

# An Update on the Appalachian Research Initiative on Environmental Science (ARIES)

**Dr. John R. Craynon, P.E.**

*ARIES Project Director, Virginia Center for Coal and Energy Research, Virginia Tech*

**Dr. Michael E. Karmis**

*Stonie Barker Professor of Mining and Minerals Engineering and  
Director, Virginia Center for Coal and Energy Research, Virginia Tech*

# What is ARIES?

- ▶ *The Appalachian Research Initiative for Environmental Science or ARIES, is a research consortium, under the direction of the Virginia Center for Coal and Energy Research (VCCER) at Virginia Tech*
- ▶ *ARIES work to address the economic, environmental and community impacts of energy production in Appalachia to assure responsible interaction with the environment, technology development that correlates with job retention and creation, and public health practices that protect families and strengthen communities.*
- ▶ *ARIES sponsors have come together in collaboration with Virginia Tech and a world-class university consortium to position the citizens of Appalachia to make informed, educated decisions about their lives, their communities and their futures.*
- ▶ *Virginia Tech is actively expanding ARIES' partnership network to increase the initiative's emphasis on public health and environmental challenges.*

# Major Research Areas

- Energy production in Appalachia
  - Coal mining
  - Natural gas
    - CBM
    - Shale gas
  - Electricity generation
  - Petroleum
  - Renewables
- First priority focus has been coal mining

# ARIES Member Companies

- Alpha Natural Resources
- Arch Coal
- Natural Resource Partners
- TECO Coal Corporation
- Patriot Coal Corporation
- Cliffs Natural Resources
- Norfolk Southern Corporation
- CSX Corporation

Coal associations are participants

In discussions with other companies interested to join

# ARIES Research Partners

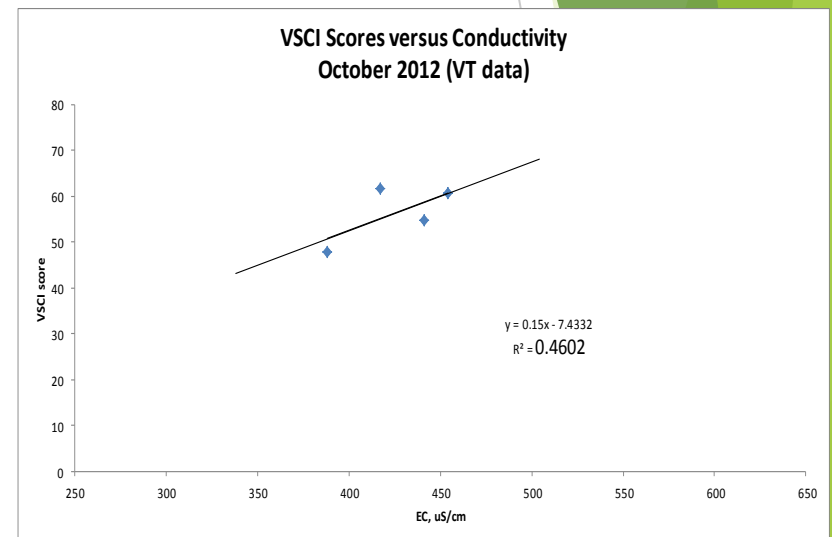
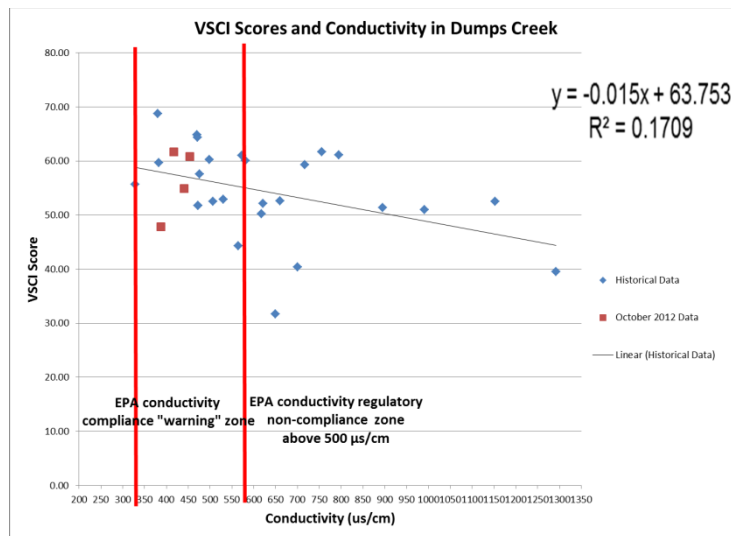
- Virginia Tech
  - VCCER at VT is the managing entity for ARIES
- West Virginia University
- University of Kentucky
- Ohio State University
- Pennsylvania State University
- University of Pittsburgh
- Marshall University
- Edward Via College of Osteopathic Medicine
- Consultants in Epidemiology & Occupational Health LLC  
(Georgetown & Johns Hopkins)

# Water Quality (VT, WVU, MU)

## ► Conductivity

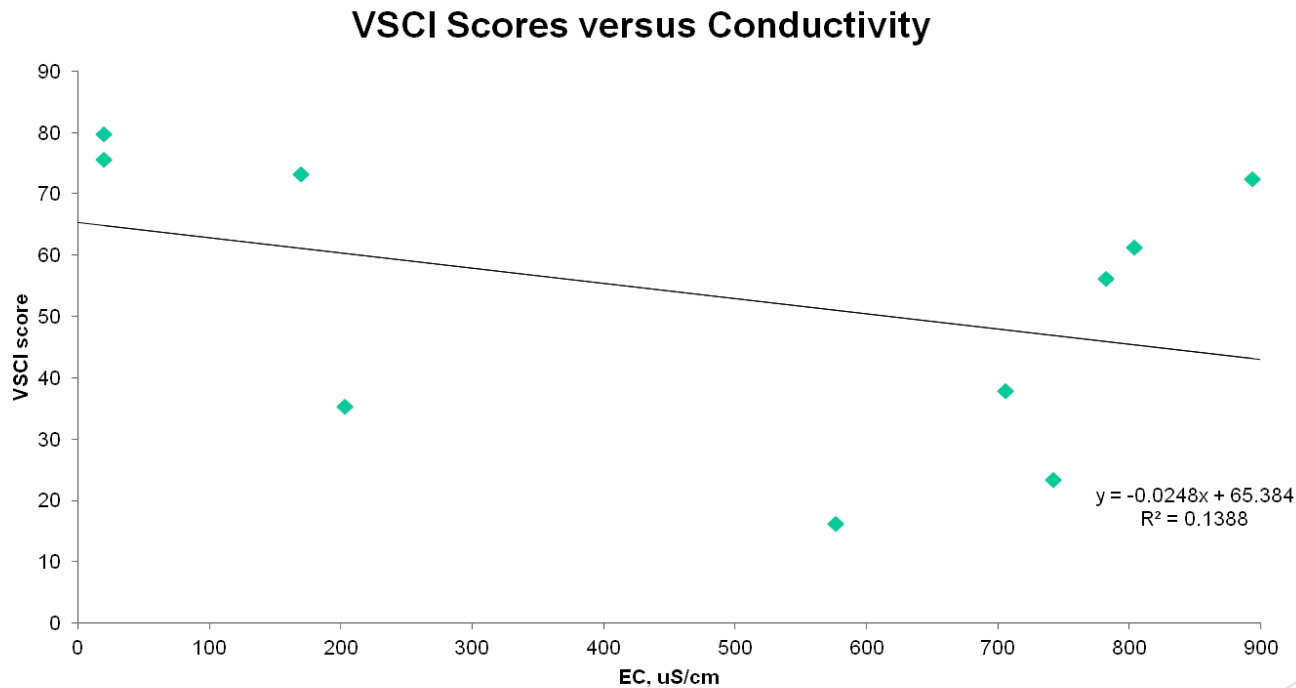
- Conductivity has been linked by the EPA to the health of the biologic communities in Appalachian streams and is being used as an indicator for permitting and regulatory actions under the Clean Water Act
- There seems to be no predictable correlation between conductivity and VSCI scores in the Dumps Creek and Straight Creek watersheds. Data collected at different times show possible correlations that are very different from EPA regulatory guidance.

# Conductivity versus VSCI scores based on historical data and VCCER/VT study



No reproducible correlation between conductivity and VSCI scores

# Straight Creek Data (May 2008) from Passmore and Pond, 2009





# EPA Region 3 Response to ARIES Findings:

- Data is good enough for asking “*did conductivity cause or contribute to biological effects...*”
- “*there is likely to be more than one mechanism of action*”
- “*Indices like VSCI (have a)...lack of individual stressor discriminatory power*”
- “*the degree of riparian disturbance, stream encroachment, sewage, algae, other household toxicants or sediment are confounding the dose-response signature of conductivity and benthic impairment.*”

# More from EPA comments:

- ▶ *“VSCI is designed to detect all stressors, not just conductivity”*
- ▶ *“(VSCI) is intended to detect many stressors, both water and habitat quality”*
- ▶ *“It is important to characterize the ion matrix in any data set before determining whether the US EPA conductivity benchmark applies....”*

# Summary of EPA Feedback:

- The chemistry and biology of any given stream segment is too complicated to use one parameter, such as conductivity, as a predictor of stream condition as indicated by a measure such as VSCI
  - **EPA's implication: ARIES work is flawed**
- We agree with EPA...it's too complicated to use only conductivity
  - **ARIES implication: EPA's regulatory approach is flawed**

# ARIES health research emphasis

- Epidemiological studies focused on determining disparities in human health among mining and non-mining counties
- Analysis of exposure, bioavailability and metabolism of materials associated with mining
- Analysis of exposures via dust
- Analysis of other factors contributing to health issues
  - Lifestyle, poverty, obesity, etc.
  - Exposure to biocontamination (inadequate or non-existent sewage treatment)

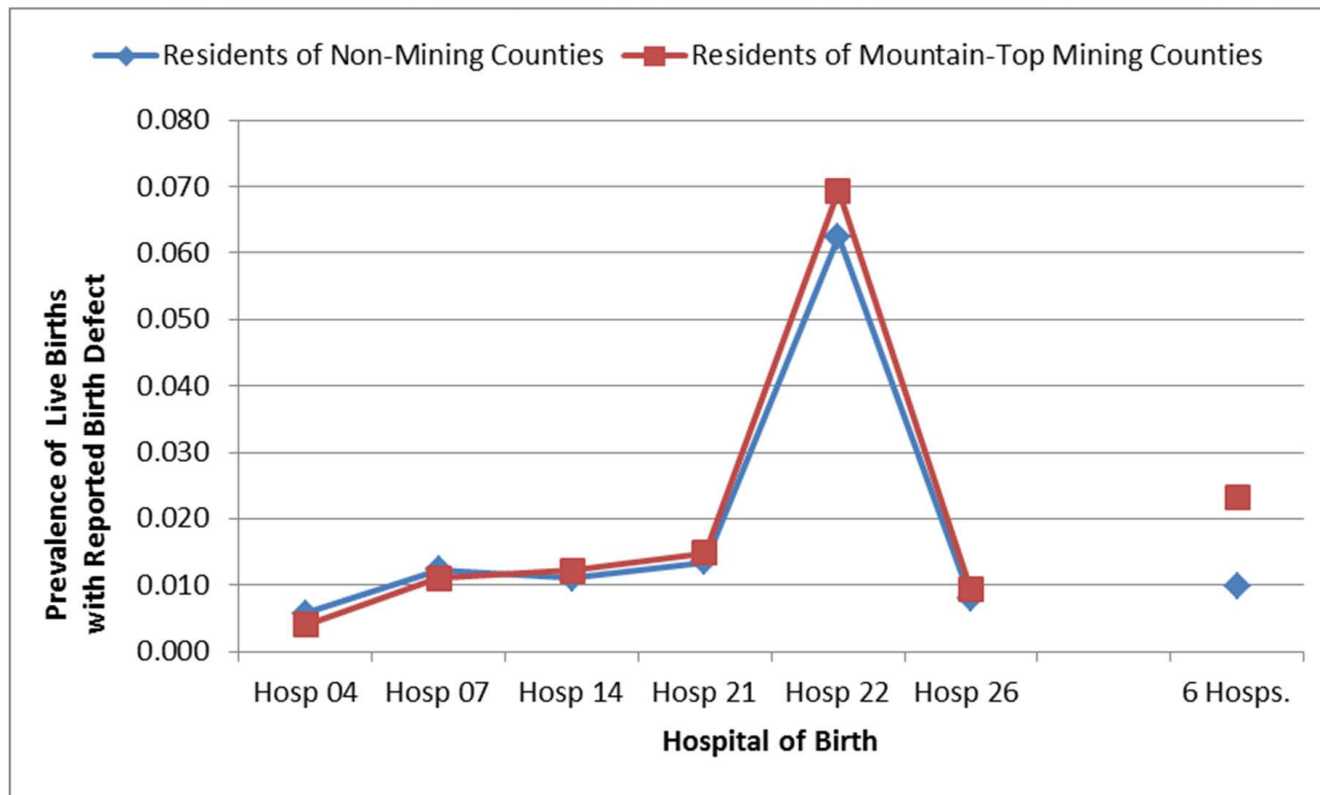
# Human Health

- ▶ Birth Defects in Mining Counties
  - Ahearn et al. (2011) posited that living in counties with mountaintop mining caused birth defects
  - Recent ARIES-sponsored work by Li et al. shows that the data that Ahearn used was skewed by a reporting problem at one hospital
  - Li et al. show **NO CORRELATION** between county of residence in WV and birth defects

# CEOH Findings

- West Virginia birth defect reporting rates by mining group of maternal residence (MTM- mining vs. Non-mining) is confounded by reporter (i.e., hospital of birth)
- Hospital adjusted analyses show no difference in birth prevalence rates by maternal residence, whether analyzed by all hospitals (PRR = 1.08;  $p = 0.16$ ) or by most contributory hospitals (PRR = 1.01;  $p = 0.87$ )

# Birth Defect Prevalence by Hospital



Slide courtesy of Li et al.

# Birth Defect Study

## Conclusion

- Analyses of the birth defect reporting rates on West Virginia birth certificates demonstrate that maternal residence in mountain-top mining counties is not an independent risk factor for birth defects, contrary to the Ahern et al. (2011) hypothesis.



# Coal Mining Dust and Health

- Based work by WVU, USGS, EPA and others, there have been concerns about the health impacts of dust from surface coal mining operations
- Studies suggested correlation to disease and proximity to mountaintop coal mining...

# ARIES Dust Study

- Using an interdisciplinary approach, ARIES is addressing research related to coal mining and dust
- Mining departments at UK and WVU collecting dust samples and evaluating size distributions
- Environmental exposure researchers at OSU will determine composition and bioavailability of materials in coal mining dust

# ARIES Dust Study (cont.)

- Modelers at UK will determine transport of dusts in various size fractions based on wind speeds and directions
- Health researchers at UK and Pitt will work to determine potential health impacts based on bioavailable constituents of coal mine dusts
- Epidemiologists will determine if there are proximity correlations to exposures of coal mining dusts and health outcomes

# Further Research Needs

- ▶ Current project is set to continue for another 2.5 years
  - ▶ Field data critical to connecting water quality and benthic ecology with specific discharges
  - ▶ Statistical analyses of geospatial data at regional- and local-scale
- ▶ Clear need for extended work
  - ▶ Ecological and community wellbeing - what links may exist between bacterial water impairments and specific benthic and human outcomes?
  - ▶ Policy - how can sustainable solutions be achieved given the current inventory of stakeholders and resources?

# ARIES UPDATE (Cont.)

- ▶ Re-designed ARIES Website [www.energy.vt.edu/ARIES](http://www.energy.vt.edu/ARIES)
- ▶ Year 3 EMPHASIS AREAS
  - ▶ Emphasis Area A: Stream Protection and Restoration
  - ▶ Emphasis Area B: Materials characterization and handling
  - ▶ Emphasis Area C: Water impacts of UG coal mining
  - ▶ Emphasis Area D: Community and health impacts

# Current Activities

- ▶ Planning beginning for ARIES meeting in April 2014
  - ▶ -Lexington, KY
- ▶ Identifying details for ECEP 2015 symposium
- ▶ Pursuing new funding and research opportunities
  - Industry and foundations
- ▶ **ARIES next steps**
  - ▶ Directing continued research and publications
  - ▶ Addressing emerging topics and concerns
  - ▶ Looking for opportunities for continued peer-reviewed publications and outreach on ARIES and results
  - ▶ Seeking continued and expanded support
    - ▶ - Resources are the key to results

# Topics for Future Research

- Restoration of stream form and function
- Water issues related to natural gas extraction
- Use and disposal of coal combustion residues
- Water issues in electricity generation

# Topics for Future Research (cont.)

- Upland reclamation and wildlife issues
- Coal preparation chemicals
- Eco-friendly mining technologies
- Potential “crossover” research, e.g.:
  - Use of lessons about TDS, selenium, etc. in gas production and electrical generation
  - Expansion of community well being to address concerns in gas production and electricity generation



# “Environmental Considerations in Energy Production” symposium

- International symposium to focus on ARIES and similar work
- Hosted by SME
- Fourteen technical sessions on various topics - 46 peer-reviewed papers in proceedings volume
- Held in Charleston, WV, April 14-18, 2013

# Summary and Status

- ARIES has already produced meaningful results and over 65 peer-reviewed publications in less than three years
- Commitment to the program essential to get return on investment and need for new sponsors
- Program of research being reviewed for efficiencies and to deal with funding levels
- Consideration of expansion to utility, oil and gas, and potentially hard rock mining issues
- ARIES has assembled an elite cadre of various disciplines at a number of institutions which can be expanded as needed to address research questions

# Conclusions

- ▶ Since coal mining (and use) will be important for decades to come, focus needs to be on doing it the best possible way based on good science
- ▶ Other aspects of energy production, such as unconventional gas production, also need the development of good science
- ▶ Regulations and other structures that can lead us to “sustainable development” need to have good science to get full participation and acceptance

# Benefits of ARIES

- Answers basic questions about cause and effect
- Allows for development of best practices and innovation
- Reduces environmental costs and promotes addressing key issues
- Removes regulatory conflicts by creating new focus on real problems and science
- Informs the public discussion and creates opportunity for “**social license**”

# ARIES

- For more information:

<http://www.energy.vt.edu/ARIES>

Or call:

John Craynon, ARIES Project Director

(540) 231-9462 or (540) 505-3362

[jcraynon@vt.edu](mailto:jcraynon@vt.edu)