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Risk Issues & the Proposed Pit Rule

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RISK OVERVIEW

- Risk & Decision Process
- What is in the pits
- Risk evaluation of detected constituents
- OCD Proposal
- Alternative Impacts
- Conclusions

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Value of Risk Evaluation

- Oil and Gas Act requires that risk be considered in the regulatory process.
- Is transparent and makes explicit to all parties the agency's objective in proposing regulatory action.
- Provides an understanding of the technical basis and rationale of proposed standards and regulatory requirements.
- Minimizes unnecessary expenditures of financial and technical resources (industry and agency) due to unclear regulatory policy.

Drilling/Reserve Pits

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What is in the Drilling/Reserve Pits?

- Drilling/Reserve pits contain…
  - Formulated drilling mud (water-based);
  - Rocks and debris created as the drill bit cuts through subsurface layers of mineral deposits and soils;
  - Hydrocarbons as the drilling encounters pockets of oil and gas; and
  - Salts derived from natural deposits and from brine drilling fluids.

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Central Risk Questions

- Will any of the constituents contained in a closed drilling pit pose an unreasonable risk to the public health, environment, or natural resources of the State of New Mexico?
- If so, what is the most effective way to mitigate that risk?

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The Industry Sampling Program

What's in the Pits and how much?

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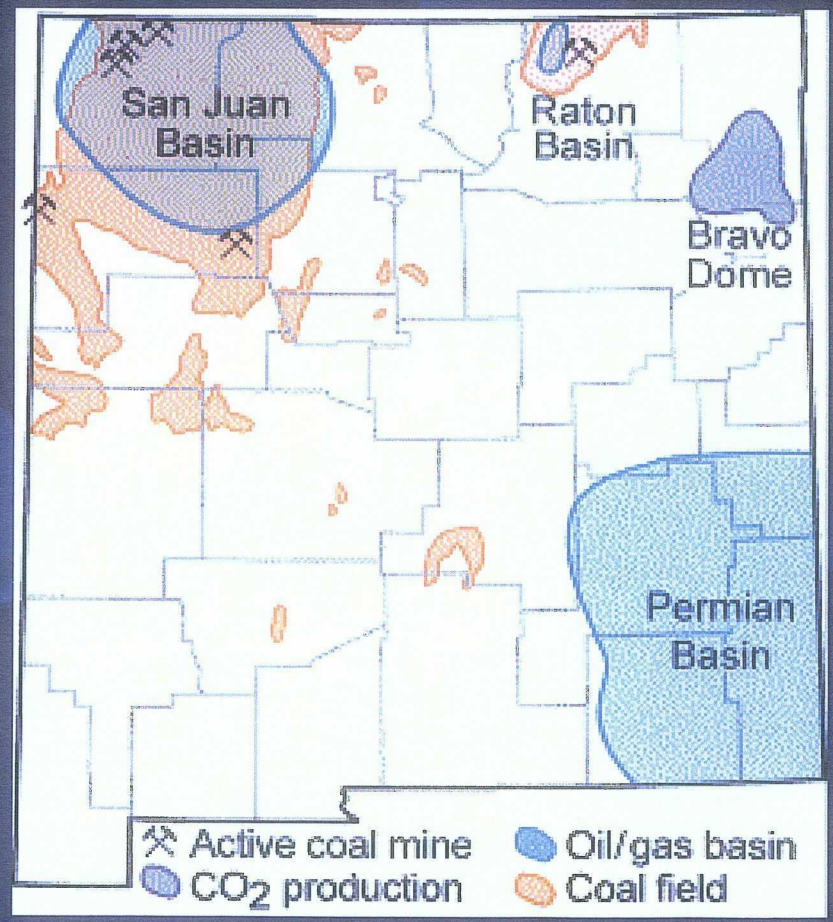
Drilling/Reserve Pit Sampling Programs

- A third party collected samples of the contents of temporary pits (after fluids removed; just prior to closure).
- The samples were analyzed for a full range of constituents using standard EPA methods for metals, volatile and semivolatile organic compounds, anions, cations, TPH, PCBs, radium isotopes, and other analytes.
- Where the EPA methods allow, a TCLP leachate of each sample was prepared and analyzed (selected metals and volatile organics).

The Sampling Program

Because of differences in geology and operating practices…

- Three drilling/reserve pits in NW New Mexico (San Juan Basin; generally gas production at depths of 600–9000 ft), and
- Three pits in SE New Mexico (Lea County in the Permian Basin; generally oil production at 7000+ ft).



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The Sampling Program

- Twelve samples of pit contents were collected at depth by auger at 11 locations in each pit...11 samples + 1 duplicate from each pit.
- Laboratory results were subjected to an independent quality assurance audit, then evaluated by my staff.
- Any constituents having at least one of the 12 samples exhibiting a concentration above the detection limit (including estimated concentrations) was included in the analysis of each pit

What was found? – TPH

- TPH was evaluated by EPA Method 8015, which separates petroleum hydrocarbons into gasoline-range (GRO) and diesel-range (DRO) fractions.
- Most of the hydrocarbons in both the northwest and southeast pits were in the DRO-size fraction.
  - SE NM average Total TPH (GRO+DRO) was 7700 mg/kg
  - NW NM average Total TPH (GRO+DRO) was 1800 mg/kg
  - OCD's proposed criterion is 2500 mg/kg.

QUESTION: Is Total TPH a risk issue?

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What was found? -- Chloride

- The average concentrations of Chloride anion were found to be:
  - SE NM was 126,000 mg/kg
  - NW NM was 3,900 mg/kg

QUESTION: Does chloride at these levels present a risk?

What was found? – Arsenic

- Arsenic is not a component of commercial drilling muds, and its presence is likely due to natural subsurface minerals being brought up during drilling.
  - Average NW was 4.1 mg/kg
  - Average SE was 2.3 mg/kg
  - NMED's Tier 1 Residential Soil Screening Level = 3.9 mg/kg (version 4)
- Arsenic levels in TCLP leachates were not detectable, indicating that the natural arsenic-containing minerals will not dissolve in water, are not environmentally mobile, and are not bioavailable.

CONCLUSION: Arsenic exists in New Mexico drilling/recycle pits in a chemical form that does not pose health or environmental risks.

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What was found? -- Barium

- Barium (in the form of barium sulfate) is a common component of drilling muds.
  - Average SE was 1763 mg/kg
  - Average NW was 10,000 mg/kg
  - NMED SSL of 5450 mg/kg
- Barium levels in the TCLP leachates were low (estimated to be less than 3% of total; and were less than the WQCC 3103 criterion of 1 mg/L).
- Low water solubility indicates that barium in the pits is not environmentally mobile, and not bioavailable.

CONCLUSION: Barium is in a form that is generally not soluble in water, and therefore does not pose a health or environmental risk.

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What was found? -- Benzene

- Benzene is a natural constituent of petroleum and natural gas, and is not considered to be a component of water-based drilling mud formulations. It is a recognized carcinogen.
  - Average SE NM was 8.17 mg/kg
  - Average NW NM was 0.12 mg/kg
  - NMED SSL is 10.3 mg/kg
- All soil samples exhibiting benzene concentrations above SSL were from LC-1 (SE NM) and were highly diluted (1000X vs. 5-100X due to other analytes). High dilution ratios magnify analytical variability, and greatly complicate interpretation of such data.
- Benzene was found in all LC-1 leachate samples at concentrations above the WQCC 3103 criterion ((0.01 mg/L).

QUESTION: Although complicated by high dilution ratios, should benzene be considered a possible regulatory issue?

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What was found? – Halogenated Compounds

- Several unusual halogenated compounds were reported by the laboratory at detectable levels. Subsequent lab discussions revealed that these were "QC surrogates" purposely added to the sample to evaluate analytical recoveries

2,3,4-TRIFLUOROTOLUENE – Method 8015 (TPH)
o-TERPHENYL – Method 8015 (TPH)
DECACHLOROBIPHENYL – Method 8082 (PEST/PCB)
TETRACHLORO-m-XYLENE – Method 8082 (PEST/PCB)
4-BROMOFLUOROBENZENE – Method 8260 (VOC)
DIBROMOFLUOROMETHANE – Method 8260 (VOC)
2-FLUOROBIPHENYL – Method 8270 (SVOC)
2-FLUOROPHENOL – Method 8270 (SVOC)
2,4,6-TRIBROMOPHENOL – Method 8270 (SVOC)

What was found? -- Other Compounds

- The average soil concentrations of other detected Metal, VOC, SVOC, PCB analytes were below available NMED SSLs or SSL surrogate criteria.
- The average leachate concentrations of all other analytes were below available WQCC 3103 criteria or drinking water surrogate criteria.

CONCLUSION: Other compounds detected do not to pose significant risk to public health and the environment.

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The OCD Sampling Program

What's in the Pits and How Much?

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OCD's Sampling Program

- It appears that OCD collected samples of solids from the surface at the four corners of each pit and mixed them to create a composite sample for analysis.
- OCD also collected water samples, suggesting that the fluids in the sampled pits had not yet been removed for closure.
- OCD tested each sample for VOCs, SVOCs, Total Metals; Anions; Cations; TPH, and other metrics (pH, etc.)

OCD's Sampling Program

- SE Pits: Of 20 detected analytes having SSLs:
  - Only arsenic (average of all pits) exceeded its NMED criterion.
  - Arsenic is present in a form that is not water soluble, therefore not environmentally mobile and not bioavailable.
- NW Pits: Of 23 detected analytes having SSLs:
  - None exceeded its NMED criterion.

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Conclusions from Industry & OCD Findings

- Analytes of possible regulatory concern:
  - TPH
  - Chloride
  - Benzene

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Thoughts from a Risk Perspective

Total Petroleum Hydrocarbon (TPH)

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TPH Method

- OCD has suggested use of EPA Method 418.1 as a simple and inexpensive test for TPH.
  - The Method 418.1 procedure is no longer part of the EPA method series because it specifies that an ozone-depleting solvent (banned in the US) be used to extract the hydrocarbons.
  - Laboratories running 418.1 assays are either using an alternative extraction solvent (unspecified), or are breaking the law.

TPH Method

- Solvent extraction is non-specific in that biological fats and waxes are extracted along with petroleum hydrocarbons.
- It is possible for a soil sample to be reported as having a high level of "TPH" due to extraction of the waxy coating and essential oils of leaves and other plant debris, even though no petroleum is actually present in the sample.

RECOMMEND: If TPH is an issue, use EPA Method 8015m (GRO+DRO) or EPA Method 9071 (Oil & Grease).

TPH Standard

- NMED developed a risk-based SSL of 2500 mg/kg for "waste oil", based on
  - the size classes of hydrocarbons that "waste oil" is assumed to comprise, and
  - the pathways of exposure relevant to the health risks to a hypothetical resident who directly contacts that material.
- It appears that OCD has simply adopted NMED's "waste oil" criterion.

  QUESTION: Has OCD considered whether "waste oil" SSL is appropriate for petroleum crude oil and natural gas hydrocarbons?

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TPH Standard

- OCD has not specifically stated the nature of their concern(s) about TPH:
  - Cancer?
  - Suppression of immune function?
  - Unpleasant taste in well water?
- OCD has not given the members of the OCC the technical information they need to judge whether the OCD-proposed regulation of TPH is appropriate.

TPH Standard – Risk Critique

- OCD has not given a technical rationale for proposed 2500 mg/kg standard.
  - Not clear why NMED number applicable to pit materials
  - If OCD's 2500 mg/kg criterion is "safe", it is not clear to me why current closure practices need to change.
- A better rationale would look at the risks presented:
  - Direct contact – but under 4' cover; construction and residental and primary exposure scenarios.
  - Groundwater – leaching risk, but low solubility, volatilization and biodegradation makes significant exposure unlikely.
- Primary toxicants of TPH are BTEX in the GRO fraction, and PAHs in the DRO fraction.. Better to regulate specific toxicant, than nebulous mixture like TPH. Data indicate only benzene of possible concern.

Question: Why regulate TPH?

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Thoughts from a Risk Perspective

Chloride

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Chloride Anion

- Chloride anion is highly water-soluble
- The proposed rule does not state the nature of OCD's concern, although protection of ground water is suggested by their analytical approach.
  - While salt (sodium chloride) can be toxic to plants, it is not the chloride anion that is primarily responsible. Rather, it is the sodium cation, which attracts a large shell of water molecules, that competes with plant roots for available moisture, causing dehydration of plant tissues.
  - A similar mechanism is at play in animal tissues – excess sodium pulls water out of the cells, disrupting biological functions.
- Chloride is therefore a poor predictor of the risks associated with sodium chloride. Direct measurement of sodium or one of its surrogate metrics (e.g., electroconductivity, etc.) is better.

Chloride Anion: Risk Analysis

- Potential pathways:
  - Direct exposure is primarily salt driven; but no direct contact (under 4' cover)
  - Groundwater is other potential route
- If chloride is of concern, recommended level:
  - Direct exposure is addressed by cover
  - Groundwater should be based on protection of groundwater use. Therefore, a leachable standard of 3500 mg/l is protective.
  - A non-leachable field test may simplify field administration of the standard.
  - Measurement of sodium is a better metric for risk evaluation.

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Thoughts from a Risk Perspective

Benzene

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Benzene

- Benzene may or may not be an issue—analytical results were highly diluted
- Benzene has a short half life. Benzene will be volatilized during evaporation and mixing
- The pathways of potential concern:
  - Direct contact (but under liner and 4' cover)
  - Groundwater use

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Benzene Standard

- Pathway analysis:
  - Direct contact is limited to construction or other physical disturbance—a process that will further reduce concentrations
  - Groundwater is unlikely to be of concern given the long time required to reach water versus benzene's half life and on-going evapotranspiration processes.

    Recommendation: Tier 1 Screening Level for benzene in soil to minimize risk to a construction worker is 174 mg/kg (i.e., NMED's SSL for a construction worker).

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Thoughts from a Risk Perspective

3103 Analytes

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3103 Analytes

- Based on the Industry and OCD sampling programs, most of these compounds are not present in New Mexico's drilling/recycle pits.
- The 3103 constituents that were detected may or may not be an issue
- The pathways of potential concern:
  - Direct contact (but under liner and 4' cover)
  - Groundwater use

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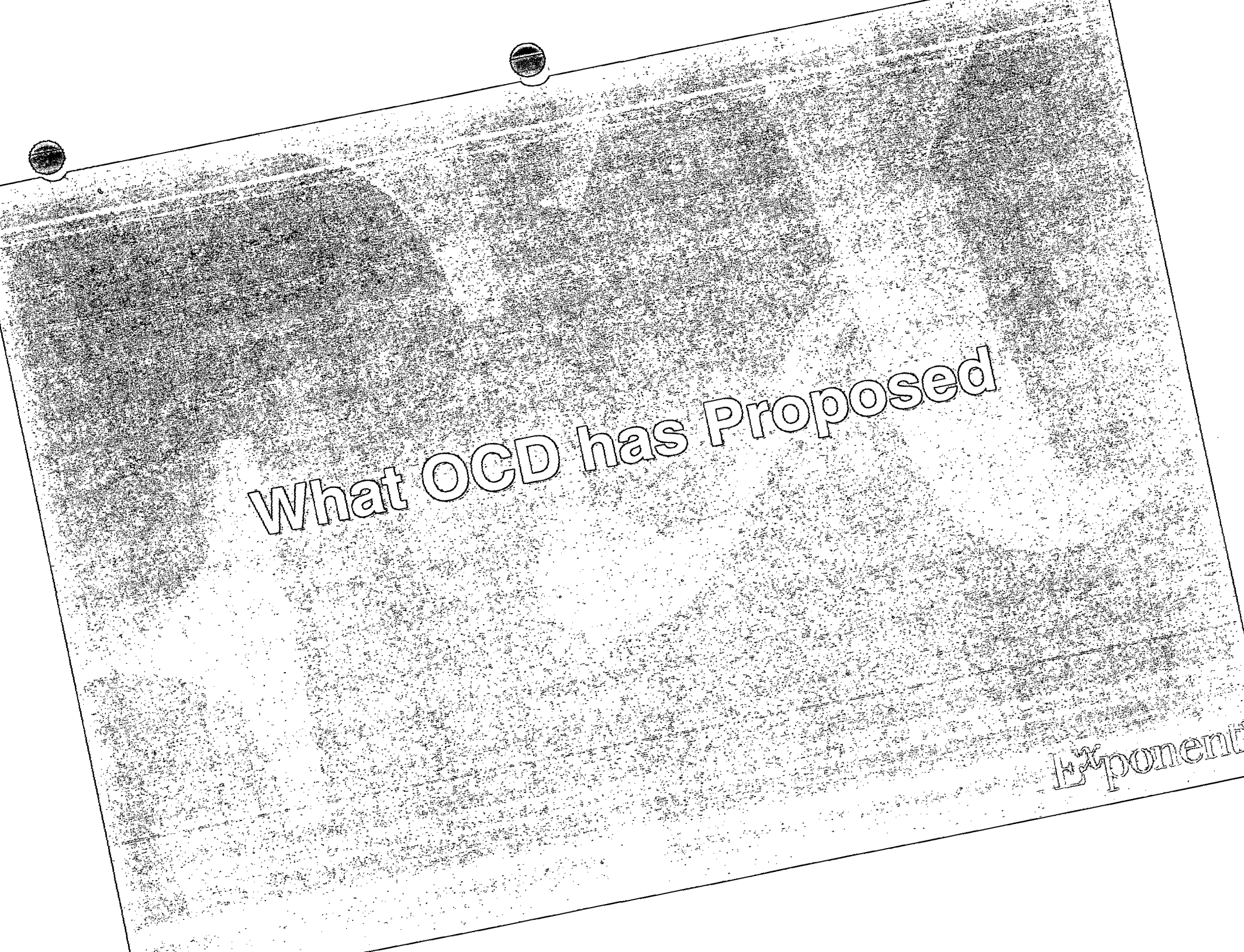
3103 Constituents

- Pathway analysis:
  - Direct contact is limited to construction or residential exposures
  - Groundwater is unlikely to be of concern given dilution and attenuation processes (DAF >100)

Conclusion: The risks posed by the 3103 constituents by these routes are *de minimis*.


What OCD has Proposed

Proposed OCD Pit Rule – Temporary Pits

- Proposes treatment and release standards.
- Existing industry data would suggest pits will not meet these standards.
- In essence, all drilling materials will have to be hauled and disposed of at a commercial OCD-approved landfill.

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Thoughts from a Risk Perspective

Alternative Risk Considerations

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Alternative Risk/Consequence

- All decisions have consequences.
- OCD rule addresses
  - Direct exposure risk
  - Groundwater risk, both by removing pit contents
- The Industry sponsored a study evaluating the likely consequences of OCD's proposal to transport, and dispose of pit material to an OCD-approved commercial landfill:
  - Economic Impact
  - Vehicular Accidents, Injuries, and Fatalities
  - Environmental Consequences

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Alternative Risk/Consequence

- Economic Impacts
  - It is estimated that the proposed Pit Rule will add more than $50 million per year compliance costs of finding and producing oil and gas in New Mexico.
  - It is estimated that the Industry will drill approximately 1400 wells per year in the State.
  - There are only four OCD-approved landfills in New Mexico...all in the southeastern part of the State. New landfill capacity may need to be developed.
  - Increases in heavy truck traffic will accelerate deterioration and repair of New Mexico roads, especially near the four existing landfills.

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Alternative Risk/Consequence

- **Vehicular Accidents, Injuries, and Fatalities**
  - Assumes the proposed pit rule will result in heavy trucks traveling a minimum of 27.4 up to 81.2 additional million vehicle miles (mvm) per year…80% on rural highways and 20% on urban highways.
  - Based in statistics from the Federal Motor Carrier Safety Administration, an additional 0.85 – 2.53 fatalities, 14 – 41 injuries, and 71 – 142 property damage only (PDO) crashes can be expected on an annual basis.
  - Data from the Industry and OCD sampling programs suggest that no fatalities or injuries are expected from exposures to the constituents of drilling/recycle pits in New Mexico.

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Alternative Risk/Consequence

- Environmental Consequences
  - The proposed Pit Rule will result in estimated truck and dust emissions equivalent to twice the emissions from currently permitted stationary sources.
    - Drilling material hauled – ↑ 1.5MM to 2.7MM yd^3
    - VOC emissions – ↑ 660 tons to 1900 tons/year
    - Dust emissions – ↑ 13,000 to 41,000 tons/year
    - CO_2 emissions – ↑ 50,000 to 149,000 tons/year
  - Increased CO_2 emissions will put the Governor's GHG emission reduction goals in NW New Mexico at risk.

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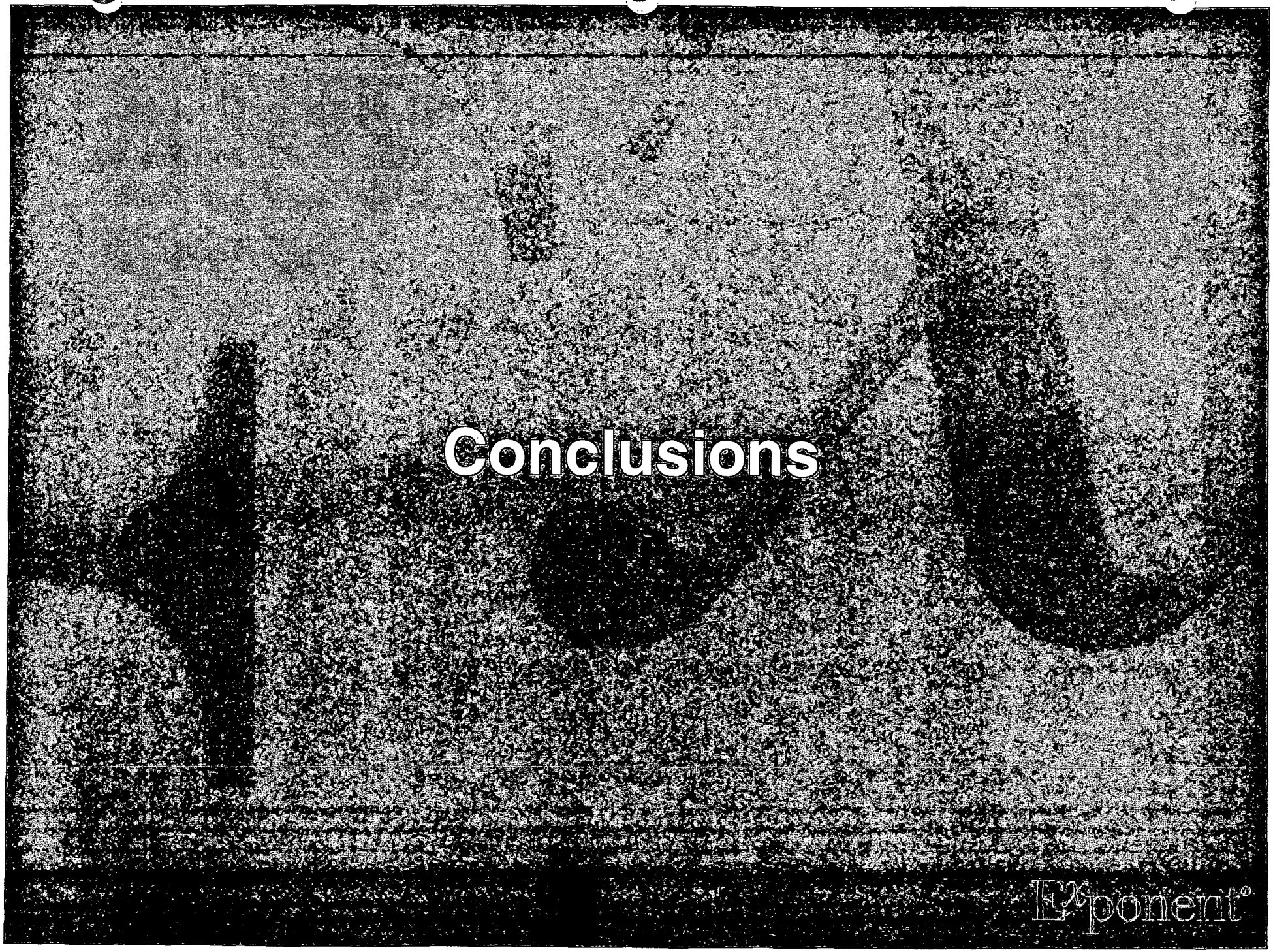
Conclusions
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Conclusions

- What is the risk?
  - Only a few of the constituents found in the drilling/recycle pits may be of regulatory concern (TPH, chloride, and benzene).
  - These constituents pose little risk to public health and the environment by expected pathways of exposure.
  - Based on OCD's proposed language, it appears that OCD's primary concern is odor and taste impacts on ground water.
  - For evaluating risk...
    - BTEX and PAHs are better metrics than TPH
    - Sodium is a better metric than chloride
- Does the proposed Pit Rule reduce actual risk?
  - No, it mostly transfers the risk.
    - Transfers direct exposure risk to landfill
    - Transfers ground water impact to landfills

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Conclusions

- At what cost?
  - In lives (0.85 – 2.53 fatalities/year)
  - In injuries (14 – 41 injuries/year)
  - In emissions (greenhouse gas emissions increased by up to 149,000 tons/year; airborne dust up to 41,000 tons/year)
  - To ground water (low total mass of wastes in pits to high mass in landfills yielding greater potential impact if released)
  - In $ (more than $500,000,000 additional drilling costs over 10 years)
  - In State revenue (unknown)
- For what benefits?
  - Speculative decrease in direct exposure
  - Fewer pits with ground water impacts, by concentrating impacts at landfill locations

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Conclusions

- Proposed Industry approach provides similar benefits at less cost
  - Small onsite pit closures (small mass of toxicant) present less overall risk to ground water than large concentrated landfills (large mass of toxicant)
    - If liners do not fail, both onsite pit closure and landfills are equally protective
    - If liners do fail, onsite pit closures are more protective than landfills
  - Direct exposure risks (residential and construction) are *de minimis* for onsite pit closure
  - Other cumulative impacts are minimized (e.g., lives, injuries, emissions, etc.)

Conclusions

- If both OCD and Industry approaches achieve similar results, but Industry achieves same results at a lower cost, then:
  - OCD is not making a risk judgment
  - OCD is making a value judgment that the mere presence of "waste" justifies the costs in lives, injuries, emissions, etc., regardless of the risk that the "waste" objectively presents.
- OCC should make the appropriate risk judgment.