Research needs for Road Stabilization and Dust Suppression

David E. James, Ph.D. PE

University of Nevada, Las Vegas

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Research needs

- What information is needed to help
  - Road managers and environmental planners
- Make objective decisions about
  - Whether or not to use a suppressant / stabilizer instead of alternative approaches
  - If selecting a stabilizer, which kind, and in what amount and by what method should it be employed?

We need information about . .

- Chemical composition, both “active” ingredients and potential trace contaminants
- Potential environmental toxicity and occupational risk
- Performance in representative conditions
- Cost
- A location from which we can retrieve these data

Organizations recently (last 5 years) publishing research

- Performance and toxicity
  - US EPA National Risk Management Research Laboratory (RMRL)
- Performance
  - US Army Engineer Research & Development Center
  - Federal Highway Administration - Central States - field study and major literature evaluation
- Runoff constituents and rates
  - US EPA ETV and US EPA RMRL
  - UNLV

Recent (last 5 years) published studies – Stabilization

- FHWA 2007 – Surdahl et al – evaluated 6 stabilizers for 2 years – central Arizona – 2 organic non-petroleum+water absorbing combination products worked best
- Virginia DOT 2004 – Bushman et al – evaluated 7 stabilization products for 9 months – 1.75 mile unpaved road northern Virginia – observed variations in IRI concluded constructing bituminous roadway is most cost-effective

Recent published studies
Dust suppression performance

- Rushing – 2007a – 4 types suppressants field tested up to 220 days – temperate climates
- Rushing – 2007b – lab studies 18 types suppressants
- Rushing – 2006 – 14 suppressants field tested up to 90 days – arid climates
- EPA ETV (MRI/RTI) – 2006 – 5 suppressants field tested up to 122 days with reapplication

Example data – EPA ETV Ft. Leonard Wood – 77-79 days

Suppressant	type	TP control efficiency, %	PM10 control efficiency, %	PM2.5 control efficiency, %
DustGuard	hygroscopic salt	75	88	58
EK35	synthetic organic	74	86	56
Envirokleen	petroleum organic	>99	>98	>90
PetroTac	resin emulsion	94	98	>90
TechSuppress	natural resin + wetting agent	84	76	>90

Recent published studies – suppressant toxicity data

- EPA ETV - 2006 – 3 tests (1 acute, 2 chronic) of 3 palliatives vs 3 species -
  - 1 palliative inhibited fathead minnows, mysid shrimp, *Ceriodaphnia*
- Irwin et al (EPA) – 2008 – acute tests of 6 suppressants vs 3 species at 3 rainfall ages
  - 2 palliatives inhibited water fleas (invertebrate – *Daphnia)* in lab – concluded probably wouldn't inhibit in environment – or very localized

Sept 2008 EPA report – Irwin et al

- EPA – National Risk Management Research Laboratory – Sept 2008
- Simulated rough grading & heating/cooling
- 6 dust suppressants
- Plots - Surface runoff – 9 water quality parameters and fish, algal, invertebrate toxicity
- Columns - Subsurface leaching – 9 water quality parameters

Recommendations for follow-on in Irwin et al 2008 EPA report

- Best measure of potential real-world effects
  - Monitor sensitive invertebrate populations near application sites – upstream/downstream
- Longer (> 2 month) timeframes for runoff testing to better assess biodegradation potential

Recent published studies - runoff/leachate constituent data

- Irwin et al (EPA) – 2008 – measured 9 water quality indicators in 6 suppressants
  - All 6 suppressants met data quality objectives for 5 indicators – pH, TDS, TOC, DO and nitrate
  - For 4 indicators, at least 1 suppressant not consistent with data quality objectives, but most not cause for concern.
  - 2 suppressants showed elevated TSS
  - Soil source affected indicator values

Recent sources for runoff/leachate constituent data

- Irwin et al (2008) - runoff and leachate from cured, temperature cycled suppressants - lab results
- EPA ETV (2006) - standard EPA methods - developed for Clean Water Act and RCRA for 2 suppressants
- UNLV (2002) - surface runoff from applied 11 suppressants, as weathered - number of elevated constituents varied with suppressant

Conclusions from search of published literature

- Several suppressants/stabilizers perform well and have low environmental toxicity
- Number of suppressants/stabilizers with independent performance data exceeds number with independent environmental toxicity data
- Very few suppressant/stabilizers have been tested simultaneously for performance, water quality constituents and toxicity

Key words for path forward

- Standardize
- and
- Compare

- As stated by D. Jones et al, 2008,
- standardization has been established for paved road materials
- Similar model could be established for stabilizers and suppressants

State of Practice paper – D. Jones et al – Research needs

- Standard protocol to establish minimum research requirement for additives, including
  - Additive description / categorization
  - Laboratory studies of performance and environmental impacts
  - Field experiments
  - Data analysis

State of Practice paper – D. Jones et al – Research needs

- Environmental protocol describing
  - Internationally recognized laboratory & field procedures for assessing environmental impacts, especially to
  - Establish boundary conditions of performance (and potential toxicity)
  - Standardized risk-benefit analysis procedure

Recommendations of 2002 EPA Expert Panel

- Authors: Piechota et al 2004
- Potential Environmental Impacts of Dust Suppressants, Avoiding another Times Beach
- US EPA 600/R-04/031
- Available at: http://faculty.unlv.edu/piechota/LinkFiles/epa-unlv-dust-suppressant-report-2004.pdf

EPA Expert Panel – dust suppressant constituents

- Sufficient chemical composition data to assess environmental risks
  - Standardized and sufficient constituent reporting in Material Safety Data Sheets
  - Exact composition data (FIFRA requires exact statement of active constituents herbicides, insecticides, fungicides etc)
- Uniform bioassay reporting – same tests, same species

There's a potential backlog

- Number of *marketed* products (UNLV grad students found about 90 in 7 major categories)
- greatly exceeds
- Number of *tested* products!
  - 18 characterized for performance
  - 10 characterized for toxicity
  - However, test protocols sometimes not comparable

Applied research serving needs of agency managers

- To compare need standardized
  - Characterization of palliative formulations
  - Methods for performance testing – both stabilization and dust emissions
  - Methods for generating and measuring constituent runoff/leaching
  - Methods and organisms for environmental toxicity testing

Research needs - Evaluate performance & potential impacts

- To evaluate commercial palliatives and stabilizers -and get some characterization data on the plethora of commercial products
- Rapid characterization of both performance and environmental impacts
- Suggest lab-based testing with accelerated but standardized wear, dust measurement, runoff and leaching tests
- For standardized wear and dust measurement examples, see Rushing 2007b

Research need - standardized field test sites

- Done by the roofing industry for weathering studies - WSRCA sites for southwest in Las Vegas and northwest near Seattle
- Suggest several in each major climate / soil regime.
- Probably couldn’t economically set up all combinations, but set up several extremes in terms of particle size and surface chemistry

Standardized test sites (cont)

- Examples
  - Northeast, acidic soils, moderate organics - freeze/thaw, humid, moderate-high rainfall
  - Southwest, alkaline, low organic, no freeze/thaw, arid
- Apply on instrumented road section, with standardized maintenance
- Evaluate at fixed intervals
- Will help assess performance as stabilizer, dust suppressant, and potential migration of contaminants

Site characterization - Soil Chemistry

- 2002 EPA Expert Panel recommended
  - Moisture content
  - pH
  - Particle shape
  - Mineralogy
  - Particle surface chemistry (not specified)
    - The author might recommend cation exchange capacity
    - Surface charge (negative or positive) at specified pH
    - Sorption of standard compound

Site characterization : Engineering tests - EPA Expert Panel

- Geotechnical / Mechanical characterization
- Gradation - AASHTO T-11 and T-27
- Plasticity tests - AASHTO T-89 and T-90
- Particle size distribution (ASTM standards)
- Visual survey
- Other reports recommended
- CBR

EPA Expert Panel – Standard risk assessment protocol

- Standardized test protocols for chemical constituents and toxicity in
  - dust suppressant concentrate,
  - runoff
  - in soil after application.
- Initial recommended threshold levels

Research need - to develop accessible repository of test results

- Database combining performance data with toxicity data & metadata about test conditions
- currently performance and toxicity data scattered
- Need identified by both Jones et al, 2008 and EPA Expert Panel

EPA – Expert Panel – recommended Clearinghouse

- Composition
- Occupational and environmental toxicities
- Prohibited applications
- Weathering descriptions
- Guidelines for application
- Regulatory and manufacturer contacts

Exemplary Manufacturer's web page

- Rohm and Haas
- http://www.rohmhaas.com/wcm/about_us/product_risk.page
- Provide links to other databases
- Links to MSDS's for Rohm and Haas products
- Including acrylate monomers potentially present in some palliative formulations
- Links to other web pages → next 2 slides!

Is toxicity/degradation data available for constituents?

- Yes, the Echem Portal at http://webnet3.oecd.org/echemportal/
- Links to 11 databases, including
- HPVIS (maintained by US EPA)
- http://www.epa.gov/hpvis/
- High Production Volume Information System – (> $1x10^6$ lb/year)
- health and environmental effects information

Database examples in other countries

- Chemical Risk Information Platform (CHRIP) – Japan – (operated by National Institute of Technology and Evaluation)
- http://www.safe.nite.go.jp/english/kizon/KIZON_start_hazkizon.html
- EnviChem (operated by Finnish Envt Institute)
- http://www.ymparisto.fi/default.asp?contentid=141944&lan=en
- ESIS (operated by European Chemicals Bureau)
- http://ecb.jrc.ec.europa.eu/esis/

Mixture/formulation problem

- Toxicity of mixtures different from toxicity of single components!
- Synergistic – enhance toxicity
- Inhibitory – reduce toxicity
- Start with individual constituent data to formulate a low toxicity product
- still must test completed proprietary formulations

Solution -

- Proposed standardized toxicity protocols for palliative mixtures. Recommend
  - Acute - 48 hr LC50
  - Chronic 7 day LC50
- Put results into repository
- Provide tool to allow path analysis to work backwards from aquatic toxicity data to application site to determine if observed toxicity thresholds could be attained
- See EPA Expert Panel report for examples

But road surface stabilization & dust suppression all local

- 1,000's of combinations of
  - Suppressant type
  - Suppressant application rate and method
  - Road base soil characteristics
  - Climate
- Database of toxicities, lab performance, chemical constituents may help guide selection, but
- Still need to test locally

EPA Panel recommended Develop regulations that contain

- Application Practice Guidelines (APGs) include information about
- types of areas where can apply specific suppressants (predominant biota and soil types),
- Wind velocity limitations at the time of application,
- specific limitations on application in proximity to water bodies, runoff channels, and residential areas,
- Regulations on types of containers used to transport suppressants

Research should generate data to let us

- Know what's in them
  - Clearinghouse for suppressant components & mixed suppressant MSDS's (standards for MSDS's)
- Be able to compare them
  - performance data
  - environmental & toxicity data
  - field protocols

Thank you!

Questions?

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- See http://matrix.vtrc.virginia.edu/698/Road_Stabilization

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