



Potential Public Health Impacts of Natural Gas Development and Production in the Marcellus Shale in Western Maryland

**Presentation of the Report to the Marcellus Shale
Safe Drilling Initiative Advisory Commission**

August 18, 2014

Frostburg, Maryland

Presentation Outline

- Background to the Report
- Project Description
- Summary of Report and Recommendations
- Independent Reviews
- Public Comment Period and Next Steps

Background

- 6/6/11 – Executive Order signed
- 6/25/13 – MDE, DHMH establish public health study in Memorandum of Understanding (MOU)
- 10/18/13 – DHMH and University of MD School of Public Health sign MOU for public health study
- 12/10/13 – U MD submits draft scoping document
- 6/28/14 – U MD presents draft final report at Garrett Community College
- 8/18/14 – Final report presented to Advisory Commission



University of Maryland School of Public Health Team Members

- **Donald K Milton**, MD, DrPH, Director, Maryland Institute for Applied Environmental Health (MIAEH), School of Public Health, University of Maryland College Park
- **Sacoby Wilson**, PhD, MS, Assistant Professor, MIAEH, School of Public Health, University of Maryland College Park
- **Thurka Sangaramoorthy**, PhD, MPH, Assistant Professor, Anthropology, University of Maryland College Park
- **Amir Sapkota**, PhD, Associate Professor, MIAEH, School of Public Health, University of Maryland College Park
- **Keeve Nachman**, Assistant Scientist, Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health
- **Laura Dalemarre**, MPH, Program Associate, MIAEH, School of Public Health, University of Maryland College Park
- **Meleah Boyle**, Graduate Assistant, MIAEH, University of Maryland-College Park
- **Christian Jenkins**, Undergraduate Assistant, University of Maryland College Park
- **Josh Trowell**, Undergraduate Assistant, University of Maryland-College Park



Project Description and Deliverables

- Scoping Report
 - Including public input
- Baseline Assessment
 - Including local health priorities, health infrastructure, vulnerable populations, secondary health determinants
- Impact Assessment
- Final Report with Recommendations
- Independent Reviews (arranged by DHMH)

Sources of Data

“The impact assessment is based on available data from other states with ongoing UNGDP regarding exposure and health outcomes and on epidemiologic and toxicologic data from other contexts that are relevant to potential UNGDP related exposures.”

(Marcellus Report, Executive Summary, p. xv)

Potential Impacts

“Our assessments of potential health impacts are not predictions that these effects will necessarily occur in Maryland, where regulation is likely to be stricter than in some states where UNGDP is already underway.”

(Marcellus Report, Executive Summary, p. xv)



Impacts That Should Be Addressed

“Rather, we provide assessments of the impacts that could occur and that need to be addressed by preventive public health measures if and when drilling is allowed.” (Marcellus Report, Executive Summary, p. xv)

Scoping

- Review of public health-specific comments in response to the Best Management Practices Report forwarded by MDE in the Fall 2013
 - 113 comments were reviewed and categorized according to the ten key themes
 - Additional topics derived from these comments
 - Economic impact emerged as a new theme
 - Natural disasters were added to the climate change/weather theme

Themes

Theme	Total Number of Comments
Water quality	99
Zoning	69
Baseline health assessment	67
Secondary impacts	65
Economic impact	63
Climate change, natural disasters, and weather	52
Air quality	43
Populations of concern	29
Occupational impacts	26
Healthcare infrastructure	25
Benefits	7

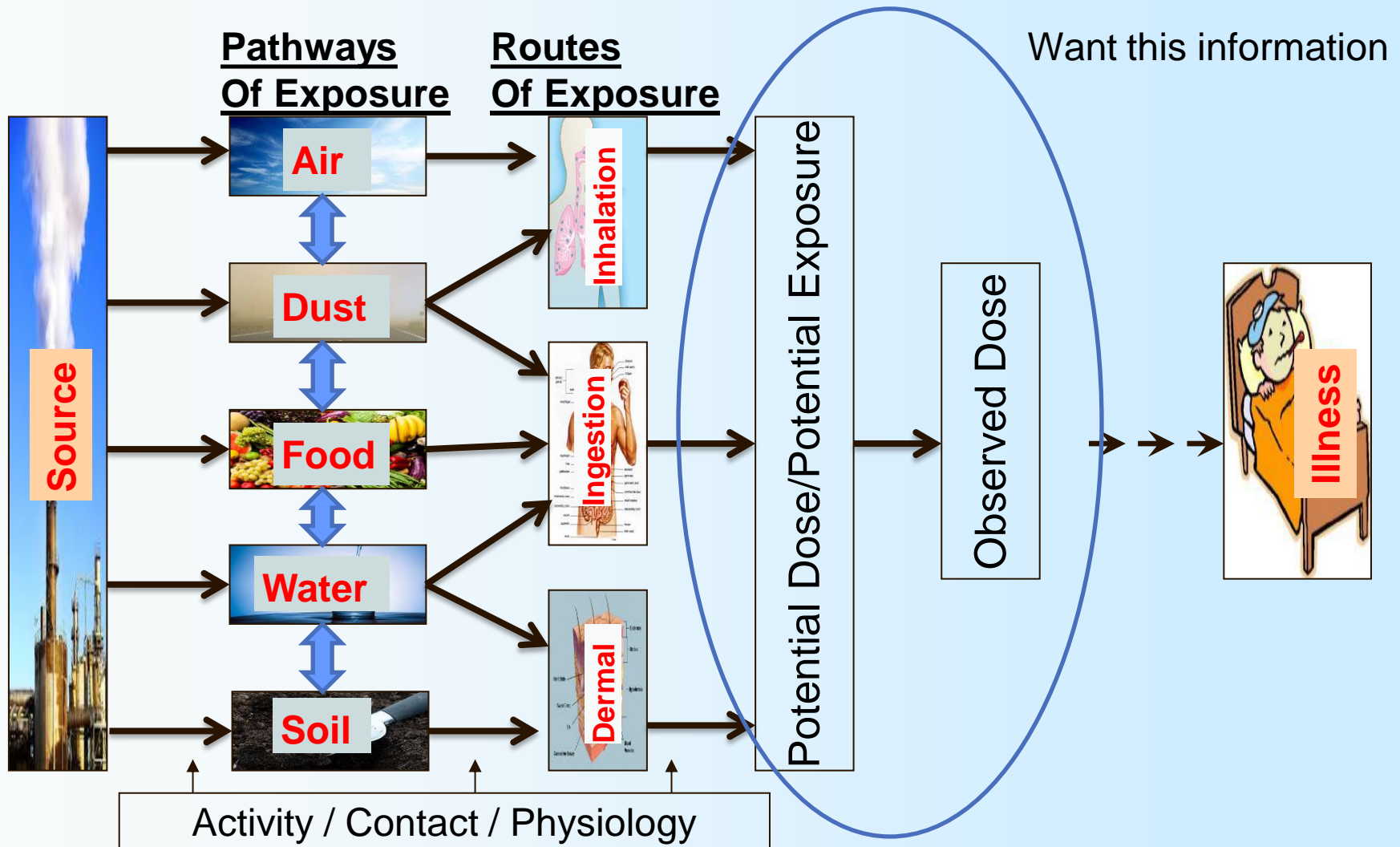
Baseline Assessment

- Baseline assessment of the population likely to be directly affected:
 - Assessment of the population's health
 - Demographics
 - Major causes of morbidity and mortality
 - Local health priorities
 - Consideration of vulnerable populations
 - Social determinants of health
 - Local healthcare infrastructure
 - Social infrastructure
 - Social support

Impact Assessment

- Review of key concepts
- Methods
- Assessment of major stressors
 - Air quality
 - Production/Flowback Water related issues
 - Water quality
 - Soil quality
 - Naturally Occurring Radioactive Materials
 - Noise
 - Earthquakes
 - Public Safety
 - Traffic
 - Crime
 - Sexually Transmitted Diseases
 - Occupational Health
 - Health Care Infrastructure
 - Cumulative Exposures
- Recommendations for each stressor **IF** Maryland moves forward with UNGDP

Impact Assessment: Exposure-Illness



Impact Assessment: Methodology

- Comprehensive Review of Literature
 - 197 peer-reviewed journal articles
 - 76 reports
- Where applicable, analyzed the primary data instead of relying on author's interpretation
- Conducted noise monitoring
 - Inside and outside homes in Doddridge County in WVA
 - Near natural gas compressor stations

Impact Assessment: Rating Criteria

- Evaluation of Hazards
 - Vulnerable populations
 - No (1): Affects all populations equally
 - Yes (2): Disproportionately affects vulnerable population
 - Duration of exposure
 - Short (1): Lasts less than 1 month
 - Medium (2): Lasts at least one month but less than one year
 - Long (3): Lasts one year or more
 - Frequency of exposure
 - Infrequent (1): Occurs sporadically or rarely
 - Frequent (2): Occurs constantly/ recurrently

Impact Assessment: Rating Criteria II

- Likelihood of health effects
 - Unlikely (0): Evidence suggests exposure is unrelated to adverse health outcomes
 - Unknown (1): No or inconclusive evidence or data relating exposures to adverse health outcomes.
 - Possible (2): Evidence suggest exposure to the agent is potentially related to adverse health outcomes.
 - Likely (3): Evidence in other settings have shown exposure to the agent is related to adverse health outcomes.

- Magnitude/severity of health effects
 - None(0): Does not cause any adverse health effects
 - Low(1): Causes of health effects can be quickly and easily managed or do not require treatment
 - Medium(2): Causes health effects that necessitate treatment and are reversible
 - High(3): Causes health effects that are chronic, irreversible or potentially fatal

Impact Assessment: Rating Criteria III

– Geographic extent

- Localized (1): Effects restricted to immediate vicinity
- Community-wide (2): Effects not restricted to immediate vicinity

– Effectiveness of Setback

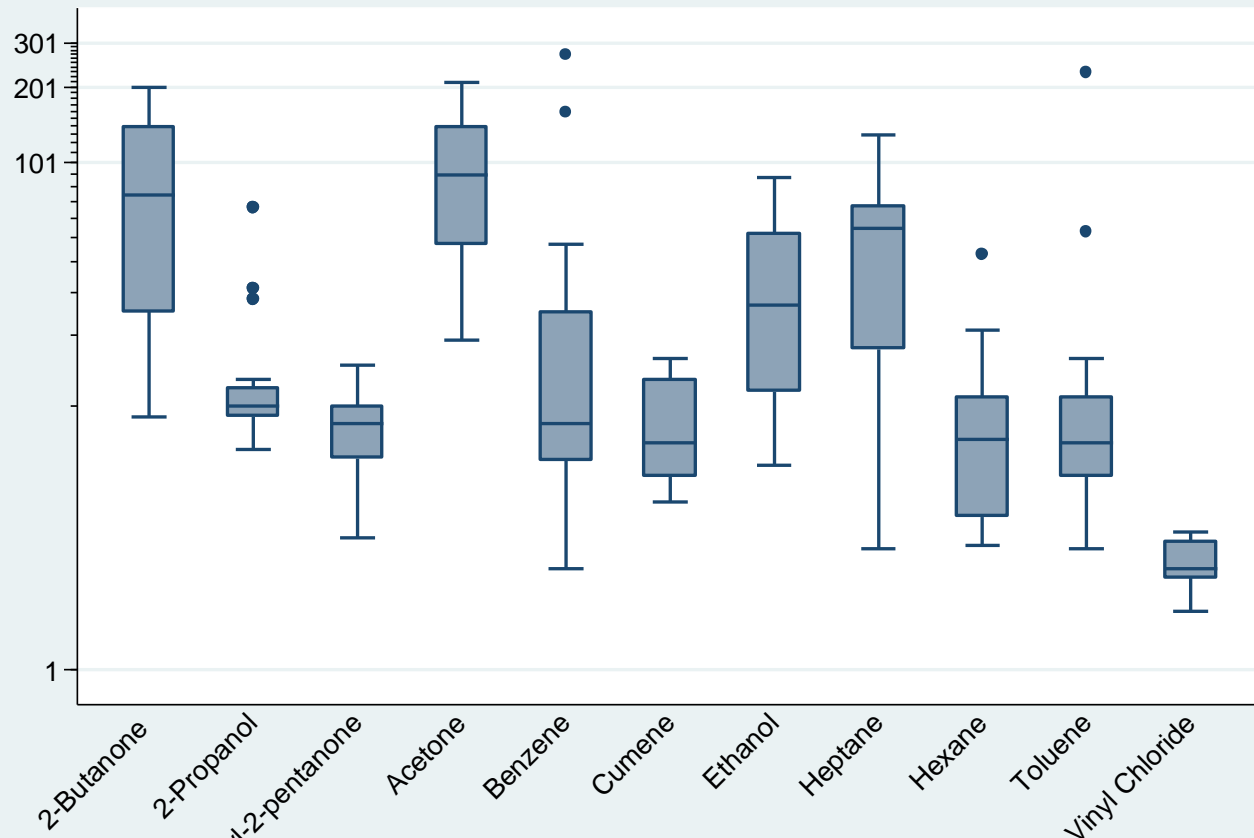
- Positive(1): Setback potentially minimizes exposure
- Negative(2): Setback unlikely to minimize exposure

Overall Rating Framework

Result	Score	Color
<u>Low likelihood</u> that UNGDP related changes will have negative impact on public health	6-9	Green
<u>Moderately high likelihood</u> that UNDGP related changes will have negative impact on public health	10-14	Yellow
<u>High likelihood</u> that UNGDP related changes will have negative impact on public health	15-17	Red

Impact Assessment: Air Quality

VOC Results from West Virginia



Data Source: Dr. Michael McCawley, Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations (ETD-10 Project). <http://www.wri.org/wp-content/uploads/2013/10/A-N-L-Final-Report-FOR-WEB.pdf>

Impact Assessment: Air Quality

- **VOC Results from WVA**
 - Concentrations for some of the important VOCs, such as benzene, were high near selected well pads
 - Samples collected at control sites in Morgantown, using same method, had no detectable levels of these VOCs.
- Existing literature supports negative health effects associated with exposure to VOCs (benzene, butadiene, formaldehyde, hexane to name few)
- Evidence from CO suggest exposure to UNGDP-associated air pollution possibly related to adverse birth outcomes

Evaluation: Air Quality

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	3
Magnitude/severity of health effects	3
Geographic extent	1
Effectiveness of Setback	1
Overall Score	15
Hazard Rank	H

Disproportionately affects vulnerable population (living near site, w/o mineral rights)

Will last >1 year, particularly related to flaring, compressor stations

Continuous exposure

Air pollutants that are associated with UNGDP are known to have negative health effects in other settings.

Resulting adverse health effects can be chronic, and irreversible

Adverse effects more prevalent in the close proximity to source

Effective setback distance can minimize exposure

High likelihood that UNGD associated changes in air quality will negatively impact public health in MD

Impact Assessment: Flowback – Production Water

Water Quality

- Potential for groundwater contamination a major issue
- A large fraction of the population in Garrett and Allegany Counties relies on ground water
- Approximately 3-7 million gallons of water used per well (12-42 million gallons/well pad)
- Water, including flowback and production from UNG-Development contains:
 - Naturally occurring chemical hazards
 - Radiological materials that may exist in subsurface
 - Chemicals used in UNG-Development

Impact Assessment: Flowback – Production Water

Water Quality

- Methane in drinking water wells in active drilling areas of PA were 17x higher than those located >1km away (Osborn et al 2011). A separate study concluded that methane contamination primarily related to groundwater geochemistry, NOT shale gas recovery. (Molofsky et al 2013)
- There is a dearth of information linking exposures with human health outcomes

Impact Assessment: Flowback – Production Water

Soil Quality

- Soil quality is most likely to be impacted by unintentional spills or leaks, storm water runoff, and use of brine on roads
- Human health impacts of soil contamination with fracking fluids have not been described

Impact Assessment: Flowback – Production Water

Naturally Occuring Radioactive Materials (NORM)

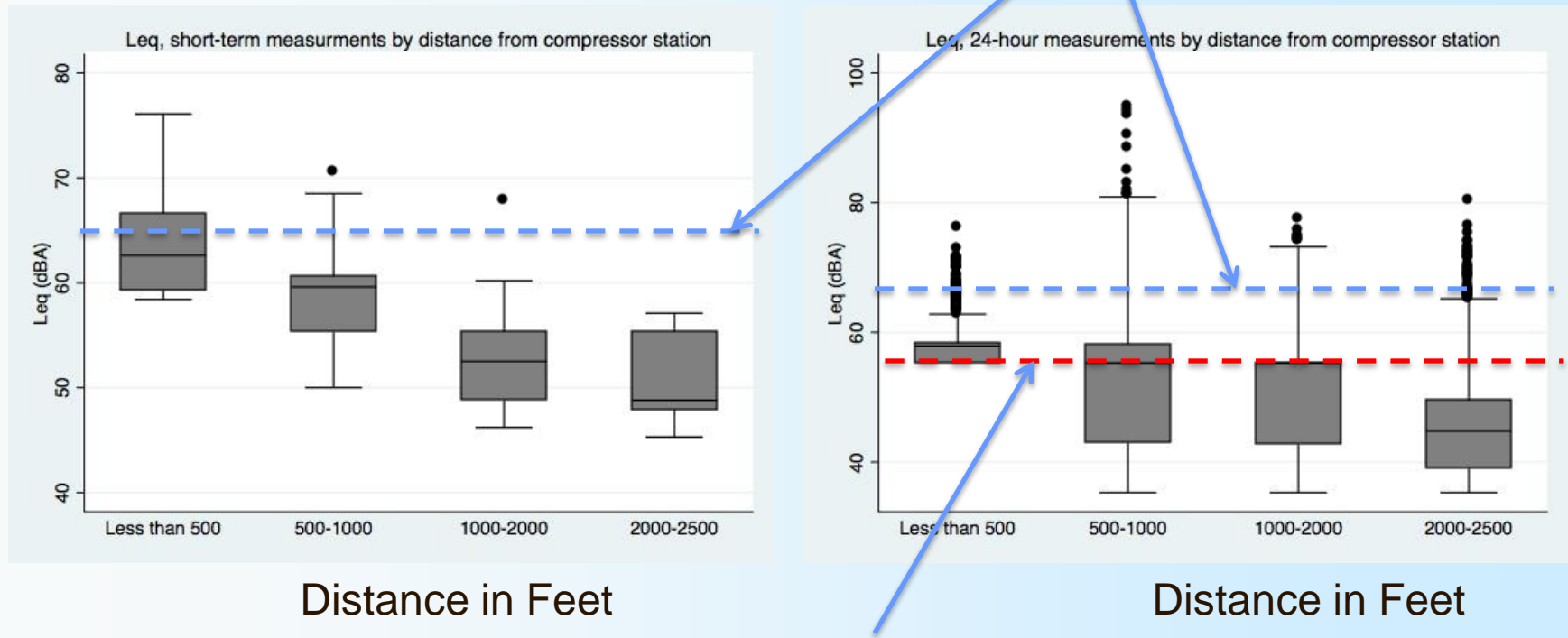
- Evidence suggest recovered wastewater can be contaminated with (NORM)
- Specific composition of NORM depends on the geologic composition of bedrock
- Radium, often used as an index of radiological contamination, may not adequately capture overall radioactivity
- Strong body of epidemiological studies have established link between exposure to radionuclides with adverse health outcomes.

Impact Assessment: Noise

MD Daytime Standard (65 dBA)

Short Term Daytime Noise Level (20 min)

24-hr Noise Level



Distance in Feet

Distance in Feet

Nighttime Standard (55 dBA)

Impact Assessment: Noise

- Environmental noise can lead to a variety of adverse health outcomes at decibel levels ranging from 35-75 A-weighted decibels
- Exposure is determined by the duration and intensity of the noise
- Most common health effects include annoyance and sleep disturbances
- Children, elderly, chronically ill, and hearing impaired individuals are more susceptible to environmental noise



Impact Assessment: Social Determinants of Health

- Traffic:
 - An estimated 1000 truck round trips needed for a single well development (~6,000 trips/well pad)
 - Increased emissions
 - Accidents
 - Deteriorating road conditions
 - Safety issue for young children, drivers and pedestrians
 - Delayed response time for 911 calls
- Crime
 - Increased crime rate associated with UNGDP operations.
 - Arrests associated with disorderly conduct increased by 17% in heavily fracked counties of PA and by 32% in Battlement Mesa, CO
- Sexually Transmitted Diseases
 - Increased by 32% in PA and 217% in Battlement Mesa CO

Impact Assessment: Occupational Health

- Exposure to Crystalline Silica known to cause silicosis and lung cancer
- Worker exposures to diesel particulate matter, volatile organic compounds and polycyclic aromatic hydrocarbons are of particular concern at UNGDP sites

Impact Assessment: Health Care Infrastructure

- Negative impacts predicted due to increase in workforce and potential health care utilization rates
 - 1327-2825 migrant workers on average during the first 10 years of drilling predicted by RESI
 - Unclear if revenues from UNGDP will be substantial enough to directly impact health care infrastructure in Western MD
- Increasing health care utilization, regardless of insurance status, would strain existing healthcare infrastructure, likely leading to decreased quality, availability, and access to services
 - Allegany and Garrett counties (HPSA and MUA areas with high levels of uninsured and medically assisted populations) have vast health care needs

Impact Assessment: Cumulative Exposure/Risk

- Exposure to Multiple Chemicals
 - Volatile Organic Compounds
 - Polycyclic Aromatic Hydrocarbons
 - Particulate Matter and Others
- Exposure to physical hazards : Noise, NORM
- Psychosocial stressors
 - Stress: loss of control, community identity
 - Surface owners who lack mineral rights
- Other community level vulnerability
 - Poverty
 - Crime
- Positive exposures
 - Jobs and income
 - Improvements in infrastructure and tax revenue
- The net health effects associated with these exposures may be greater than the simple sum of effects associated with individual exposures

Hazard Evaluation

Air Quality

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	3
Magnitude/severity of health effects	3
Geographic extent	1
Effectiveness of Setback	1
Overall Score	15
Hazard Rank	H

Flowback and Production Water Related Issues*

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	1
Magnitude/severity of health effects	1
Geographic extent	2
Effectiveness of Setback	2
Overall Score	13
Hazard Rank	M

**** Hazard rank predominantly driven by water quality issues***

Hazard Evaluation

Noise

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	2
Magnitude/severity of health effects	1
Geographic extent	1
Effectiveness of Setback	1
Overall Score	12
Hazard Rank	M

Earthquake

Evaluation Criteria	Score
Vulnerable populations	1
Duration of exposure	1
Frequency of exposure	1
Likelihood of health effects	1
Magnitude/severity of health effects	0
Geographic extent	2
Effectiveness of Setback	2
Overall Score	8
Hazard Rank	L

Hazard Evaluation

Social Determinants of Health

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	3
Magnitude/severity of health effects	2
Geographic extent	2
Effectiveness of Setback	2
Overall Score	15
Hazard Rank	H

Health Care Infrastructure

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	2
Magnitude/severity of health effects	2
Geographic extent	2
Effectiveness of Setback	2
Overall Score	15
Hazard Rank	H

Hazard Evaluation

Occupational Health

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	3
Magnitude/severity of health effects	3
Geographic extent	2
Effectiveness of Setback	2
Overall Score	17
Hazard Rank	H

Cumulative Exposure

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	3
Frequency of exposure	2
Likelihood of health effects	2
Magnitude/severity of health effects	1
Geographic extent	2
Effectiveness of Setback	2
Overall Score	14
Hazard Rank	M

Recommendation Categories

- Comprehensive Gas Development Plans
- Disclosure of Well Stimulation Materials
- Air Quality
- Flowback and Production Water-Related
- Naturally Occurring Radioactive Materials
- Noise
- Earthquakes



Additional Recommendations

- Social Determinants of Health
- Healthcare Infrastructure
- Cumulative Exposure/Risk
- Occupational Health

Recommendations for Comprehensive Gas Development Plans

R1. Require assessment of air quality and other potential health impacts and propose strategies to protect the community and workers from exposure to hazardous air pollutants.

R2. Require assessment of whether application of standard setback distances will be adequate to protect public health, including consideration of prevailing winds and topography.

R3. Require disclosure of planned well stimulation methods and classes and amounts of chemicals to be used.

R4. Require a quality assurance plan.

R5. Require an air, water, and soil-monitoring plan.

R6. Require assessment of impact on and a monitoring plan for potential fugitive emissions from existing and historic gas wells within the horizontal extent of the fractured area.

R7. Require that all UNGDP materials and wastes be stored in closed tanks; open pits shall only be used for storage of fresh water.

Recommendations on Disclosure of Well Stimulation Materials

R8. Require preliminary disclosure at time of CGDP submission (see CGDP recommendations), detailed disclosure at time of well permit application, and detailed reporting of actual materials used within 30 days of finishing well stimulation activities. Require notification of MDE, local emergency responders and public notice of significant variances from materials and concentrations proposed in the permit within 24-hours of occurrence.

R9. Require detailed disclosures to include CAS numbers, volume and concentration of every chemical or distinct material including proppants, their physical form, and identification of engineered nanomaterials – including drilling muds and hydraulic fracturing and other fluids – used in well stimulation. Do not allow claims of trade secrets for identities and concentrations of specific chemicals or nanomaterials used in well stimulation.

R10. Require detailed disclosures to include base fluid volume and sources including percentages that are recycled fracturing fluid, production water, and fresh water.

R11. Require simultaneous submission to state regulators and FracFocus.

R12. Collaborate with California to develop a State controlled and archived Internet Web site consistent with the provisions of California SB 4.

R13. Implement the provisions of H.B. 1030 for timely access to disclosed information by medical professionals, emergency responders, poison control centers, local officials, scientists, and the public.

Recommendations on Air Quality

R14. Require a minimal setback distance of 2000 feet from well pads and from compressor stations not using electric motors.

R15. Require electrically powered motors wherever possible; do not permit use of unprocessed natural gas to power equipment. This recommendation is designed to reduce VOCs and PAHs emissions from drilling equipment and compressors.

R16. Require all trucks transporting dirt, drilling cuttings to be covered.

R17. Require storage tanks for all materials other than fresh water and other UNGDP equipment to meet EPA emission standards to minimize VOC emissions.

R18. Establish a panel consisting of community residents and industry personnel to actively address complaints regarding odor.

R19. Conduct Air Quality Monitoring

- a. Initiate air monitoring to evaluate impact of all phases of UNGDP on local air quality (baseline, development and production).**
- b. Conduct source apportionment that allows UNGDP signal to be separated from the local and regional sources.**
- c. Conduct air monitoring with active input from community members in planning, execution, and evaluation of results.**
- d. Conduct air monitoring in a manner to capture both acute and chronic exposures, particularly short-term peak exposures.**
- e. Clearly communicate to community members expectations about what is achievable through air monitoring.**

Recommendations on Flowback and Production Water

R20. Prohibit well pads within watersheds of drinking water reservoirs and protect public and private drinking water wells with appropriate setbacks.

R21. Implement UMCES-AL/MDE water monitoring plan. Require monitoring of water quality during initial gas production and at regular intervals thereafter.

R22. Implement the UMCES-AL recommendations for management and recycling of flowback and production fluids.

R23. Require identification and monitoring of “signature” chemicals in fracturing fluids to allow for future identification of ground water infiltration/contamination.

R24. Conduct soil monitoring in areas potentially impacted by UNGD upset conditions.

R25. Prohibit flowback and production wastewater or brine use to suppress road dust, de-ice roads, or other land/surface applications.

R26. Conduct research to identify the appropriate suite of priority radionuclides for assessment of radiological activity.

Recommendations on Noise

R27. Implement noise reduction strategies recommended by UMCES-AL in the MD Best Management Practices, including requiring electric motors wherever power supplies are available and construction of artificial sound barriers.

R28. Require a setback of 2,000 feet for natural gas compressor stations using diesel engines, 1000 feet for stations using electric motors and sound barriers.

R29. Establish a system to actively address noise complaints.

Recommendations on Earthquakes

R30. Collect baseline data on seismic activities using methods that can record earthquakes smaller than magnitude 3.

R31. Restrict issuing UIC Class II permits for disposal of UNGDP fluids until licensing requirements adequately addresses earthquake risk.

R32. Implement use of sensitive seismic monitoring technology to better detect small earthquake activity that could presage larger seismic events as well as using a “traffic-light system” that sets thresholds for seismic activity notification.



Recommendations on Social Determinants of Health

R33. Increase state and local highway patrols to closely monitor truck traffic subject to the Oilfield Exemption from highway safety rules.

R34. Empower local communities to control truck speed and traffic patterns.

R35. Route truck traffic to maintain separation between UNGDP activities and the public.

R36. Consider use of pipelines to move UNGDP fluids between sites.

R37. Enact a Surface Owners Protection Act as recommended in the MDE Part I report.

R38. Engage local communities in monitoring and ensuring that setback distances are properly implemented.

R39. Create a mapping tool for community members using buffer zones (setback distance) around homes, churches, schools, hospitals, daycare centers, public parks and recreational water bodies.

Recommendations on Health Care Infrastructure

R40. Closely monitor whether prospective UNGDP companies provide adequate health insurance coverage for all employees.

R41. Organize a local health care forum with key stakeholders to assess health care services and anticipated needs related to UNGDP.

R42. Inform and train emergency and medical personnel on specific medical needs of UNGDP workforce.

R43. Review and monitor county-level tax revenues and assess improvements necessary to meet increased services need.

R44. Establish a committee of state and local stakeholders (including UNGDP officials and local providers and residents) for early identification of impacts to healthcare infrastructure.

R45. Initiate monitoring of UNGDP healthcare-related costs.

Recommendations on Cumulative Exposure/Risk

R46. Initiate a birth outcomes surveillance system

R47. Initiate a longitudinal epidemiologic study of dermal, mucosal, and respiratory irritation

R48. Develop funding mechanism for public health studies



Recommendations for Occupational Health

R49. Require implementation of NIOSH and OSHA recommended controls for silica exposure in UNGD operations.

R50. Provide MOSH with resources to regularly inspect UNGD workplaces and monitor worker exposures.

R51. Establish community outreach programs to help transient workers feel more welcome in the community as a means of reducing rates of depression, suicide, and drug use.

R52. Require employers to provide employee assistance programs including counseling and substance abuse treatment.

Independent Reviews

- DHMH separate contracted with three nationally recognized experts to review the scoping document and final report
 - Jonathan Levy, ScD, Boston University
 - Lynn Goldman, MD, MS, MPH, George Washington University
 - John Adgate, PhD, MSPH, University of Colorado

Comments from Independent Reviewers

- Adgate: “...the lack of substantive research to address the main public health concerns about UNGDP is still one of the major limitations facing both public health experts and decision-makers. This report is a good implementation of the HIA methodology. It should help inform Maryland decision-makers on the potential public health impacts of UNGDP.”
- Levy: “In summary, this was a solid report that provided insight about key pathways linking UNGDP with public health, with a concrete list of recommendations that are well supported by the literature. While there are clearly areas of potential improvement or refinement, and some of the content was not central to the decisions at hand, the HIA is based on a solid foundation and provides important insight for decision makers.”
- Goldman: “...Nonetheless, and notwithstanding the many points that I have raised in this review, I think that this approach is a major step forward in identifying potential health threats in conjunction with proposed UNGDP in Maryland.”



Next Steps

- Comments may be submitted through October 3, 2014 to dhmh.envhealth@maryland.gov.
- Written comments can also be submitted to:
Environmental Health Bureau, Marcellus Shale Comments
Maryland Department of Health and Mental Hygiene
201 W. Preston Street, Room 327
Baltimore, MD 21201

Next Steps (continued)

- Symposium on September 12, 2014.
- The team from the Maryland Institute for Applied Environmental Health will attend the September 15, 2014 meeting of the Marcellus Shale Advisory Commission to discuss the health report
- Dr. Mitchell will review comments and provide information to the Commission

Thank You

- Questions/Comments from the Commissioners?
- Questions/comments from the public?