

Marcellus Shale Public Health Study Final Progress Report

Saturday, June 28, 2014
Garrett College
McHenry, MD



SCHOOL OF
PUBLIC HEALTH





Agenda

Time	Topic	Presenter
2:00 – 2:10	Welcome and Introduction	Drs. Clifford Mitchell and Donald Milton
2:10 – 2:15	Scoping Process	Dr. Sacoby Wilson
2:15 – 2:35	Baseline Health Assessment <ul style="list-style-type: none">• Methods• Key findings	Dr. Sacoby Wilson
2:35 – 3:05	Impact Assessment <ul style="list-style-type: none">• Methods• Assessment of major stressors	Dr. Amir Sapkota
3:05 – 3:35	Recommendations and Limitations	Dr. Donald Milton
3:35 – 4:30	Moderated Discussion	Dr. Sacoby Wilson



Rules of Engagement

- Hold all questions and comments until the discussion
 - Take turns speaking and share time equitably to ensure the participation of multiple people, we will start with one question per person
 - Listen carefully and respectfully, trying to understand different parties' views
 - Refrain from blame or attacks
 - The presentation is being video recorded, not Q&A
 - Audio recording is being made for transcription only
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Role of the Public Health Study

- Assess potential health impacts to inform decisions about whether to permit Unconventional Natural Gas Development and Production (UNGDP) in Maryland
 - Make recommendations to limit negative health impacts if the State decides to permit UNGDP
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Health Impact Assessment (HIA)

- HIA concept provides a framework for the public health study
 - National Academies of Science Report, Improving Health in the U.S.: The Role of Health Impact Assessment
 - HIA Stages:
 - Screening
 - Scoping
 - Assessment
 - Recommendations
 - Reporting
 - Monitoring & Evaluation
-



HIA & the Public Health Study

HIA

- Screening
- Scoping
- Assessment
- Recommendations
- Reporting
- Monitoring & Evaluation

Public Health Study

- Detailed Scoping
 - Assessment
 - Baseline
 - Impact
 - Final Report
 - Monitoring & assessment recommendations
 - Public health response and mitigation strategies
-



SCOPING PROCESS



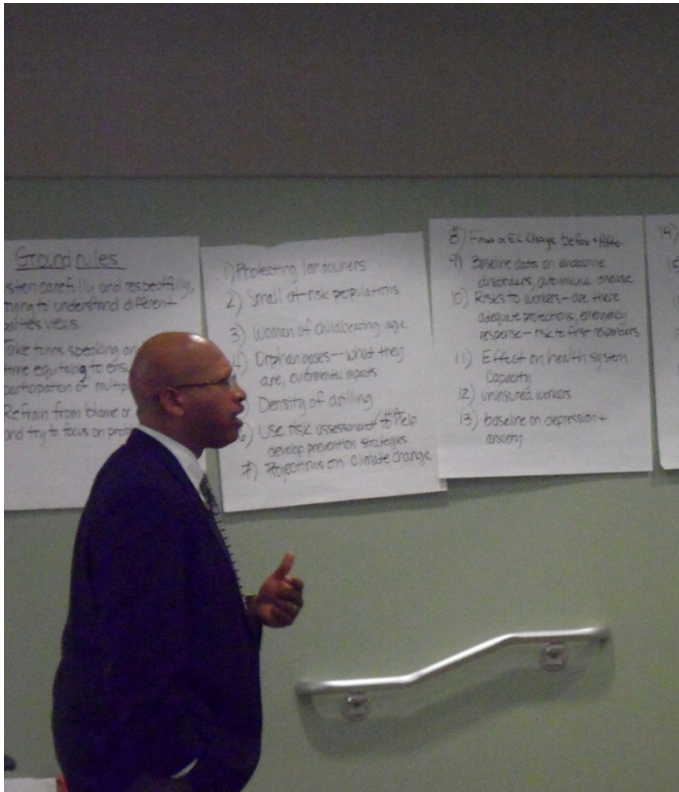
Scoping Process

- Stakeholder engagement
 - Meeting September 24, 2013 at Frostburg State University
 - Website www.marcellushealth.org
 - Meeting October 5, 2013 at Garrett College
- Purpose: to discuss natural gas drilling and extraction in the Marcellus Shale in Western Allegany and Garrett counties
- Participants included concerned community members and advocates





Scoping



- Ten themes emerged:
 - Air contamination
 - Baseline health assessment
 - Benefits
 - Healthcare infrastructure
 - Occupational issues
 - Secondary impacts
 - Vulnerable populations
 - Water contamination
 - Weather and climate change
 - Zoning



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



Comments on Scoping

- Draft Scoping Report released for public comment on December 23, 2013 to January 23, 2014
- Received 46 comments from concerned residents, environmental advocacy organizations, and the industry
- Recently received comments from external reviewers
- Revising scoping report based on comments

DRAFT for Public Comment

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

December 2013

Maryland Institute for Applied Environmental Health
School of Public Health
University of Maryland, College Park





BASELINE HEALTH ASSESSMENT



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
-



Social Determinants of Health





Baseline Assessment Methodology

- Descriptive statistics
 - Mapping
 - 2012 American Community Survey 5-year estimates
 - 2013 Primary Medical Care Health Professional Shortage Areas
 - 2013 EPA-regulated facilities
 - 2012 ESRI USA landmark data
 - 1980 Basic Data Report No. 11, Garrett County Gas Well records
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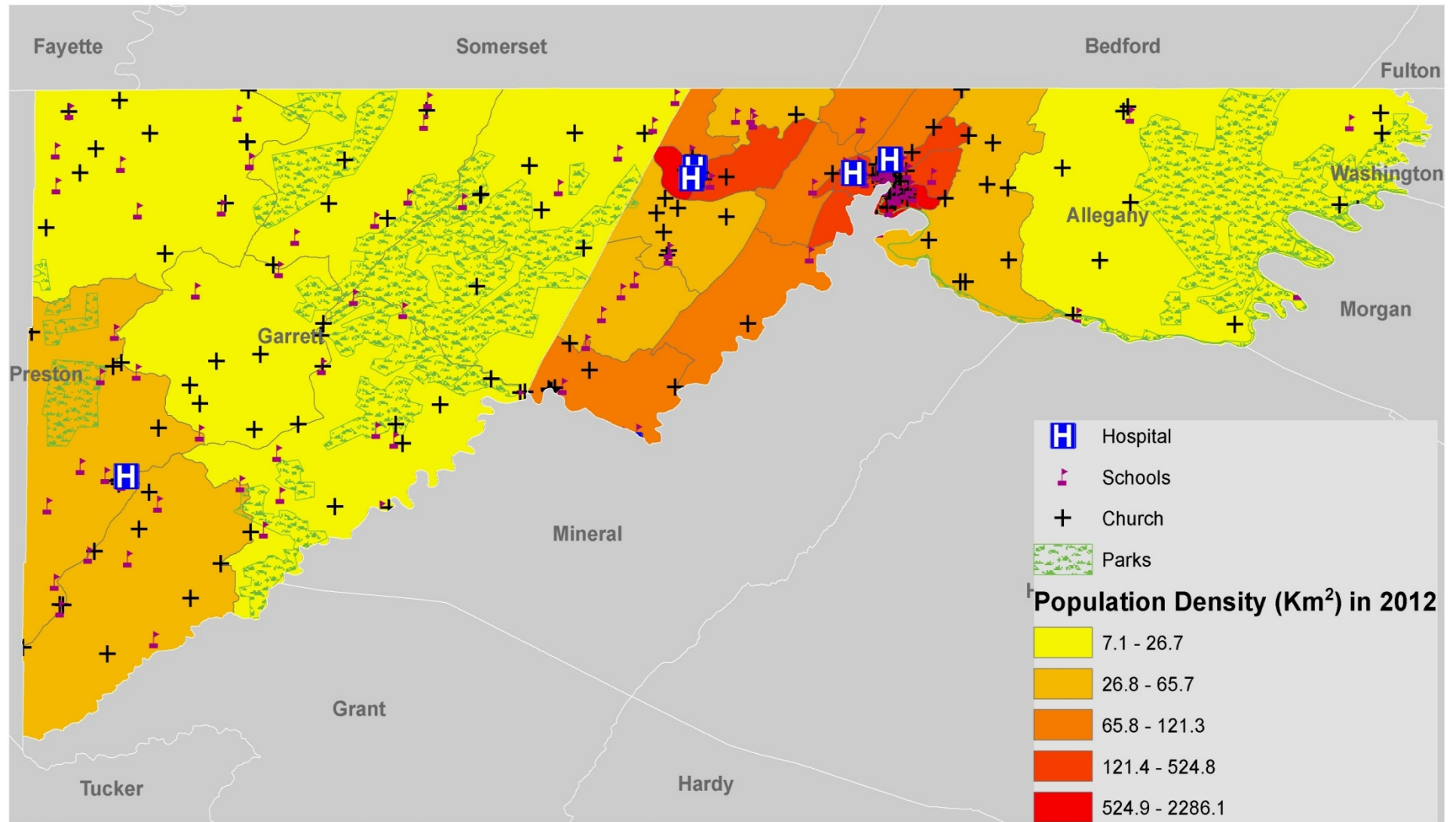
Environmental Factors

BASELINE HEALTH ASSESSMENT



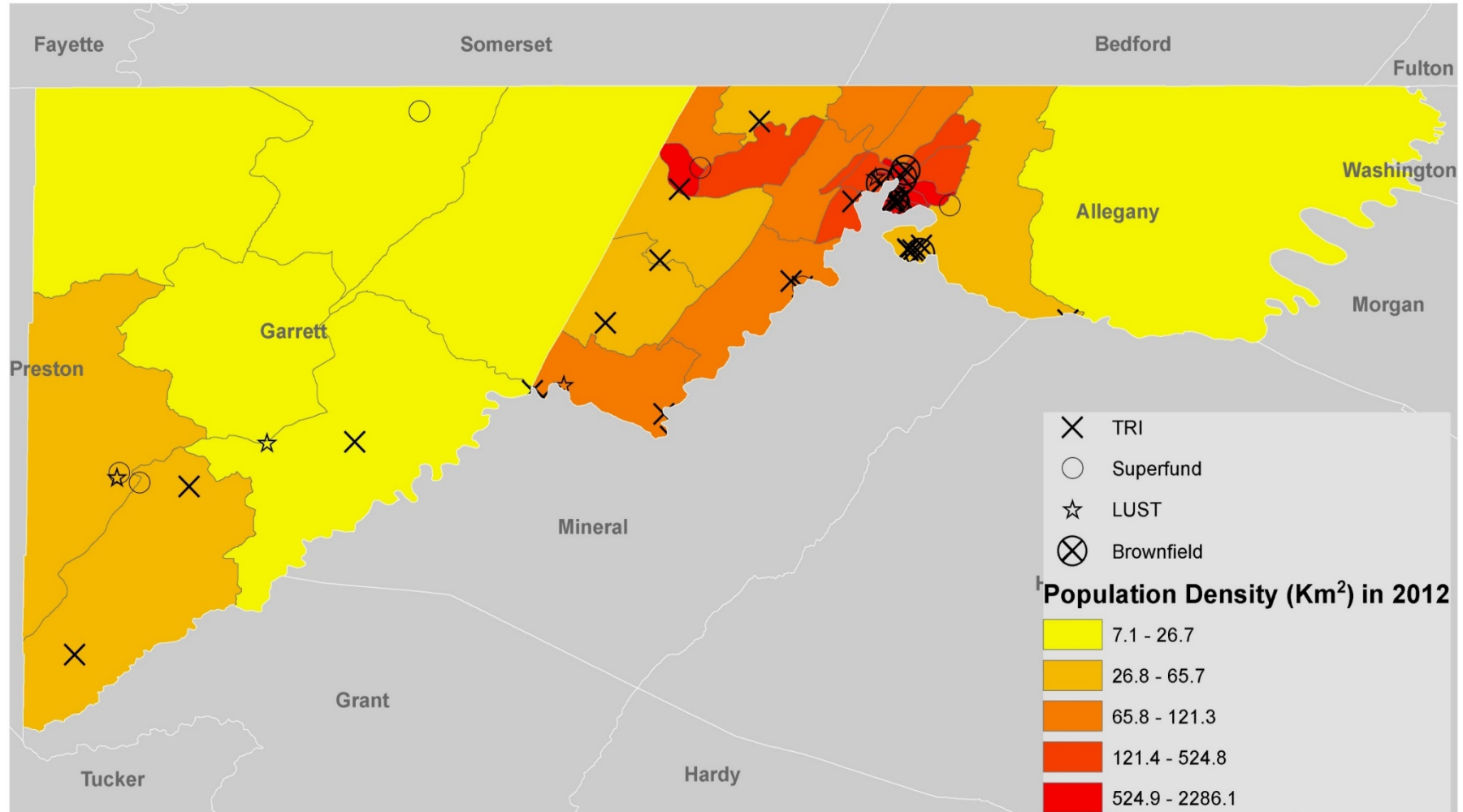


Community Assets and Receptors



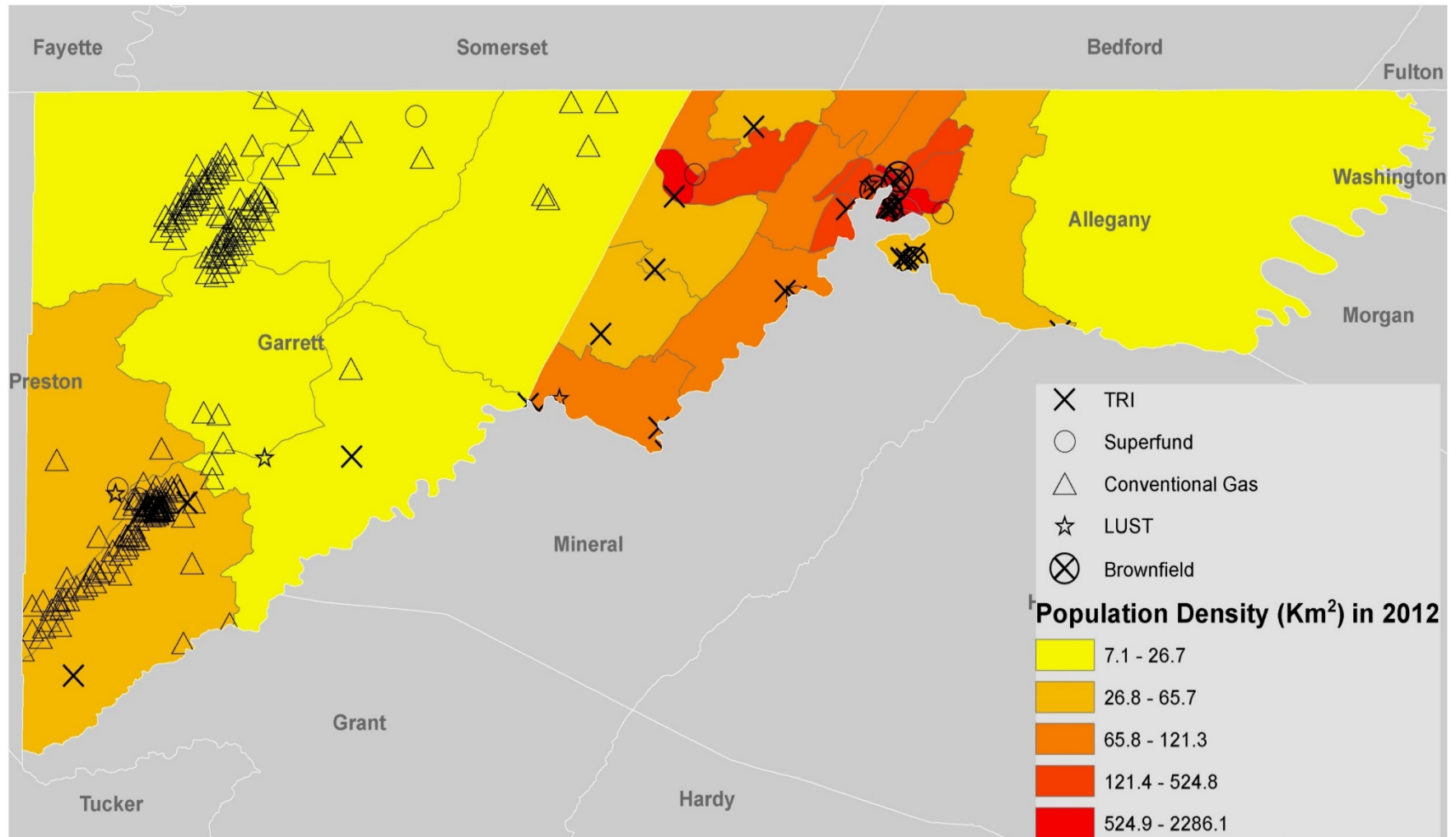


Toxic Release Inventory (TRI) Facilities, Superfund Sites, Leaking Underground Storage Tanks (LUSTs), and Brownfields in Garrett and Allegany Counties in Relation to Population Density



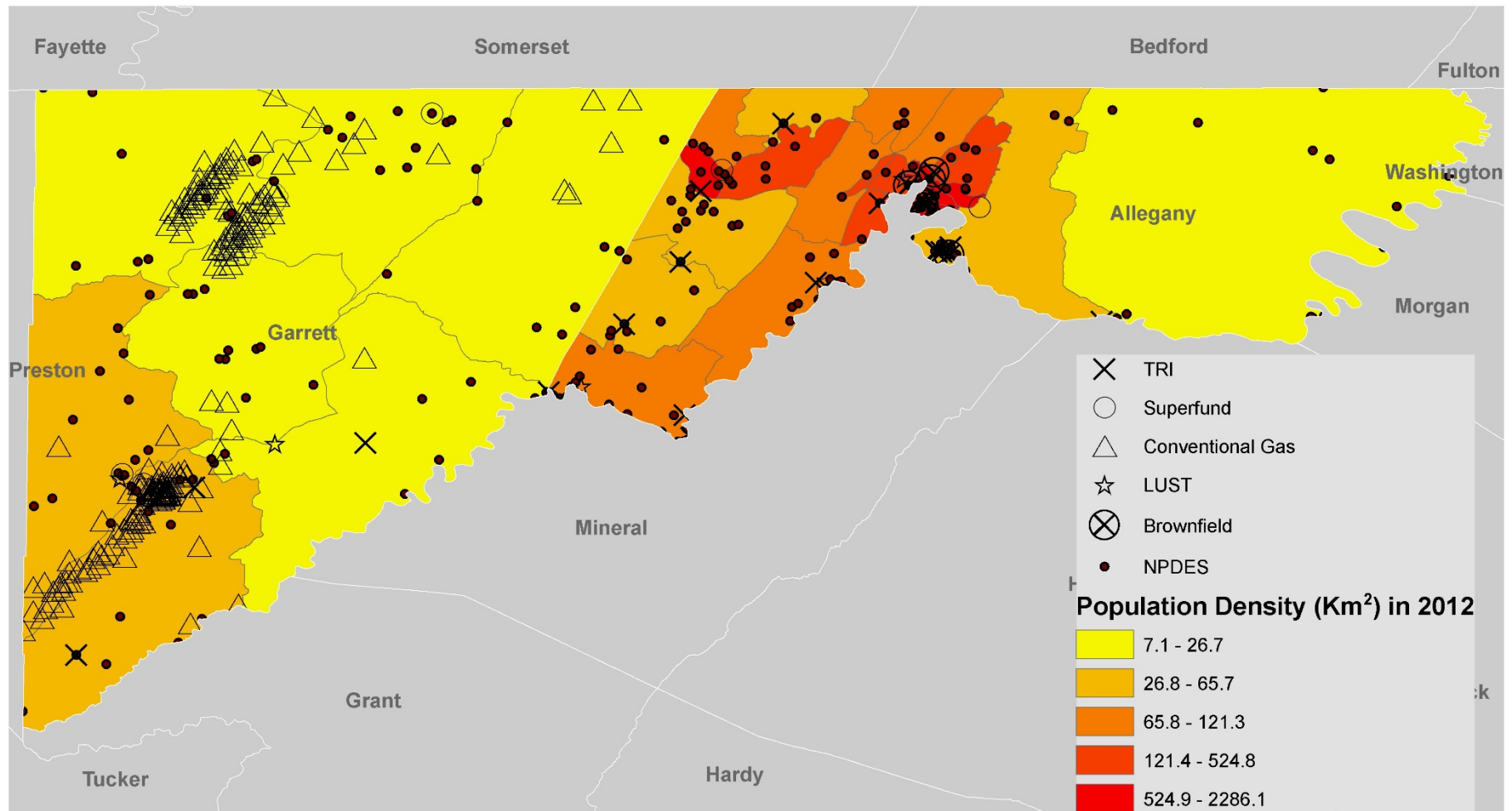


EPA-Regulated Facilities & Conventional Gas Wells in Relation to Population Density in Garrett and Allegany Counties



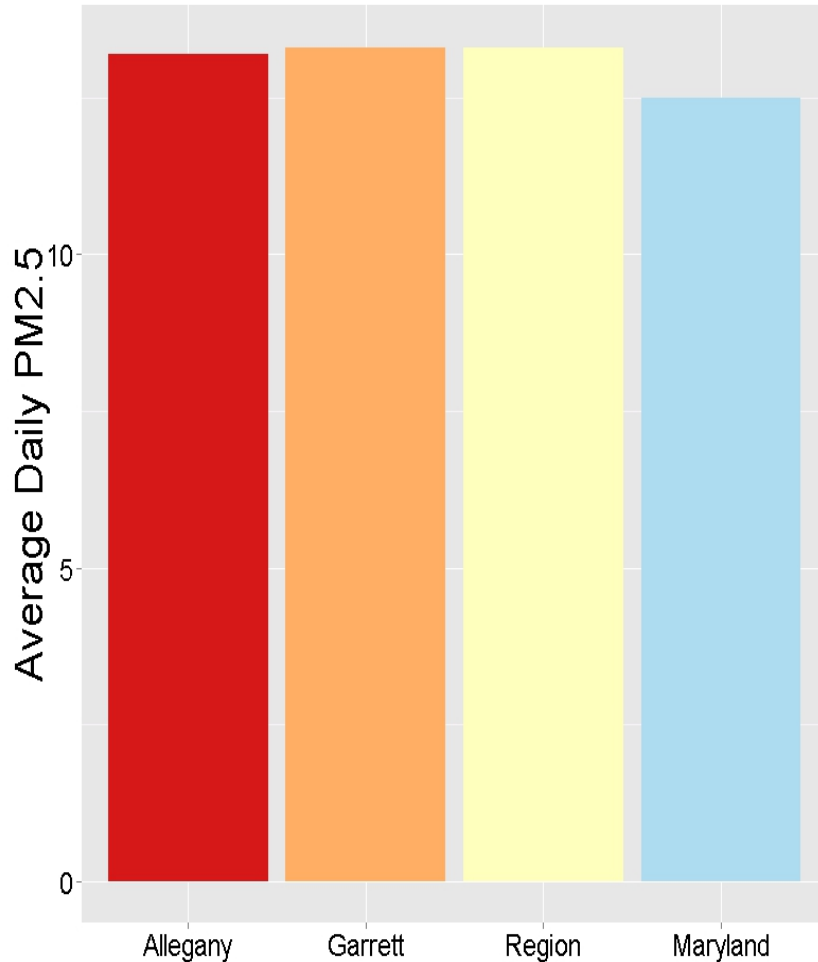


EPA-Regulated Facilities including Facilities with Discharge Permits in Relation to Population Density in Allegany and Garrett Counties





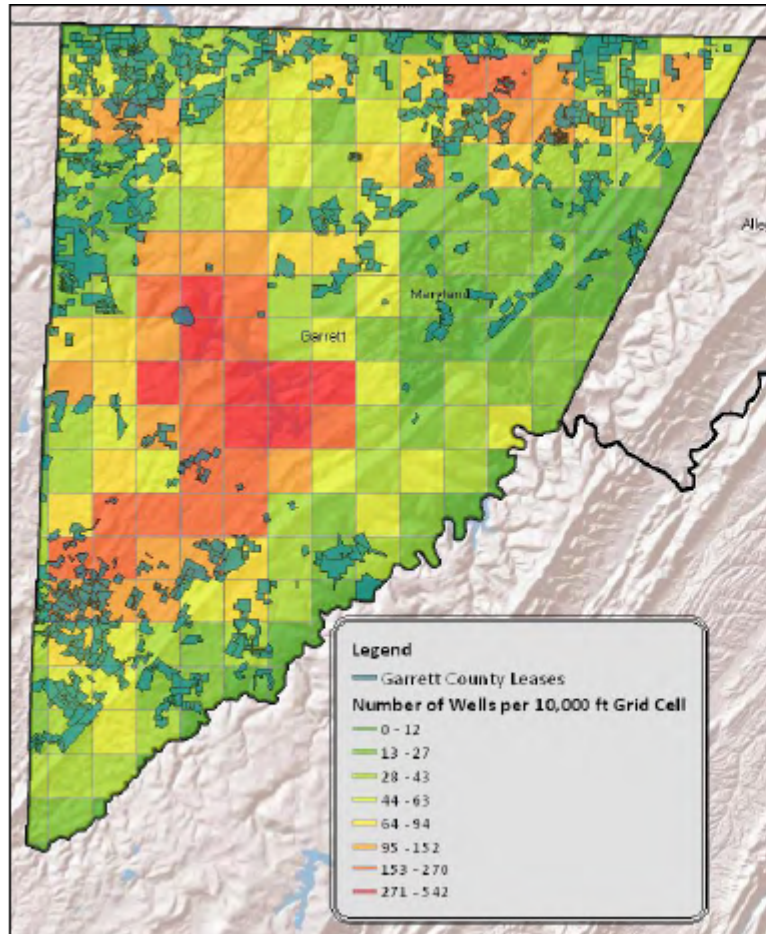
Air Pollution in Garrett and Allegany Counties (2014)



- Average daily PM_{2.5} levels ranged from 13.2 to 13.3 ug/m³ in Allegany and Garrett Counties
- These levels are higher than the average mean for the state of Maryland and annual standard (12 ug/m³) but lower than the daily standard (35 ug/m³).
- UNGDP activities could lead to more air pollution in counties including from truck traffic and gas flaring.
- This could increase exposure risks for nearby populations and increase health risks for children, elderly, individuals with asthma and other respiratory conditions



Private Wells and Health



Source: MDNR

- Private wells are concentrated most heavily around McHenry, Grantsville and Oakland
- 14,264 well location records are currently available in Garrett County
- Approximately, 8,250 or 58% of well records occur in grid cells that contain Marcellus shale gas leases
- New development could lead to exposure and health risks for populations on well water

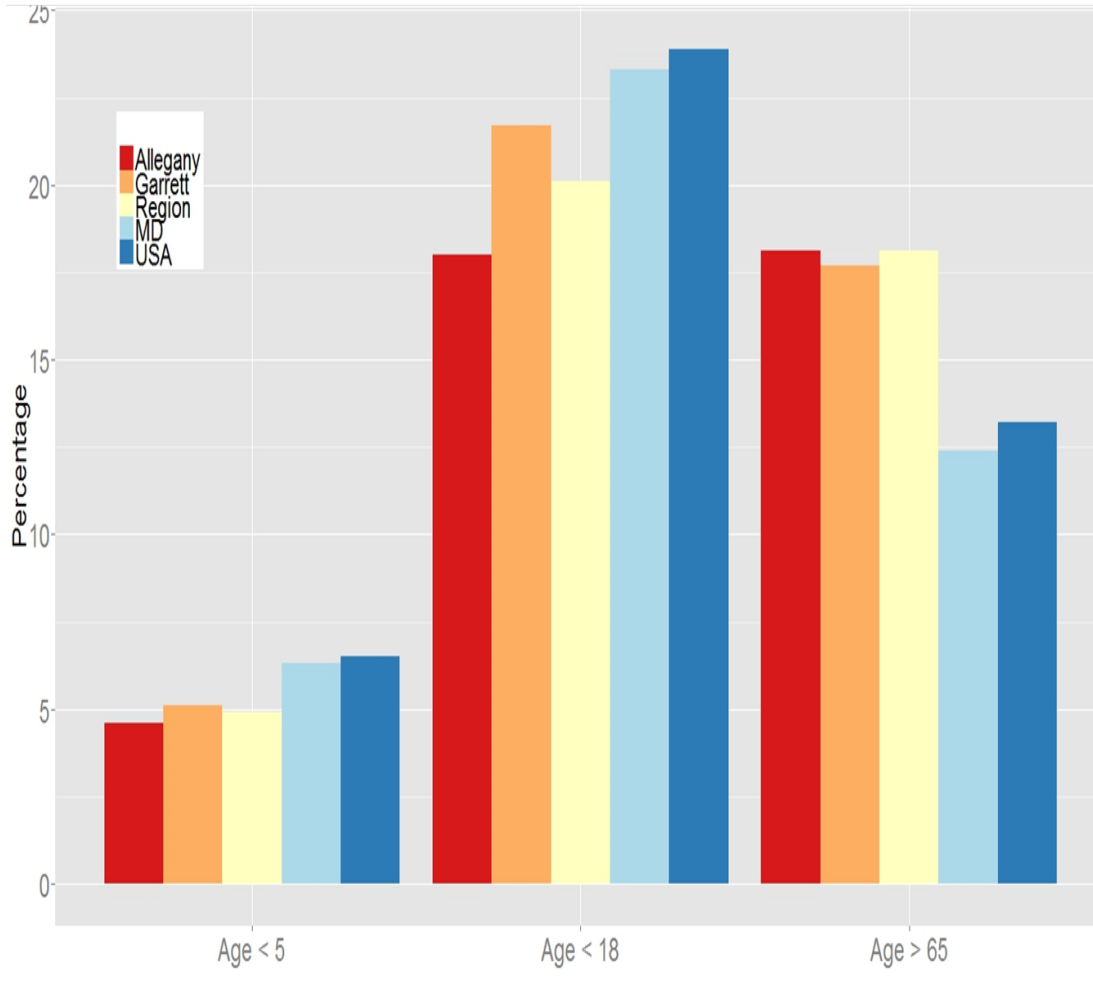


Demographics

BASELINE HEALTH ASSESSMENT



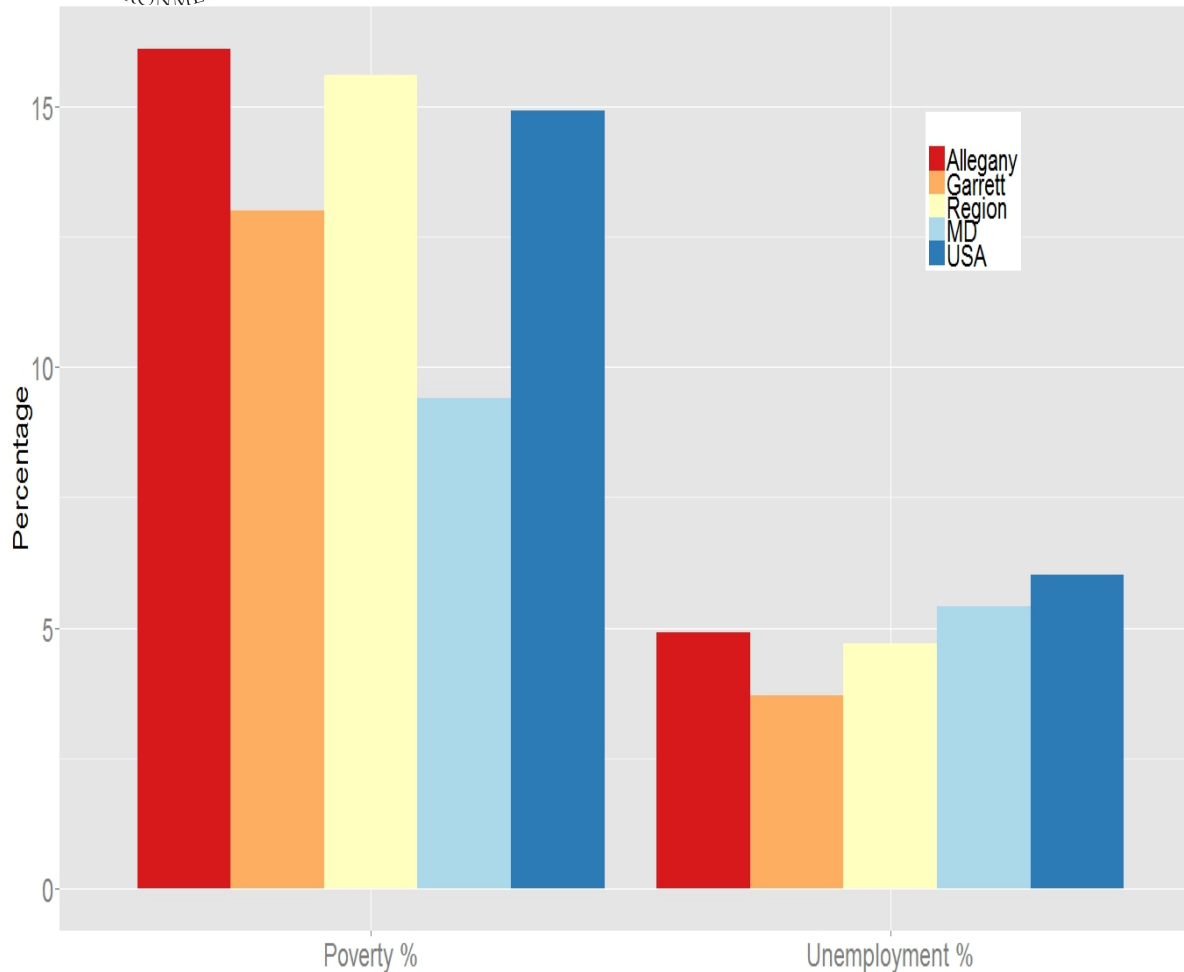
Age



- Higher elderly population in Garrett and Allegany counties compared to state and nation
- Elderly residents may be more vulnerable to exposure to chemicals in air and water due to compromised immune systems and comorbidities
- Children also have potential health risks because their immune systems are still developing and have higher breathing rates than other age groups
- Elderly populations and children should be viewed as sensitive human receptors



Socioeconomic Status



- Over 15% of the population in Allegany County is below the federal poverty level.
- Individuals in poverty may have access to fewer resources such as insurance and health care, higher exposure to social stressors, and may not have opportunity to move away from industrial pollution sources.
- Also, pollution sources tend to concentrate in poor communities leading to disparities in burden and exposure.

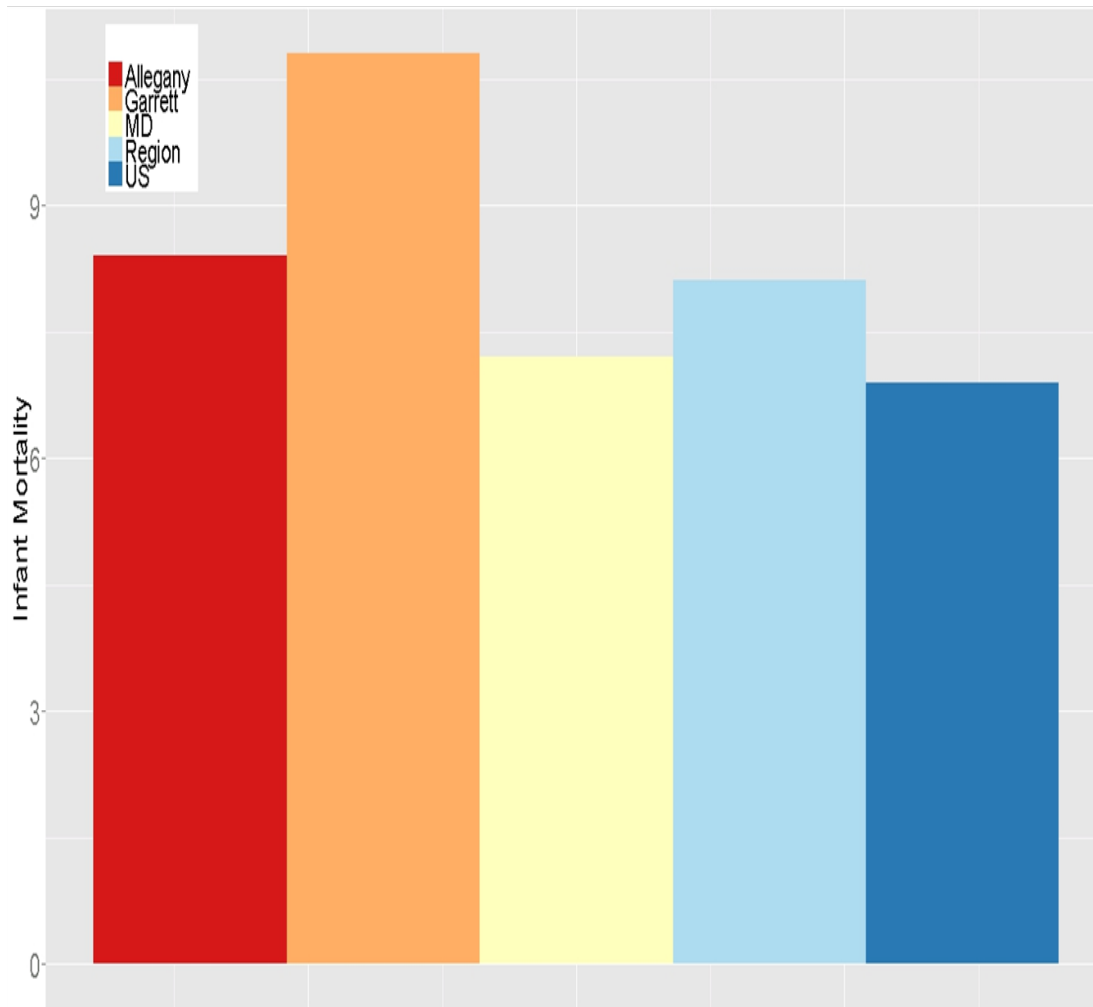


Health

BASELINE HEALTH ASSESSMENT



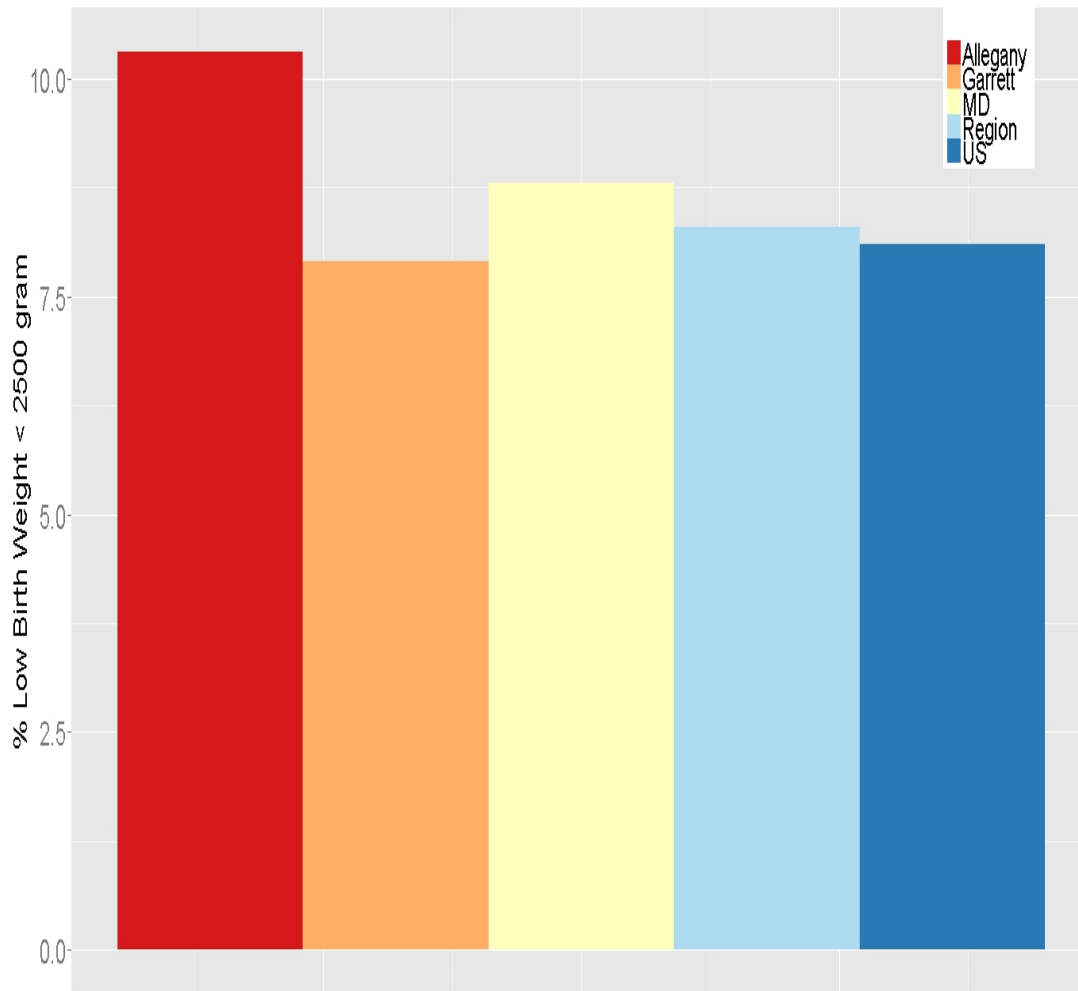
Infant Mortality (2006-2010)



- Infant mortality rates of 8.4 (Allegany) and 10.8 (Garrett) are higher than the rates for the region, MD, and US
- Previous research has shown a relationship between exposure to air pollution including traffic related pollution and infant mortality
- Increase in social stressors related to UNGDP could have an impact on maternal stress and infant mortality



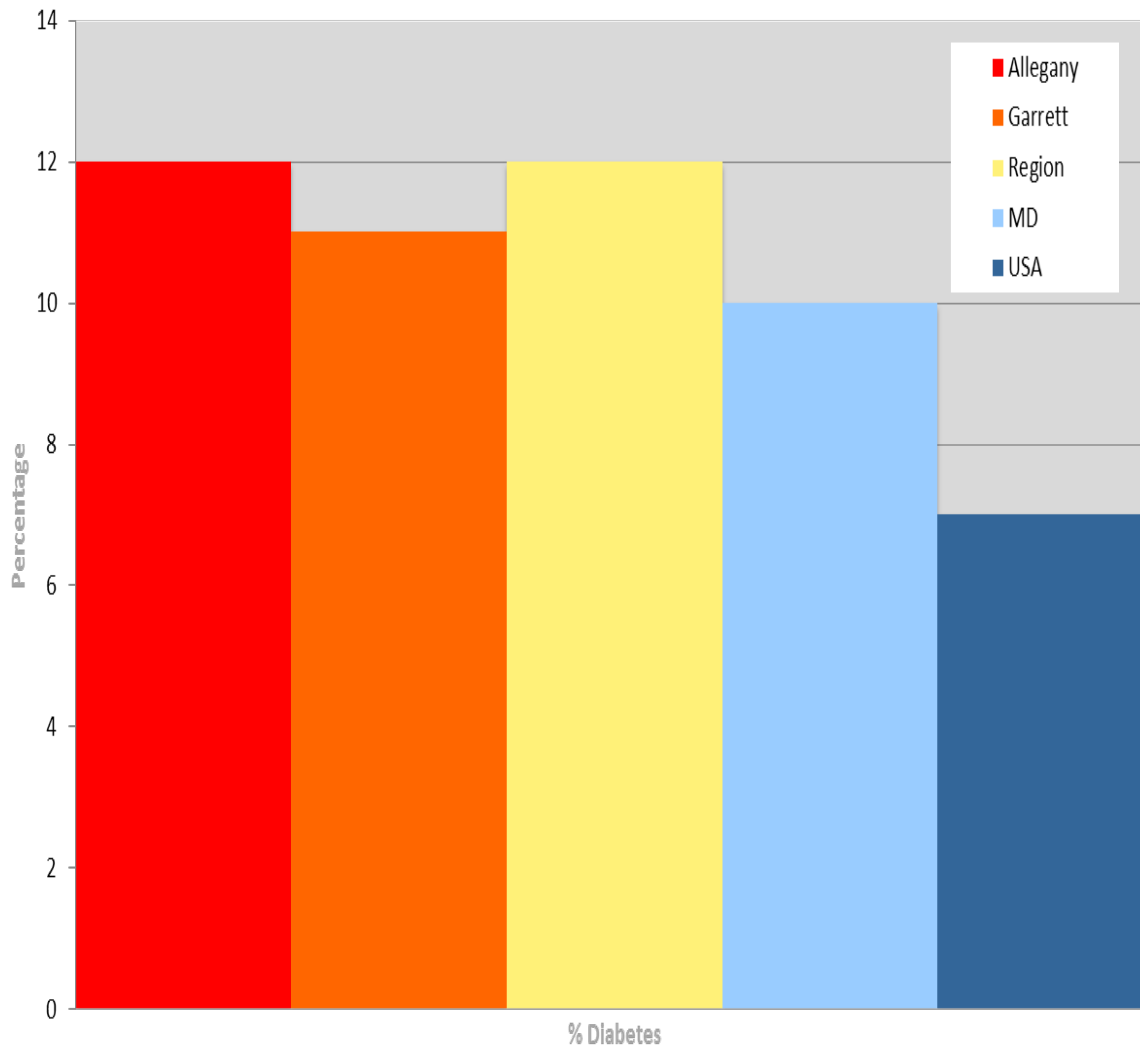
Low Birth Weight (2006-2012)



- Percentage of babies born with low birth weight (LBW) in Allegany (>10%) was higher than % low birth weight for Garrett, MD, region, and US
- Previous research has shown an association between exposure to air pollution including traffic-related air pollution and birth weight
- Air pollution emitted from UNGDP activities including truck traffic could increase this problem in counties of concern



Diabetes (2010)



- Percent with diabetes in Allegany (12%) is higher than the diabetes rate in Garrett (11.3), MD (9.7%), and the US (7%)
- Previous research has explored the link between exposure to particulate matter and risk of diabetes
- Individuals with diabetes are a population of concern due to access to resources including medical care



Cancer Rates in Allegany County, Garrett County, Maryland, and the Region (MD, WV, PA)

Cancer type	Allegany County Incidence Rate (95% CI)	Garrett County Incidence Rate (95% CI)	Maryland Incidence Rate (95% CI)	Region (MD, WV, PA) Incidence Rate (95% CI)
Non-Hodgkin's Lymphoma	23.6 (19.4, 28.6)	20.5 (14.7, 28.1)	17.8 (17.3, 18.3)	16.2 (12.6, 20.5)
Leukemia	16.2 (12.6, 20.5)	9.1 (5.2, 14.9)	11.2 (10.8, 11.6)	13.3 (9.4, 18.3)
Melanoma	17.1 (13.4, 21.6)	16.3 (10.7, 23.8)	21.2 (20.6, 21.7)	17.1 (12.5, 23.0)
Breast Cancer	114.0 (100.7, 128.8)	118.9 (98.0, 143.3)	128.0 (126.2, 129.7)	111.8 (92.0, 136.2)
Prostate Cancer	146.6 (131.3, 163.4)	113.3 (93.1, 137.0)	157.2 (155.0, 159.3)	137.8 (115.3, 164.7)
Bladder Cancer	20.1 (16.4, 24.4)	21.6 (15.5, 29.6)	19.2 (18.7, 19.7)	24.7 (19.4, 31.4)
Colorectal Cancer	52.1 (45.9, 59.0)	43.1 (34.2, 53.7)	41.5 (40.7, 42.2)	50.3 (40.6, 62.3)



IMPACT ASSESSMENT

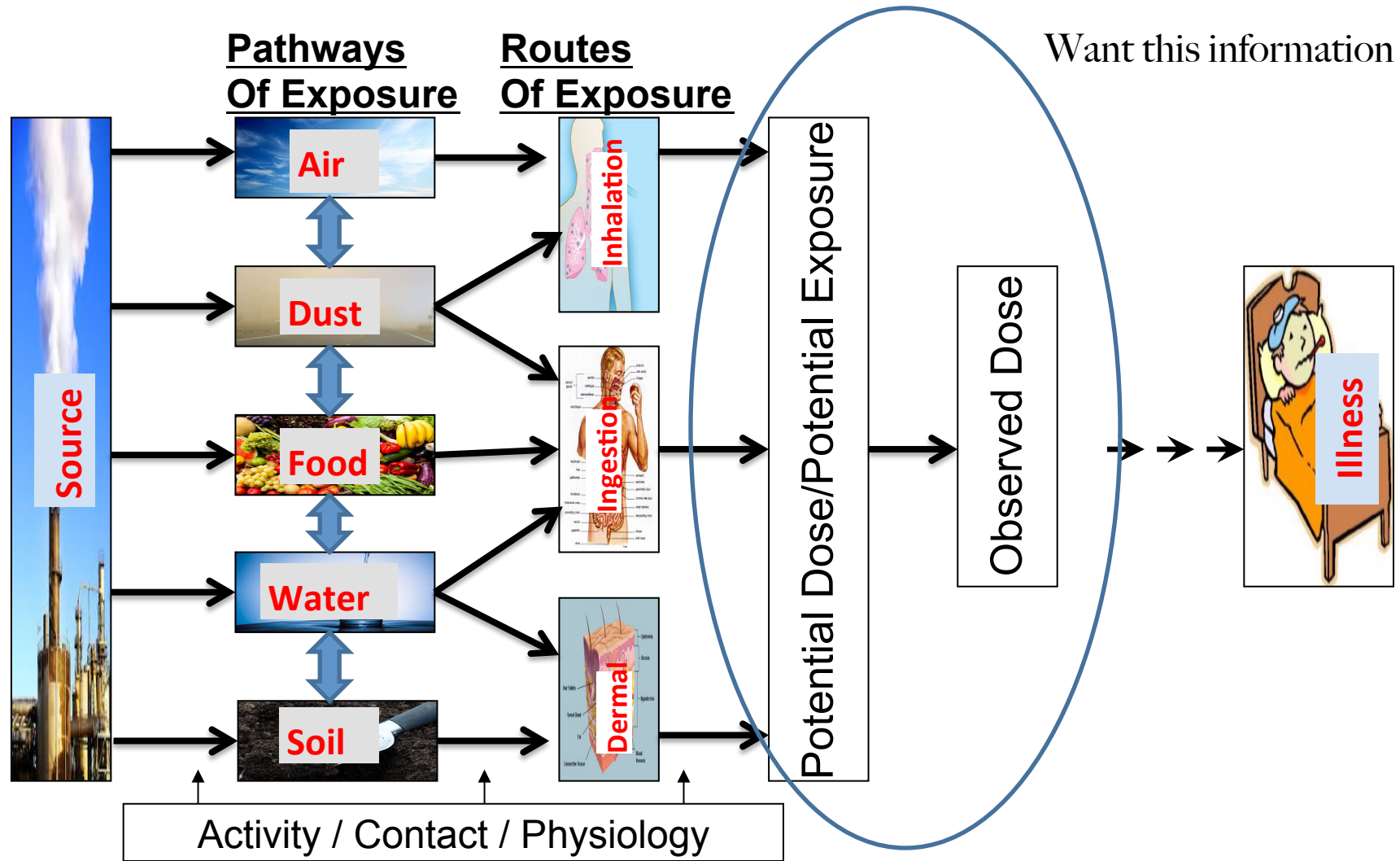


Impact Assessment

- 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: Key Points

Exposure

- Dose makes the poison
 - Concentration of agent in the environment
 - Frequency of exposure
 - Duration of exposure
 - Carcinogens: non-threshold
 - Non-carcinogens: Threshold
-



Impact Assessment: Key Points

Health Effects

- Acute vs Chronic outcomes
 - Gap in time between when exposure happens and when you get sick
 - Duration of epidemiological studies >3-5 years, additional 1-2 years for publication of results in peer-reviewed journals
 - Absence of investigation/Absence of data \neq absence of risk or harm
-



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: Methodology

- 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: Methodology

– Likelihood of health effects

- Unlikely (1): Little/no evidence that exposure is related to adverse health outcomes.
- Possible (2): Evidence in other settings 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: Methodology

– Geographic extent

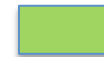
- Localized (1): Effects restricted to immediate vicinity
- Community-wide (2): Effects not restricted to immediate vicinity

– Effectiveness of Setback

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

– Public Health Impact

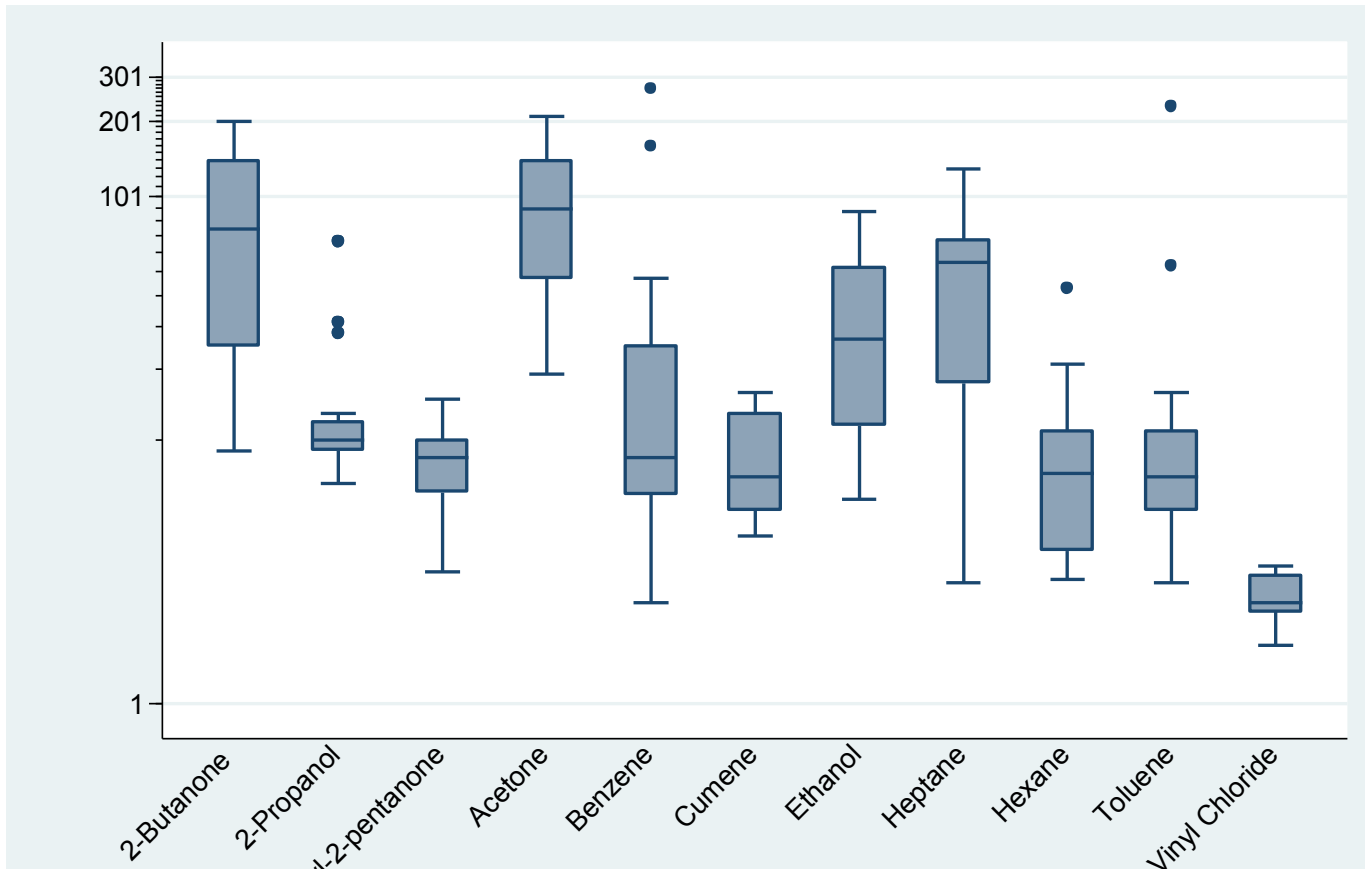
- No-Low: Impact received a score of 6-9
- Medium: Impact received a score of 10-14
- High: Impact received a score of 15-17





Impact Assessment: Air Quality

VOC Results from WVA



Data Source: Dr. Michael McCaskey. 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 considerably 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 UNG-Development and Production associated air pollution possibly related to adverse birth outcome (congenital heart defects, neural tube defects)
-



Evaluation: Air Quality

Evaluation Criteria	Score	
Vulnerable populations	2	Disproportionately affects vulnerable population (living near site, w/o mineral rights)
Duration of exposure	3	Will last >1 year, particularly related to flaring, compressor stations
Frequency of exposure	2	Continuous exposure
Likelihood of health effects	3	Air pollutants that are associated with UNGDP are known to have negative health effects in other settings.
Magnitude/severity of health effects	3	Resulting adverse health effects can be chronic, and irreversible
Geographic extent	1	Adverse effects more prevalent in the close proximity to source
Effectiveness of Setback	1	Effective setback distance can minimize exposure
Overall Score	15	
Hazard Rank	H	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 is a major issue because 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 concentrations in drinking water wells located in active drilling areas of PA were 17x higher than those located >1km away (Osborn et al 2011). Separate study with co-authors from oil/gas industry concluded that methane contamination primarily related to groundwater geochemistry, NOT shale gas recovery. (Molofsky et al 2013)
 - Despite evidence of human exposures, dearth of information linking it with human health
 - Issue of lag time between exposure and disease
-



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

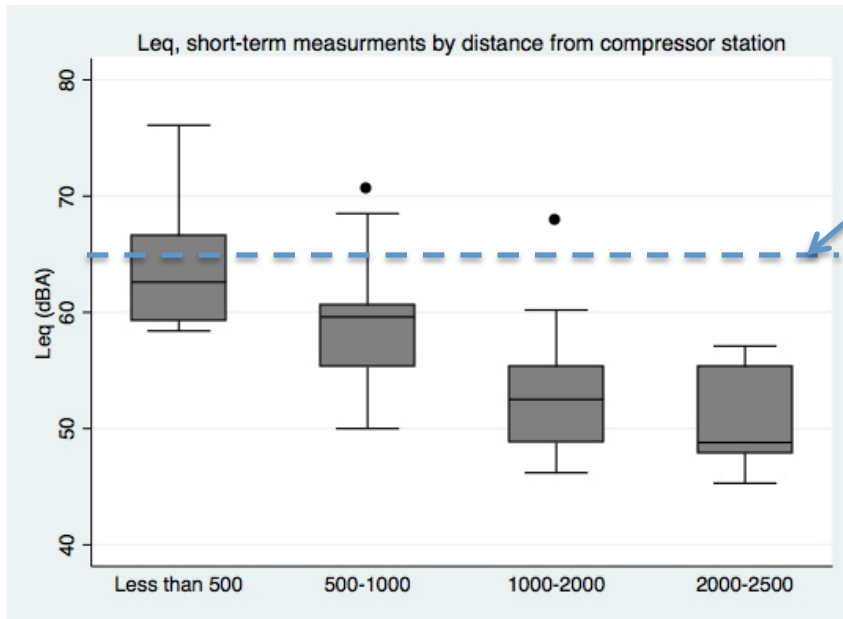
Naturally Occurring Radioactive Materials (NORM)

- 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

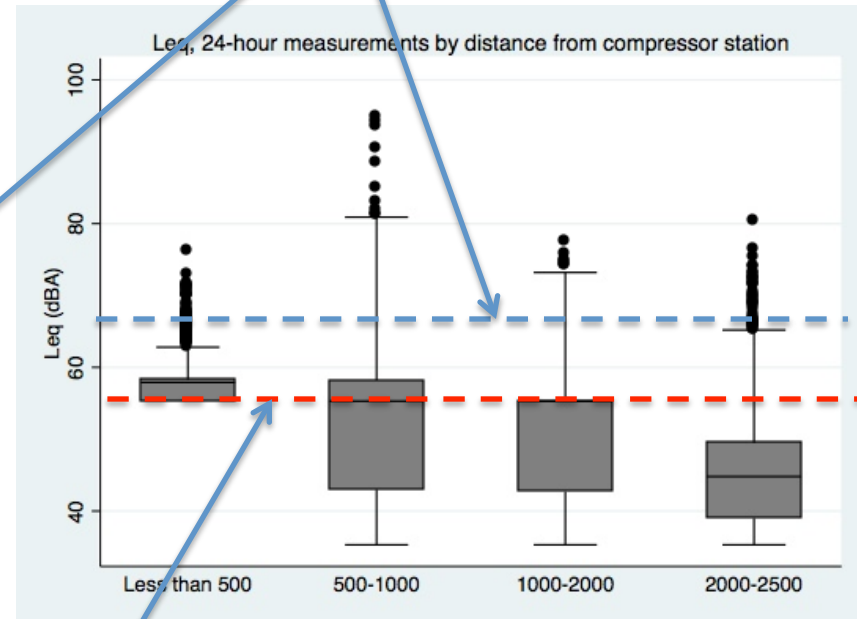
Short Term Daytime Noise Level (20 min)



Distance in Feet

MD Daytime Standard (65 dBA)

24-hr Noise Level



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: Earthquakes

- Wastewater disposal thorough deep injection well is known to be associated with larger earthquakes
 - Majority of earthquakes associated with UNG-Development are relatively small ($< M_3$)
 - It remains unclear if the underground stress associated with UNG-Development and Production activities is cumulative over space and time, and if it can result in earthquakes of much larger magnitude years/decades later
-



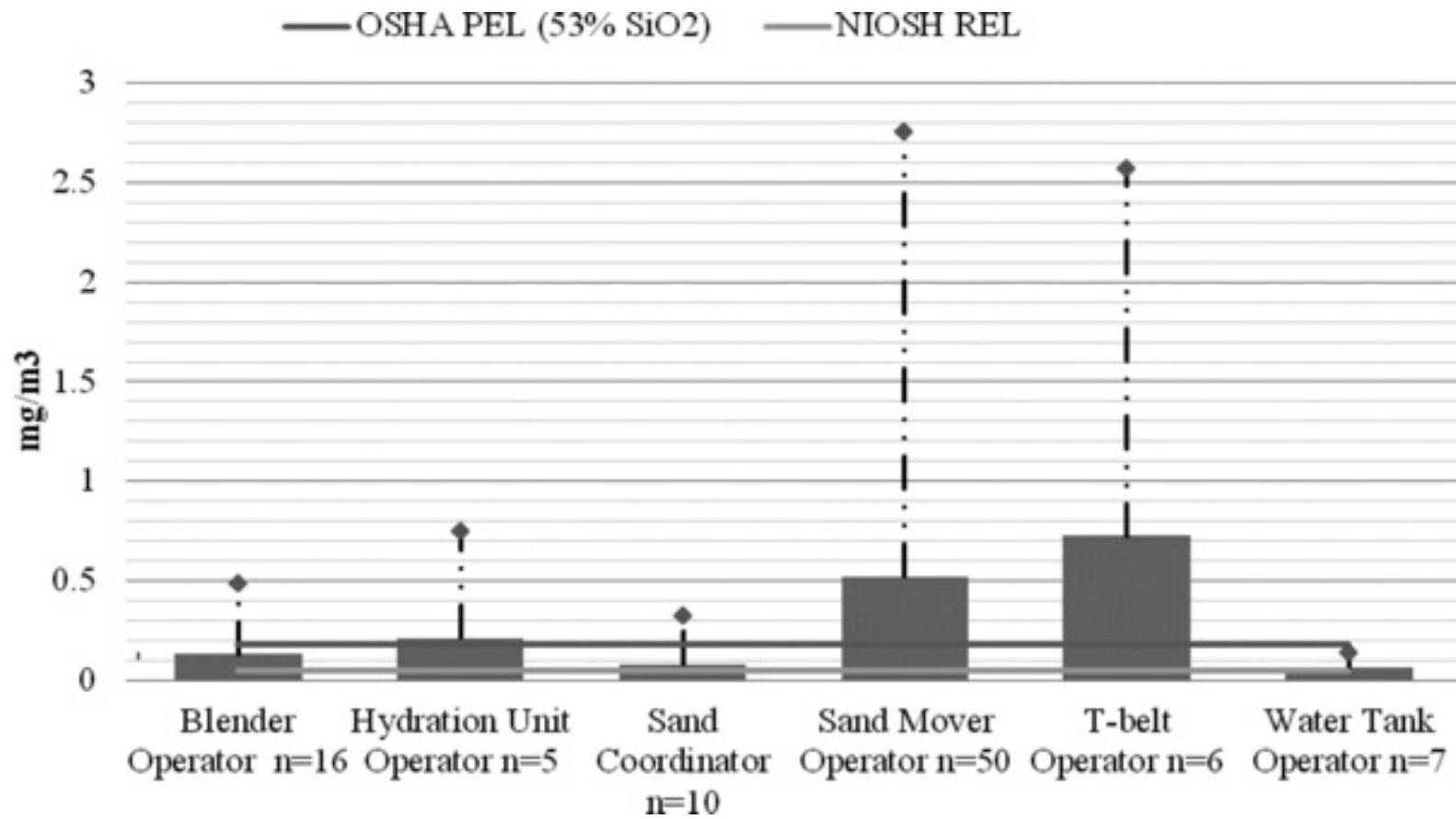
Impact Assessment: Public Safety

- 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

UN GDP Worker Exposure to Crystalline Silica





Impact Assessment: Occupational Health

- Exposure to Crystalline Silica is known to cause silicosis and lung cancer.
- In addition to silica, worker exposure 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 the increase in workforce and their 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
 - Increase in health care utilization, regardless of insured or uninsured workforce, would strain the 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

- Traditional approach: single chemical agent → particular health outcome
 - Not sufficient because community exposure does not take place in vacuum.
 - Cumulative Exposure/Risk is an emerging field:
 - Science policy tool that helps to organize/analyze information to examine, characterize, and possibly quantify combined threats from multiple stressors.
-



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

Production/Flowback 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

Public Safety

Evaluation Criteria	Score
Vulnerable populations	2
Duration of exposure	2
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

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



Hazard Evaluation

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



RECOMMENDATIONS



Recommendations: CGDP

- Comprehensive Gas Development Plans
 - Require assessment of air quality and other potential health impacts and propose mitigation strategies
 - Require assessment of whether standard setback will be adequate to protect public health including consideration of prevailing winds and topography
 - Require chemical disclosure
 - In the CGDP prior to the public hearing, rather than at the permitting of individual wells
 - Implement other provisions MDE revised disclosure plan using FracFocus
 - Require disclosure of proppants and use of engineered nanomaterials
 - Require that presence of trade secret materials be acknowledged in disclosure to FracFocus
-



Recommendations: CGDP

- Require a quality assurance plan
 - Require an air, water, and soil monitoring plan
 - Require assessment of impact on and monitoring of existing and historic gas wells within the fractured area for potential fugitive emissions
 - Require that all UNGDP materials and wastes should be stored in closed tanks, open pits shall only be used to store fresh water
-



Recommendations: Air Quality

- Require emission permit from MDE for each well pad
 - Require minimal setback distance of 2000 feet from well pads and from compressor stations not using electric motors
 - Require electrically powered motors wherever possible to reduce VOCs and PAHs emissions from drilling equipment and compressors. Do not permit use of unprocessed natural gas to power equipment.
-



Recommendations: Air Quality

- Require all trucks transporting dirt, drilling cuttings to be covered
 - Require storage tanks meeting EPA 2013 standards for all material other than fresh water to minimize VOC emissions
 - Establish a panel consisting of community residents and industry personnel to actively address complaints regarding odor.
-



Recommendations: Air Quality

- Air Quality Monitoring
 - Initiate air monitoring to evaluate impact of all phases of NGDP on local air quality (baseline, development and production)
 - Conduct source apportionment that allows NGDP signal to be separated from the local and regional sources
 - Air monitoring should be conducted with active input from community members in planning, execution, and evaluation of monitoring.
 - Air monitoring should capture both acute and chronic exposures, particularly short term peak exposures.
 - Expectations about what is achievable through air monitoring should be clearly communicated to community members.
-



Recommendations: Flowback – Production Water Related

Water & Soil Quality

- Prohibit well pads within watersheds of drinking water reservoirs
 - Implement UMCES-AL/MDE water monitoring plan. Require monitoring of water quality during initial gas production and at regular intervals thereafter.
 - Require recycling of 100% of fracking fluids, implement “Green Completion”
 - Require identification and monitoring of “signature” chemicals in fracking fluids to allow for future identification of ground water infiltration/contamination
 - Conduct soil monitoring in areas potentially impacted by UNGD upset conditions
 - Wastewater or brine should not be used to suppress road dust or to de-ice roads
-



Recommendations: Flowback – Production Water Related

NORM

- Research should be conducted to identify the appropriate suite of priority radionuclides for assessment of radiological activity.
 - In the meantime, metrics such as total alpha activity, or total gamma activity should be used to assess radiological contamination and support decision-making.
 - Prohibit use of flowback brines for purposes of road de-icing and other types of land/surface applications
-



Recommendations: Noise

- 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
 - 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.
 - Establish a system to actively address noise complaints
-



Recommendations: Earthquakes

- Collect baseline data on seismic activities that can record earthquakes smaller than magnitude 3.
 - Restrict issuing UIC Class II permits for disposal of UNGDP fluids until licensing requirements adequately addresses earthquake risk.
 - 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.
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Recommendations: Public Safety

- Increase state and local highway patrols to closely monitor truck traffic subject to the Oilfield Exemption from highway safety rules.
 - Empower local communities to control truck speed and traffic patterns.
 - Route truck traffic to maintain separation between UNGD activities and the public (such as, avoid trucking during school bus transport).
 - Consider use of pipelines to move UNGDP fluids between sites.
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Recommendations: Occupational Health

- Require implementation of NIOSH and OSHA recommended controls for silica exposure in UNGD operations.
 - Provide MOSH with resources to regularly inspect UNGD workplaces and monitor worker exposures.
 - Establish community outreach programs to help the transient workers feel more welcome in the community as a means of reducing rates of depression, suicide, and drug use.
 - Require employers to provide employee assistance programs including counseling and substance abuse treatment.
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Recommendations: Health Care Infrastructure

- Closely monitor whether prospective UNGDP companies provide adequate health insurance coverage for all employees
 - Review and monitor county-level tax revenues and assess improvements necessary to meet increased services need.
 - Organize local health care forum with key stakeholders to assess health care services and anticipated needs related to UNGDP
 - Establish committee of UNGDP officials and local providers and residents for early identification of impacts to health care infrastructure
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Recommendations: Health Care Infrastructure

- Consider health infrastructure as a high level priority when appropriating local government revenues derived from UNGDP and engage in long-term planning.
 - Inform and train emergency and medical personnel on specific medical needs of UNGDP workforce
 - Establish a panel of state and local experts to review health care infrastructure access, with attention to emergency & trauma care, vulnerable populations
 - Initiate monitoring of UNGDP healthcare -related costs
 - Initiate ongoing monitoring of health services use by collecting information on patients' occupational status
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Recommendations: Cumulative Exposure/Risk

- In addition to the recommendations identified for individual hazards:
 - Enact a Surface Owners Protection Act as recommended in the MDE Part I report.
 - Engage local communities in monitoring and ensuring that setback distances are properly implemented
 - Create maps using buffer zones (setback distance) to identify specific areas where fracking should be restricted (homes, churches, schools, hospitals, daycare centers, parks, recreational water bodies)
 - Make this mapping tool publically available for community members.
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LIMITATIONS



Limitations

- Limited monitoring data available from other states with a particular lack of before/after comparisons.
 - Significant data gap related to personal exposure resulting from UNGDP
 - Epidemiological investigations looking at health outcomes extremely limited
 - Baseline health assessment did not include health survey for population of concern
 - Exposure assessment, except for small noise survey, was not part of this process.
 - Quantitative health risk assessment and comprehensive cumulative risk assessment were beyond the data and time resources available.
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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
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