion of the landfills assuming daily control are only 18 to 82 square meters (194 to 883 square feet) with side lengths of 4.3 to 9.1 meters (14 to 30 feet). An area of 18 square meters can basically be covered by unloading the contents of one haul truck onto a pile. Managing this pile would involve spreading and compacting the CCW, resulting in a larger active area than 18 square meters. Clearly, the areas considered in the Screening Assessment for daily cover are too small to be managed with heavy-duty equipment on site and are orders of magnitude smaller than what is typically managed as an active portion at CCW landfills even with daily controls. Thus, the Screening Assessment underestimates wind erosion from landfills. As discussed in Comment II.A, emissions from drop operations, entrained road dust and managing the CCW on site would by far exceed emissions from those small areas. Consequently, daily cover should definitively be recommended to minimize fugitive dust emissions and resulting risks to receptors.

II.F Assumption of Active Portion in Center of Landfill Does Not Constitute Worst Case Scenario

To simplify modeling, the Screening Assessment assumes that the operating or active portion is at the very center of the landfill to "give results that estimate an average concentration over the entire lifetime of the landfill for a receptor located in any direction."[30] This assumption, which would be acceptable for determining long-term impacts of fugitive dust emissions from the landfill, *e.g.*, for determining cancer risks over the lifetime of nearby receptors, is *not* sufficiently conservative as a worst-case scenario to determine whether fugitive dust emissions would lead to exceedances of short-term 24-hour ambient air quality standards. In order to assess short-term exceedances, the Screening Assessment should be revised to assume that the operating portion of the landfill is at the fence line closest to a potential receptor.

For example, landfill operators frequently fill in a portion of the landfill nearest to the fence line first before moving to the more central portions of the landfill. For example, at the Arrowhead Landfill in Perry County, AL, where over three million tons of fly ash from the 2008 Tennessee Valley Authority ("TVA") Kingston Plant fly ash pond spill are currently being

[29] Screening Assessment, Table 5, p. 8.

[30] Screening Assessment, p. 9.

disposed off, the landfill operator started unloading in an area nearest to residents, as shown in the photographs below. (Note the proximity of residences to the active (black) portion of the landfill. The dust and odor from this fly ash disposal were so noxious that nearby residents filed suit against the landfill owners.)

Figure 9: Arrowhead Landfill, AL, disposal of fly ash from TVA Kingston pond spill
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 10: Arrowhead Landfill, AL, disposal of TVA fly ash waste
Photo courtesy of John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Figure 11: Proximity of Arrowhead Landfill, AL, to residence
Courtesy: John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

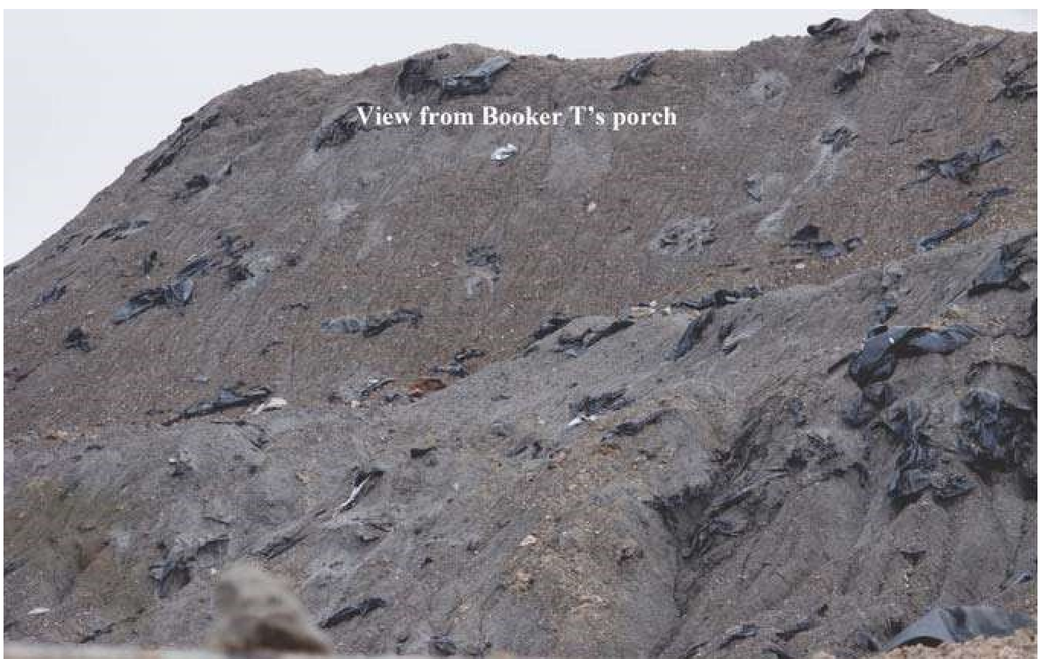

Figure 12: Arrowhead Landfill, AL, TVA fly ash waste with remnants of plastic cover as seen from a resident's porch
Courtesy: John Wathen, Hurricane Creekkeeper, Waterkeeper Alliance

Thus, the risks of fugitive dust emissions from the landfill leading to violations of the 24-hour NAAQS for PM10 and PM2.5 should be based on the active portion of the landfill being at the fence line to the closest receptor.

III. Potential Human Health Risks from Fugitive Dust via Inhalation Pathway Have Not Been Adequately Assessed

As summarized above, the Screening Assessment limits its analysis to the incremental risks of human exposure to particulate emissions in excess of NAAQS resulting from dry handling of CCW at landfills. As such, it addresses neither background concentrations of particulate matter nor a constituent-based exposure pathway.[31] In addition, it ignores the substantial emissions of carcinogenic diesel particulate emissions from haul trucks, on-site landfill equipment, and diesel-powered pumps and generators.

Coal combustion waste consists of fly ash, bottom ash, boiler slag, flue gas desulfurization ("FGD") residues, and fluidized bed combustion ("FBC") wastes and contains varying levels of toxic constituents, including metals such as arsenic, lead, mercury, cadmium, chromium, selenium and varying levels of alkalinity and crystalline silica. Trace element content also varies with the individual types of CCWs from a single boiler. Fly ash in particular, tends to be enriched in arsenic, boron, mercury, and lead. Table 10 shows concentration data in various CCWs in parts per million ("ppm").

Table 10: Concentrations of trace elements in various CCWs

	Fly Ash (ppm)		Bottom Ash (ppm)		Boiler Slag (ppm)	
Constituent	Median	Range	Median	Range	Median	Range
Aluminum[a]	—	—	—	—	—	—
Antimony[b]	4.6	0.2-205	4.0	0.18-8.4	0.8	0.25-1.0
Arsenic[b]	43.4	0.0003-391.0	4.7	0.80-36.5	4.5	0.01-254
Barium[b]	806.5	0.02-10,850	633	24-9,630	413	6.19-1,720
Beryllium[b]	5.0	0.200-2,105	2.2	1.4-2.9	7.0	7.0-7.0
Boron[b]	311	2.98-2,050	90.0	1.79-390	49.5	0.10-55.0
Cadmium[b]	3.4	0.01-76.0	3.1	0.050-5.5	40.5	0.01-40.5
Chromium[c]	136	3.6-437	120	3.4-350	—	—
Chromium VI[b]	90	0.19-651	121.0	3.41-4,710	158	1.43-5,981
Cobalt[c]	35.9	4.90-79.0	24	7.1-60.4	—	—
Copper[c]	112	0.20-655	61.1	2.39-146.3	32.0	1.37-156
Fluorine[c]	29.0	0.40-320	50.0	2.5-104	—	—
Iron[a]	—	—	—	—	—	—
Lead[b]	56.8	0.02-273	13.2	0.86-843.0	8.0	0.40-120
Manganese[c]	250	24.5-750	297	56.7-769	—	—
Mercury[b]	0.1	0.013-49.5	0.009	0003-0.040	9.5	0.016-9.5
Molybdenum[a]	—	—	—	—	—	—
Nickel[b]	77.6	0.1-1,270	79.6	1.9-1,267	83.0	3.3-177
Potassium[a]	—	—	—	—	—	—
Selenium[b]	7.7	0.0003-49.5	0.8	0.007-9.0	4.5	0.10-14.0
Silver[b]	3.2	0.01-49.5	3.0	0.06-7.1	37.0	0.01-74.0
Strontium[c]	775	30.0-3,855	800	170-1,800	—	—
Thallium[b]	9.0	0.15-85.0	na	2.0	38.5	33.5-40.0
Vanadium[b]	252	43.5-5,015	141	24.0-264	75.0	75.0-320.0
Zinc[b]	148	0.28-2,200	52.6	3.80-717	35.8	4.43-530

[31] Screening Assessment, p. 3.

Table 10 contd.: Concentrations of trace elements in various CCWs

FGD (ppm)		FBC: Fly Ash (ppm)		FBC: Bed Ash (ppm)	
Median	Range	Median	Range	Median	Range
—	—	42,300	20-88,900	18,000	9-68,800
6.0	3.65-90.0	7.75	0.125-259	10	0.125-361
32.5	0.0075-341.0	27.55	2.8-176	14.6	2.5-80
162.5	0.08-2,280	348	31.3-2,690	184	7.3-453
29.3	0.900-49.5	2.23	1.08-11.5	1.21	0.5-8
60.0	5.00-633	39.1	0.025-2,470	14.1	0.025-304
3.9	0.005-81.9	1.25	0.013-6.68	1.02	0.0125-7.16
—	—	44.8	5.17-97.1	37	4.1-86
73.0	0.17-312	—	—	—	—
—	—	19	2.5-79.8	11.3	1.4-75.8
46.1	0.04-251.0	41.1	2-99	13.8	1.65-37.1
—	—	—	—	—	—
—	—	25,300	22.2-76,500	11,100	6.2-19,300
25.3	0.01-527.0	25	1.03-105	12.5	0.848-58
—	—	165	0.05-548	241	52.2-751
4.8	0.073-39.0	0.323	0.00005-129	0.05	0.00005-16.2
—	—	6.25	2.35-48.6	14.7	6-63.4
68.1	3.7-191.0	41.4	6.25-923	22	1-945
—	—	3510	1.13-10,200	584	1.3-8,980
4.5	0.0150-162.0	8.36	0.47-166	0.952	0.152-45
3.3	0.01-10.3	1.03	0.05-11.6	1	0.05-87.6
—	—	—	—	—	—
9.0	9.0-9.0	3.28	1.25-39	3.03	0.5-25
65.0	0.01-302.0	194	36.4-3,830	69	12-5,240
90.9	0.01-5,070	38.5	25-143	34	17.4-399

From: National Research Council, Managing Coal Combustion Residues in Mines, 2006, p. 42;
http://www.nap.edu/openbook.php?record_id=11592&page=42#, pp. 42 and 43.

EPA recently published total metal concentration ranges in CCWs, which for some constituents, *e.g.*, arsenic ("As") are higher than shown in Table 10.

Table 11: Total metals concentration in CCWs (ppm)

Constituent	Mean	Minimum	Maximum
Antimony	6.32	0.00125	3100
Arsenic	24.7	0.00394	773
Barium	246.75	0.002	7230
Beryllium	2.8	0.025	31
Cadmium	1.05	0.000115	760.25
Chromium	27.8	0.005	5970
Lead	25	0.0074	1453
Mercury	0.18	0.000035	384.2
Nickel	32	0.0025	54055
Selenium	2.4075	0.0002	673
Silver	0.6965	0	3800
Thallium	1.75	0.09	100

From: U.S. Environmental Protection Agency, 40 CFR Parts 257, 261, 264 et al., Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities; Proposed Rule, Fed. Reg. Vol. 75, No. 118, June 21, 2010, p. 35169

Risks from exposure to these hazardous materials, including cancer risks and chronic and acute health risks, must be assessed in order to adequately characterize human health risks resulting from dry handling of CCW. The Screening Assessment does not evaluate these risks, nor were they adequately assessed in other EPA documents.

In response to a comment by peer reviewer Dr. William Hopkins, Virginia Polytechnic Institute and State University, regarding the lack of inhalation risks in the 2009 Risk Assessment, the EPA referred the commenter to a 1998 human and ecological risk analysis (*Non-groundwater Pathways, Human Health and Ecological Risk Analysis for Fossil Fuel Combustion Phase 2*; hereafter "1998 Risk Analysis") that evaluated cancer and chronic risks via the inhalation pathway by modeling chronic exposures to constituents in airborne CCW erosion from landfills. However, that assessment did not evaluate acute exposures to particulates. The EPA stated that it conducted the Screening Assessment to correct this deficiency.[32] There are several problems with this approach.

First, the potential exceedance of NAAQS due to airborne particulate matter from CCW landfills evaluated in the Screening Assessment is not an adequate substitute for assessing acute risks from exposure to toxic constituents of particulate matter.

Second, the 1998 Risk Analysis analyzed emissions from an active portion in the center of the landfill. While acceptable for long-term analyses, *i.e.*, cancer and chronic health impacts, this assumption is not acceptable for assessing short-term acute impacts.

Third, the 1998 Risk Analysis analyzed only non-mercury metals associated with emissions of particulates. The major reason for not including mercury in the analysis was that the risk assessment methodology for mercury is much more complex than for other metal constituents and that the methodology was, at the time under review by EPA's Office of Research and Development.[33] Yet, emissions of mercury are of particular concern due to its toxicity and its accumulation in fly ash. Implementation of the Clean Air Mercury Rule will further increase mercury content in fly ash. For example: according to EPA's *Preamble to the National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry* published December 20, 2006, sorbent injection processes significantly increase the mercury content of fly ash. Testing to date reveals that mercury in fly ash increases by a median factor of 8.5 and, in one case, the mercury content increased by a factor of 70. At the same time, other contaminant in fly ash such as arsenic and selenium also increase also increase concurrently increasing risks to human health via inhalation of fugitive dust.[34]

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[32] U.S. Environmental Protection Agency, Responses to Review Comments on Human and Ecological Risk Assessment for Coal Combustion Wastes, Final Draft, September 1, 2009, pp. 41-42.

[33] *Ibid*, pp. 24 and 45.

[34] U.S. Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry, Federal Register, Vol. 71, No. 244, December 20, 2006.

Fourth, the 1998 Risk Analysis did not analyze another fly ash component of concern, lime ("CaO"). This chemical reacts with water to form calcium hydroxide ("$Ca(OH)_2$"), giving fly ash a pH somewhere between 10 and 12, a medium to strong base. The presence of lime in fly ash can cause lung damage if present in sufficient quantities.[35]

Fifth, 1998 Risk Analysis did not analyze the presence of fine crystalline silica in fly ash which has been linked with lung damage, in particular silicosis. The Occupational Health and Safety Administration ("OSHA") allows a maximum concentration of crystalline silica in ambient air of 0.10 milligram per cubic meter ("mg/m^3").

The 1998 Risk analysis found incremental cancer risks from hexavalent chromium of 3.5 in one million, below the threshold of 10 in one million; all other contaminants did not have appreciable cancer risks, *i.e.*, incremental cancer risks were below one in one million. However, as mentioned above, this health risk assessment did not take into account mercury, crystalline silica, or diesel particulate matter emissions from haul trucks, landfill mobile equipment, and diesel-powered pumps and generators at the landfill. Thus, cancer risks can be assumed to be considerably higher than estimated by the 1998 Risk Analysis and may well exceed the 10 in one million cancer threshold.

The Screening Assessment should be revised and used as a companion document for an in-depth health risk assessment examining inhalation exposure to airborne particulate emissions associated with CCW landfill operations.

IV. Recommendations for Landfill Management

Based on the above discussion and the risks found by Screening Assessment for airborne fugitive dust emissions associated with dry handling of fly ash at CCW landfills, daily cover should be recommended for all landfills. In addition, enclosure, watering and the use of chemical wetting agents are recommended as the principal means for control of temporary emissions at the landfill. Watering is useful mainly to reduce emissions from vehicle traffic in the storage pile area. Watering of the storage piles themselves typically has only a very temporary slight effect on total emissions. A much more effective technique is to apply chemical agents (such as surfactants) that permit more extensive wetting. Continuous chemical treating of material loaded onto piles, coupled with watering or treatment of roadways, can reduce total particulate emissions from storage operations by up to 90 percent.[36]

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[35] National Research Council, Managing Coal Combustion Residues in Mines, 2006, p. 36.

[36] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, 13.2.4 Aggregate Handling and Storage Piles, updated November 2006, p. 13.2.4-5.

The following summarizes recommendations for landfill management:

- Cover active areas of landfill daily;
- Stabilize, cover, or water exposed CCW piles at landfill;
- Place windbreaks upwind of storage piles;
- Stabilize or water unpaved roads at landfill;
- Minimize CCW freefall distance from drop operations from trucks, conveyors, or loaders;
- Avoid overloading of onsite equipment.
- Keep two feet of freeboard on trucks and cover during transport; and
- Avoid trackout onto public streets by installing wheel washers.

Additional recommendations for dry handling of materials can be found in the Western Governors' Association's *WRAP Fugitive Dust Handbook*, which is in part based on EPA's AP-42.[37]

V. Typographical Errors

The following typographical errors in the Screening Assessment should be corrected:

- In Section 4.4, Controls Applied Daily, the Screening Assessment incorrectly refers to "*weekly* fugitive dust control," rather than "*daily* fugitive dust control."[38]
- In Section 5.0, Conclusions, the Screening Assessment concludes that "*even* the most conservative evaluation of daily dust controls led to particulate concentrations well below the NAAQS," instead of "*only* the most conservative evaluation..."[39]

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[37] Western Governors' Association, WRAP Fugitive Dust Handbook, September 7, 2006; http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf.

[38] Screening Assessment, p. 11.

[39] Screening Assessment, p. 11.

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Air Quality and Pollution Control

Projects include CEQA/NEPA review; attainment and non-attainment new source review ("NSR"), prevention of significant deterioration ("PSD") and Title V permitting; control technology analyses (BACT, LAER, RACT, BARCT, BART, MACT); technology evaluations and cost-effectiveness analyses; criteria and toxic pollutant emission inventories; emission offsets; ambient and source monitoring; analysis of emissions estimates and ambient air pollutant concentration modeling. Some typical projects include:

— Critically reviewed and prepared technical comments on the air quality, biology, noise, water quality, and public health and safety sections of CEQA/NEPA documents for numerous commercial, residential, and industrial projects (*e.g.*, power plants, airports, residential developments, retail developments, hospitals, refineries, slaughterhouses, asphalt plants, food processing facilities, printing facilities, quarries, and mines) and provided litigation support in a number of cases filed under CEQA.

— Critically reviewed and prepared technical comments on the air quality and public health sections of the Los Angeles Airport Master Plan (Draft, Supplement, and Final Environmental Impact Statement/Environmental Impact Report) for the City of El Segundo. Provided technical comments on the Draft and Final General Conformity Determination for the preferred alternative submitted to the Federal Aviation Administration.

— For several California refineries, evaluated compliance of fired sources with Bay Area Air Quality Management District Rule 9-10. This required evaluation and review of hundreds of source tests to determine if refinery-wide emission caps and compliance monitoring provisions were being met.

— Critically reviewed and prepared technical comments on Draft Title V permits for several refineries and other industrial facilities in California.

— Evaluated the public health impacts of locating big-box retail developments in densely populated areas in California and Hawaii. Monitored and evaluated impacts of diesel exhaust emissions and noise on surrounding residential communities.

— In conjunction with the permitting of several residential and commercial developments, conducted studies to determine baseline concentrations of diesel exhaust particulate matter using an aethalometer.

— For an Indiana steel mill, evaluated technology to control NOx and CO emissions from fired sources, including electric arc furnaces and reheat furnaces, to establish BACT. This required a comprehensive review of U.S. and European operating experience. The lowest emission levels were being achieved by steel mills using selective catalytic reduction ("SCR") and selective non-catalytic reduction ("SNCR") in Sweden and The Netherlands.

— For a California petroleum coke calciner, evaluated technology to control NOx, CO, VOCs, and PM10 emissions from the kiln and pyroscrubbers to establish BACT and LAER. This required a review of state and federal clearinghouses, working with regulatory agencies and pollution control vendors, and obtaining and reviewing permits and emissions data from other similar facilities. The best-controlled facilities were located in the South Coast Air Quality Management District.

— For a Kentucky coal-fired power plant, identified the lowest NOx levels that had been permitted and demonstrated in practice to establish BACT. Reviewed operating experience of European, Japanese, and U.S. facilities and evaluated continuous emission monitoring data. The lowest NOx levels had been permitted and achieved in Denmark and in the U.S. in Texas and New York.

— In support of efforts to lower the CO BACT level for power plant emissions, evaluated the contribution of CO emissions to tropospheric ozone formation and co-authored report on same.

— Critically reviewed and prepared technical comments on applications for certification ("AFCs") for numerous natural-gas fired, solar, biomass, and geothermal power plants in California permitted by the California Energy Commission. The comments addressed construction and operational emissions inventories and dispersion modeling, BACT determinations for combustion turbine generators, fluidized bed combustors, diesel emergency generators, etc.

— Critically reviewed and prepared technical comments on draft PSD permits for several natural gas-fired power plants in California, Indiana, and Oregon. The comments addressed emission inventories, greenhouse gas emissions, BACT, case-by-case MACT, compliance monitoring, cost-effectiveness analyses, and enforceability of permit limits.

— For a California refinery, evaluated technology to control NOx and CO emissions from CO Boilers to establish RACT/BARCT to comply with BAAQMD Rule 9-10. This required a review of BACT/RACT/LAER clearinghouses, working with regulatory agencies across the U.S., and reviewing federal and state regulations and State Implementation Plans ("SIPs"). The lowest levels were required in a South Coast Air Quality Management District rule and in the Texas SIP.

— In support of several federal lawsuits filed under the federal Clean Air Act, prepared cost-effectiveness analyses for SCR and oxidation catalysts for simple cycle gas turbines and evaluated opacity data.

— Provided litigation support for a CEQA lawsuit addressing the pollution control equipment at a proposed biomass cogeneration plant.

— Prepared comments and provided litigation support on several proposed regulations including the Mojave Desert Air Quality Management District Rule 1406 (fugitive dust emission reduction credits for road paving); South Coast Air Quality Management District Rule 1316, San Joaquin Valley Air Pollution Control District Rule 2201, Antelope Valley Air Quality Management District Regulation XIII, and Mojave Desert Air Quality Management District Regulation XIII (implementation of December 2002 amendments to the federal Clean Air Act).

— Critically reviewed draft permits for several ethanol plants in California, Indiana, Ohio, and Illinois and prepared technical comments.

— Reviewed state-wide average emissions, state-of-the-art control devices, and emissions standards for construction equipment and developed recommendations for mitigation measures for numerous large construction projects.

— Researched sustainable building concepts and alternative energy and determined their feasibility for residential and commercial developments, *e.g.*, regional shopping malls and hospitals.

— Provided comprehensive environmental and regulatory services for an industrial laundry chain. Facilitated permit process with the South Coast Air Quality Management District. Developed test protocol for VOC emissions, conducted field tests, and used mass balance methods to estimate emissions. Reduced disposal costs for solvent-containing waste streams by identifying alternative disposal options. Performed health risk screening for air toxics emissions. Provided permitting support. Renegotiated sewer surcharges with wastewater treatment plant. Identified new customers for shop-towel recycling services.

— Designed computer model to predict performance of biological air pollution control (biofilters) as part of a collaborative technology assessment project, co-funded by several major chemical manufacturers. Experience using a wide range of environmental software, including air dispersion models, air emission modeling software, database programs, and geographic information systems ("GIS").

Water Quality and Pollution Control

Experience in water quality and pollution control, including surface water and ground water quality and supply studies, evaluating water and wastewater treatment technologies, and identifying, evaluating and implementing pollution controls. Some typical projects include:

- Evaluated impacts of on-shore oil drilling activities on large-scale coastal erosion in Nigeria.
- For a 500-MW combined-cycle power plant, prepared a study to evaluate the impact of proposed groundwater pumping on local water quality and supply, including a nearby stream, springs, and a spring-fed waterfall. The study was docketed with the California Energy Commission.
- For a 500-MW combined-cycle power plant, identified and evaluated methods to reduce water use and water quality impacts. These included the use of zero-liquid-discharge systems and alternative cooling technologies, including dry and parallel wet-dry cooling. Prepared cost analyses and evaluated impact of options on water resources. This work led to a settlement in which parallel wet dry cooling and a crystallizer were selected, replacing 100 percent groundwater pumping and wastewater disposal to evaporation ponds.
- For a homeowner's association, reviewed a California Coastal Commission staff report on the replacement of 12,000 linear feet of wooden bulkhead with PVC sheet pile armor. Researched and evaluated impact of proposed project on lagoon water quality, including sediment resuspension, potential leaching of additives and sealants, and long-term stability. Summarized results in technical report.

Applied Ecology, Industrial Ecology and Risk Assessment

Experience in applied ecology, industrial ecology and risk assessment, including human and ecological risk assessments, life cycle assessment, evaluation and licensing of new chemicals, and fate and transport studies of contaminants. Experienced in botanical, phytoplankton, and intertidal species identification and water chemistry analyses. Some typical projects include:

- Conducted technical, ecological, and economic assessments of product lines from agricultural fiber crops for European equipment manufacturer; co-authored proprietary client reports.
- Developed life cycle assessment methodology for industrial products, including agricultural fiber crops and mineral fibers; analyzed technical feasibility and markets for thermal insulation materials from natural plant fibers and conducted comparative life cycle assessments.
- For the California Coastal Conservancy, San Francisco Estuary Institute, Invasive Spartina Project, evaluated the potential use of a new aquatic pesticide for eradication of non-native, invasive cordgrass (*Spartina spp.*) species in the San Francisco Estuary with respect to water quality, biological resources, and human health and safety. Assisted staff in preparing an amendment to the Final EIR.
- Evaluated likelihood that organochlorine pesticide concentrations detected at a U.S. naval air station are residuals from past applications of these pesticides consistent with manufacturers' recommendations. Retained as expert witness in federal court case.
- Prepared human health risk assessments of air pollutant emissions from several industrial and commercial establishments, including power plants, refineries, and commercial laundries.

- Managed and conducted laboratory studies to license pesticides. This work included the evaluation of the adequacy and identification of deficiencies in existing physical/chemical and health effects data sets, initiating and supervising studies to fill data gaps, conducting environmental fate and transport studies, and QA/QC compliance at subcontractor laboratories. Prepared licensing applications and coordinated the registration process with German environmental protection agencies. This work led to regulatory approval of several pesticide applications in less than six months.
- Designed and implemented database on physical/chemical properties, environmental fate, and health impacts of pesticides for a major multi-national pesticide manufacturer.
- Designed and managed experimental toxicological study on potential interference of delta-9-tetrahydrocannabinol in food products with U.S. employee drug testing; co-authored peer-reviewed publication.
- Critically reviewed and prepared technical comments on applications for certification for several natural-gas fired, solar, and geothermal power plants and transmission lines in California permitted by the California Energy Commission. The comments addressed avian collisions and electrocution, construction and operational noise impacts on wildlife, risks from brine ponds, and impacts on endangered species.
- For a 180-MW geothermal power plant, evaluated the impacts of plant construction and operation on the fragile desert ecosystem in the Salton Sea area. This work included baseline noise monitoring and assessing the impact of noise, brine handling and disposal, and air emissions on local biota, public health, and welfare.
- Designed research protocols for a coastal ecological inventory; developed sampling methodologies, coordinated field sampling, determined species abundance and distribution in intertidal zone, and conducted statistical data analyses.
- Designed and conducted limnological study on effects of physical/chemical parameters on phytoplankton succession; performed water chemistry analyses and identified phytoplankton species; co-authored two journal articles on results.
- Organized and conducted surveying and mapping of aquatic plant species in several lakes and rivers in Sweden and Germany as ecological indicators for the health of limnological ecosystems.

PRO BONO ACTIVITIES

Founding member of "SecondAid," a non-profit organization providing tsunami relief for the recovery of small family businesses in Sri Lanka. (www.secondaid.org.)

PROFESSIONAL AFFILIATIONS

Association of Environmental Professionals

PUBLICATIONS

Available upon request