



Human Health and Ecological Risks Associated with Surface Impoundments

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**Flyash Ponds and Power Plant Wastewater
Treatment Issues**

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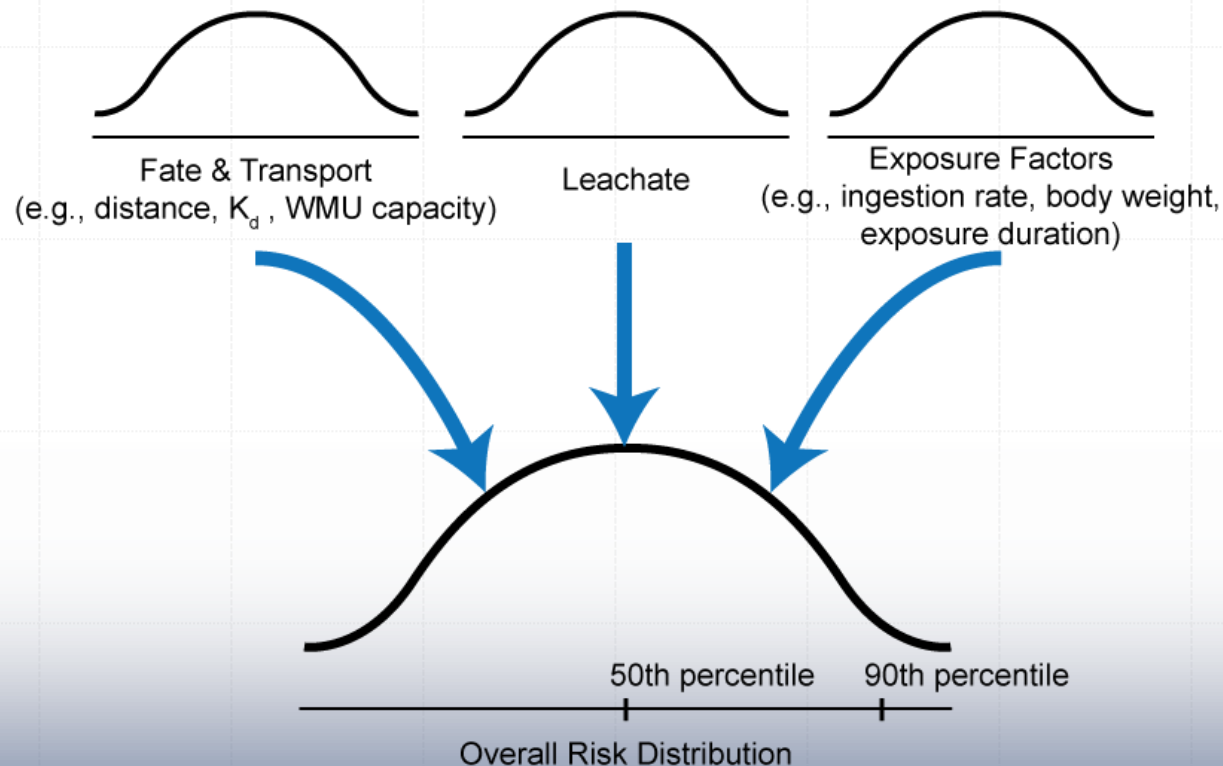
Outline

- Brief summary of EPA's risk assessment (RA): Human health and ecological
- Use of risk results in the Regulatory Impact Analysis (RIA) and implications for coal combustion residue (CCR) disposal regulation
- Case studies
- Toxicological and regulatory updates to some of the constituents in CCRs and implications for CCR RAs



2010 HHRA of Coal Combustion Residues (CCRs)

- Update of US EPA RA conducted in 2010 in support of the regulatory determination
 - › Aim was to characterize industry as a whole
 - › Determine whether regulation as hazardous waste is warranted



EPA Risk Assessment – Human Health



- "More typical" waste management scenarios (50th percentile)
 - › Landfills – Arsenic
 - › Surface impoundments – Arsenic and cobalt
 - › Risks similar to or less than those associated with background exposure to arsenic
- More extreme management scenarios (90th percentile)
 - › Landfill storage still poses minimal risk, but some exceedances
 - Arsenic, antimony, molybdenum, thallium
 - Arsenic risks still similar to background exposures
 - › Surface impoundments associated with several risk exceedances
 - Arsenic, cobalt, boron, molybdenum, nitrate, selenium, cadmium
 - Arsenic and cobalt key risk drivers

US EPA 2010 CCR RA – Results

90th Percentile

Landfills

| | |
|---------------|---|
| Arsenic (III) | 2 x 10⁻⁵ (cancer) (Unlined, co-disposed CCR and coal refuse) |
| Arsenic (V) | 5 x 10⁻⁴ (cancer) (Unlined, co-disposed CCR and coal refuse) |

Antimony, molybdenum, thallium also slightly above risk targets at 90th percentile level

Surface Impoundments

| | |
|---------------|---|
| Arsenic (III) | 2 x 10⁻² (cancer) (Unlined, co-disposed CCR and coal refuse) |
| Arsenic (V) | 2 x 10⁻² (cancer) (Unlined, co-disposed CCR and coal refuse) |
| Cobalt | 500 (non-cancer) (Unlined, co-disposed CCR and coal refuse) |

Boron, molybdenum, nitrate, selenium, and cadmium also above risk targets at 90th percentile level

EPA Risk Assessment – Ecological



- "More typical" waste management scenarios (50th percentile)
 - › Aquatic
 - Landfills – No exceedances
 - Surface impoundments – Boron
 - › Sediment
 - Landfills – No exceedances
 - Surface impoundments – No exceedances
- More extreme management scenarios (90th percentile)
 - › Aquatic
 - Landfills – Boron, lead – Other minor exceedances
 - Surface impoundments – Boron, lead, arsenic, selenium, cobalt
 - › Sediment
 - Lead, arsenic, cadmium
 - Lead, arsenic, cadmium (but much higher risks)

US EPA 2010 CCR RA – Uncertainties

- In many cases, conservative approaches that tend to overestimate rather than underestimate risk were used
- Key uncertainties
 - › Use of a 10,000-year modeling period (complete leaching, long timeframe)
 - › Well locations
 - › Sorbents used to determine partition coefficient (K_d) values
 - › Estimates of leachate concentrations
 - › Characterization of high-end receptor exposure factors
 - › Human health/ecological benchmarks
- Overall, not inappropriate to err on side of over-predicting risks, but needs to be considered in uncertainty analysis and risk management decisions
- RA results reflect hypothetical plants: do not allow for understanding of risks at any specific site

Use of RA Results in Proposed Regulations

- RA results used in Regulatory Impact Analysis (RIA)
 - › Regulatory benefits in cost-benefit analysis based on **arsenic** risks
 - Remediation costs avoided
 - **Cancer cases avoided**
 - › Several aspects of the analysis uncertain
 - Regulatory benefits dominated by beneficial use assumptions



Regulatory Impact Analysis

- US EPA's analysis of cancer cases avoided
 - › Cancer cases examined over 75-year period

| | Total Hypothetical Cancer Cases Avoided |
|-------------------------------------|---|
| Subtitle C (Hazardous Waste) | 726 |
| Subtitle D (Non-Hazardous Waste) | 296 |
| Difference between Subtitle C and D | 430 |

- › On average, difference between Subtitle C and D is about 6 excess cancer cases per year (likely an overestimate)
- › Disposal requirements under Subtitle C and D almost identical; could be no difference in cancer cases avoided

Regulatory Impact Analysis (cont'd)

- Difference in cancer cases avoided between Subtitle C and D is uncertain and makes cost-benefit estimates unreliable
- Although uncertain, cases likely overestimated:
 - › Population around waste units smaller than estimated by US EPA
 - › Analysis assumes all arsenic is in trivalent form – As(III)
 - According to RIA, if 100% As(V) is assumed, cancer cases decrease by 96%
 - › The cancer potency estimate for arsenic is 17-fold higher than value used in 2010 RA (and is a value that has not been finalized)
 - › Assumptions about non-compliance
 - › Reliance on 2010 RA risk estimates which were designed to overestimate actual risk
 - In general, hypothetical risk estimates cannot be directly used to calculate cancer cases – need properly designed epidemiological study

In Reality....

- Human health
 - › No documented human health effects for landfills or surface impoundments
 - › "Detections" and "exceedances" of human health criteria (*e.g.*, MCLs)
- Ecological
 - › Several case studies with observed adverse effects, for example:
 - US DOE Savannah River D-Area Site near Aiken, South Carolina
 - Belews Lake, North Carolina
- Effects observed at biochemical, individual, and population level
 - › Effects include lethality, reduced growth and reproductive capacity, altered development, reduced metabolic activity, and behavioral changes

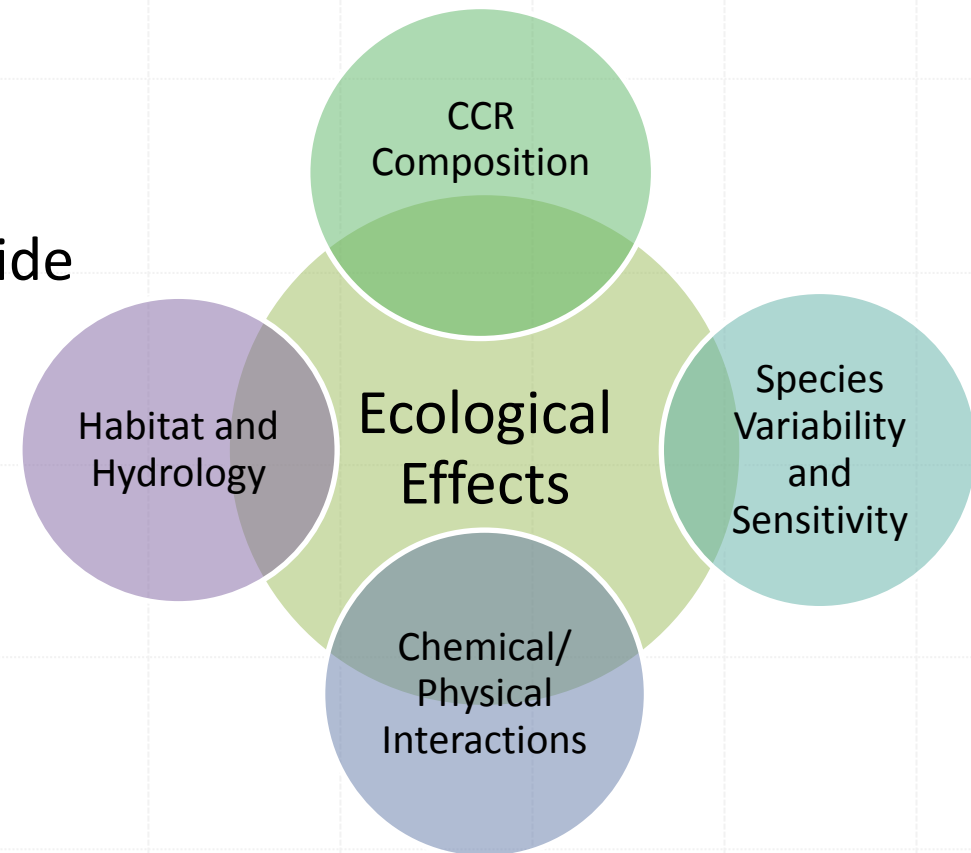
In Reality..... I

- Key Conclusions

- › Overall, effects noted at sites with outdated waste management practices
- › With the exception of selenium and boron, no individual CCP contaminant has been directly and repeatedly implicated as a controlling factor for observed ecological effects
- › While examination of several measures of effect and exposure are informative, these are often unreliable for demonstrating population-level effects when examined individually

In Reality....Kingston

- Studies ongoing...
- Human health
 - › Community studies have not shown evidence of short-term side effects
- Ecological
 - › Integrative approach
 - › Some sub organism effects observed
 - *e.g.*, delayed ovary development
 - › No adverse effects on population or community characterized



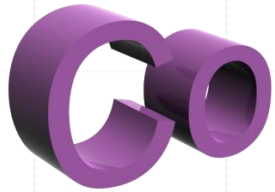
Toxicological Updates Important to CCR RA



As

- **Arsenic**

- › Major risk driver in most CCR human health RAs
- › Proposal to increase cancer potency 17-fold
 - Revised non-cancer assessment also slated for revision



Co

- **Cobalt**

- › Under Review
- › Provisional assessment shows increase in non-cancer oral criteria (67-fold)

- **Chromium (hexavalent)**

- › Proposal to evaluate as oral carcinogen (has not been considered carcinogenic in the past)
 - Without consideration of technical feasibility, health-based drinking water level could change from 100 $\mu\text{g}/\text{L}$ (current MCL) to 0.04 $\mu\text{g}/\text{L}$ (2,500-fold difference)



Cr

Overall Summary

- In 2010 CCR RA, arsenic and cobalt were two major risk drivers
 - › Surface impoundments associated more risk than landfills (human health and ecological)
- Small difference in cancer cases avoided between Subtitle C and D, especially considering uncertainties in assessment
- In reality, no evidence of human health and ecological effects associated with outdated practices
- Proposed changes to toxicity criteria in IRIS likely to affect future RA, and health-based CCR RAs and regulations

Thank You

- Please feel free to speak with me or email me any questions!
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