

Departmental Responses to Comments Received from Peer Reviewers on Maryland’s Marcellus Shale Risk Assessment

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Comments from the Natural Resources Defense Council

Introduction

These comments present the Natural Resources Defense Council's (NRDC's) comments on and recommendations for improving Maryland's "Assessment of Risks from Unconventional Gas Well Development in the Marcellus Shale of Western Maryland," dated October 2014 (hereinafter referred to as "Risk Assessment").¹

In 2011, Governor O'Malley's Executive Order 01.01.2011.11 established Maryland's Marcellus Shale Safe Drilling Initiative. An Advisory Commission was established to assist state policymakers and regulators in determining whether, and if so how, gas production from the Marcellus Shale could be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment, and natural resources.

The Executive Order directed that a three part study be conducted to examine whether gas production can be accomplished without unacceptable risk, including: Part I (recommendations regarding sources of revenue and standards of liability for damages caused by gas exploration and production), Part II (recommendations for best practices for all aspects of natural gas exploration and production in the Marcellus Shale in Maryland);² and, Part III (recommendations regarding the potential impact of Marcellus Shale drilling in Maryland). NRDC provides comments on this Part III study (Maryland's Marcellus Shale Risk Assessment).

A substantial portion of Maryland's Marcellus Shale Risk Assessment relies on the work completed by New York State for its Marcellus Shale Environmental Impact Statement. Maryland cites the *New York State Revised Draft Supplemental Generic Environmental Impact Statement (RDSGEIS)* as a primary reference used in developing Maryland's Marcellus Shale Risk Assessment.³ NRDC has been an active participant in the scientific and technical review of NYS's RDSGEIS.

While NRDC supported some of the technical and scientific work completed in the NYS's RDSGEIS, NRDC provided New York State with extensive, detailed, technical, scientific, and regulatory recommendations to improve the NYS (RDSGEIS) and its Revised Proposed Regulations for High-Volume Hydraulic Fracturing (Revised Proposed Express Terms 6 NYCRR Parts 52, 190, 550-556, 560 and 750). In sum, NRDC has recommended New York State continue the Marcellus Shale drilling moratorium until potential health impacts and the extent to which they can be mitigated can be more fully understood. NRDC provides a complete set of recommendations made to New York State as appendices to these comments (Appendices A-C), and recommends Maryland consider these best practices, while maintaining a moratorium on new hydraulic fracturing to permit the science regarding health impacts to more fully mature.

¹ Assessment of Risks from Unconventional Gas Well Development in the Marcellus Shale of Western Maryland, prepared by Maryland Department of the Environment and Maryland Department of Natural Resources, October 2014.

² Marcellus Shale Safe Drilling Initiative Study, Part II, Interim Final Best Practices, prepared by Maryland Department of the Environment and Maryland Department of Natural Resources, July 2014.

³ Maryland Risk Assessment, October 2014, Executive Summary, Page 4.

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Although Maryland identified a number of best practice mitigation measures that would be useful for reducing Marcellus shale gas exploration and production risk in Phase II of Maryland's Marcellus Shale

Safe Drilling Initiative Study,⁴ and adopted some of the mitigation measures and planning assumptions proposed by New York State, there are additional mitigations proposed in Maryland's Public Health Impacts Study and in NRDC's comments (herein) that have not been incorporated.

Best practices identified by Maryland have not yet been incorporated into regulation (and therefore are not guaranteed). Incorporation of these additional best practices will reduce risk. But the question remains: "Will these best practices reduce the risk below an "unacceptable" level?"

Best practices will not eliminate human health risk to Maryland residents because high-volume, hydraulic fracturing is not risk-free, accidents happen, human error is inevitable, and there is no guarantee these practices will be used or be effective in all cases. Nor is there any guarantee that there will be adequate regulatory resources appropriated to ensure that any practices promulgated as regulations will be properly implemented or enforced.

Maryland's public identified a number of major concerns with the proposed Marcellus Shale exploration and development, including impacts to: (1) agriculture, (2) education and schools, (3) environmental protection, (4) housing availability and values, (5) infrastructure and investment, (6) economic and fiscal sustainability, and (7) property rights.⁵ However, the Risk Assessment and Public Health Impacts Study, combined, only addressed two of the seven major topics (e.g., agriculture, education and schools, and environmental protection). Neither the Risk Assessment nor the Public Health Impacts Study (discussed below) answered the question: "are impacts to agriculture, housing availability and values, infrastructure and investment, economic and fiscal sustainability, and property rights unacceptable?"

Maryland's recently issued "Potential Public Health Impacts of Natural Gas Development and Production in the Marcellus Shale in Western Maryland," dated July 2014 (hereinafter referred to as "Public Health Impacts Study"),⁶ concluded there was a substantially higher risk associated with Unconventional Natural Gas Development and Production (UNGDP) than found in the Risk Assessment. The Public Health Impacts Study found a:

⁴ Maryland Department of the Environment, Part II of the Marcellus Shale Safe Drilling Initiative Study (Best Practices for Gas Production in the Marcellus Shale in Maryland), July 11, 2014.

⁵ Regional Economic Studies Institute, Towson University, Maryland, Impact Analysis of the Marcellus Shale Safe Drilling Initiative, Prepared for the Maryland Department of the Environment, May 23, 2014.

⁶ Potential Public Health Impacts of Natural Gas Development and Production in the Marcellus Shale in Western Maryland, Maryland Institute for Applied Environmental Health School of Public Health, University of Maryland, College Park, July 2014, Page xx.

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- **High Likelihood** that changes in air quality will have a negative impact on public health in Garrett and Allegany Counties (areas likely for potential Marcellus Shale Gas Exploration and Development);
- **High Likelihood** of adverse occupational health outcomes (while Marcellus Shale exploration and development will bring the possibility of new jobs, those who work these jobs are at greater risk of harmful occupational exposures than many other industries in Maryland);
- **High Likelihood** of adverse impacts to the healthcare infrastructure (due to expected increase in long-term migrant workers relative to population size);
- **Moderately High Likelihood** of negative impacts on water and soil quality, especially because of the larger fraction of the populations relying on well water in the potentially affected regions;

- **Moderately High Likelihood** of adverse impacts from Naturally Occurring Radioactive Material (NORM);
- **Moderately High Likelihood** of adverse impacts from industrial noise on public health;
- **Moderately High Likelihood** of adverse impacts on the social determinants of health (e.g., increased accidents and fatalities due to increased industrial traffic, increases in violent crime, other crimes, sexually transmitted diseases, mental health problems, and substance abuse);
- **Moderately High Likelihood** of net negative impact to the cumulative exposure/risk (concluding that: “significant evidence suggests that disadvantaged communities are disproportionately exposed and are more vulnerable to the effect of these hazards. Based on this, it is reasonable to assume that the combined effect of UNGDP related hazards described in this report may be higher than the simple sum, and that the impact will be more pronounced in disadvantaged communities and will be disproportionately felt by vulnerable subpopulations such as property owners without mineral rights, elderly, children, and individuals with preexisting diseases”).

There is some overlap between the Risk Assessment and the Public Health Impacts Study topics. The Risk Assessment and Public Health Impacts Study both addressed air quality, water and soil quality, NORM, and noise impact. However, the Risk Assessment concluded there was a lower risk and impact in almost every category than found by the Public Health Impacts Study. And the Public Health Impacts Study (in most cases) recommended a longer list of best management practices to mitigate risk than are listed in the Risk Assessment for those same topics. The Risk Assessment differs in that it never reaches a conclusion about whether there will be “unacceptable risks” to air quality, water and soil quality, and human health.

Overall, NRDC finds the Risk Assessment underestimates short-term, long-term, and cumulative risks and consequences (including human health impacts) of Marcellus Shale exploration and development in Maryland. Risk and consequences are both born by the public, while the economic benefit of Marcellus gas production will largely benefit corporate interests. NRDC

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also finds the Risk Assessment does not meet its stated objective of determining whether there will be “unacceptable risks.”

NRDC also finds the Risk Assessment did not adequately address financial risk. Maryland's Phase I and II Study work recommends improvements in taxation and financial assurance (bond and liability insurance), and the possibility of enacting a law creating a rebuttable presumption radius around Marcellus Shale exploration and production activities. These requirements are not, however, currently bound by statute or regulation, and may be insufficient to address short-term, long-term, and cumulative impacts that may occur to humans and the natural environment, despite Maryland's best efforts. For example,

“...The Departments considered, but ultimately did not recommend, the option of imposing strict liability on permittees for damages caused to non-surface owners and surface owners under whose land no drilling is done (so-called “innocent bystanders”). Some Commissioners strongly prefer to see such a recommendation, noting their view that hydraulic fracturing is an “abnormally dangerous activity” subject to strict liability. Some other Commissioners strongly oppose this.”⁷

Therefore, “innocent bystanders” suffering adverse impacts from shale gas development in Maryland are left to fight gas corporations in court to seek remedies to protect their health and welfare, and/or fund medical remedies to alleviate health consequences that may occur. These are “unacceptable risks” and “unacceptable consequences” for the affected public.

Maryland's study work confirmed the amount of taxes collected and financial assurance required is not sufficient to ensure the public remains whole today and in the future. There remains the risk that companies will have accidents that exceed Maryland's proposed financial assurance requirements, that exceed a company's insurance limits, or that companies may go bankrupt, requiring public taxpayer funds at a local, state, or federal level to remedy the damage. These are “unacceptable risks” and “unacceptable consequences” for the affected public.

In addition to carrying the burden of increased risk and consequences, the public may also be burdened with increased taxes required to increase police, emergency response, road repair, and address other potentially unfunded cost impacts to the community. While short-term increases in local income and potential increased tax base may offset some of that burden, in the long-term there remains substantial uncertainty about the potential human health impacts from unabated or unremediated air, water, and land pollution, and adverse impacts to property value and quality of life. In sum, these are “unacceptable risks” with little reward for the majority of the public. The public carries the burden of venturing into the unknown, and the potential for adverse human health consequences, with little upside. As explained in Maryland's Phase I study findings:

⁷ Maryland Department of the Environment, Part I of the Marcellus Shale Safe Drilling Initiative Study, December 2011, page E3.

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“...there are there are few meaningful remedies for those who do not own their mineral rights, but are nevertheless injured in some way by the activities.”⁸

“...there are few meaningful remedies for neighboring residents, landowners, or businesses whose lands are not directly involved in drilling, but who may incur damage....a patchwork of common law tort claims provides the main source of remedies for these injured parties. Availability of a remedy differs depending on the situation and even when an injury seems to fall within one of the recognized torts, certain elements may be difficult for the injured party to prove under the circumstances.”

Therefore, despite the best efforts of responsible companies implementing best practices known today, high-volume, hydraulic fracturing is not risk-free, accidents happen, human error is inevitable. Best practices known today (at this early stage) may not be prove to be the best that they could be if additional time were taken to further understand the risks and refine technology.

The Risk Assessment attempts to assign risk probability using data from other gas development projects, however, the risk probability will be a function of actual experience and qualifications of personnel, and the actual age, condition, and maintenance of equipment used, and other reservoir and site specific factors that were not taken into account. The Risk Assessment does not provide a description or name companies interested in developing the Marcellus, therefore, the corporate risk was not evaluated.

The work complete by Maryland, thus far, is a good initial start. NRDC is impressed by the amount of research completed, and recommendations to adopt scientifically and technically sound best management practices. However, NRDC finds the Risk Assessment still needs work, and our comments make a number of recommendations for improvement.

In total, the study confirms there is insufficient technical and scientific data to confirm that human health risk and consequences to the public can be eliminated or managed to an acceptable level. Until Maryland can confidentially verify that human health risk and consequences to the public can be satisfactorily addressed, the risk of Marcellus Shale exploration and development in Maryland remains at an unacceptable level to the public. Therefore, NRDC recommends Maryland continue the Marcellus Shale drilling moratorium until potential health impacts and the extent to which they can be mitigated can be more fully understood.

⁸ Maryland Department of the Environment, Part I of the Marcellus Shale Safe Drilling Initiative Study, December 2011, page 19.

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Overall Recommendations

1. Definition of Unacceptable Risk. The stated primary objective of the Risk Assessment is to determine whether, and if so how, gas production from the Marcellus Shale in Maryland could be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment, and natural resources. Yet the term “unacceptable risk” is never defined. Remarkably, a report with a primary objective of assessing “unacceptable risks” only uses the term three places in the entire 241 page report. And, the risk assessment methodology (Executive Summary Pages 4-7) does not include methods designed to reach a conclusion about whether there are – or are not – “unacceptable risks.” Instead, the report assigns risk but never decides whether that risk is “unacceptable” to the public.

Risk and consequences are both born by the public, while the economic benefit of Marcellus gas production will largely benefit corporate interests. While the public carries the burden of increased risk and consequences, it may also be burdened with increased taxes required to increase police, emergency response, road repair, and address other potentially unfunded financial impacts to the community. Short-term increases in local income and potential increased tax base may offset some of that burden; however, in the long-term there is substantial uncertainty about the potential human health impacts that may occur from unabated or un-remediated air, water, and land pollution.

What may be an “acceptable” risk to a corporation is not likely “acceptable” to the public. This is especially true for the majority of the public that are not employed in the gas industry, or likely to benefit from lease sales, or other economic transactions, and who are weighted with the burden of increased risk and consequences. For example, the Risk Assessment does not answer what level of increased asthma, respiratory disease, cancer mortality, noise, visual impact, or water contamination (etc.) is “acceptable” for the majority of the public.

Recommendation: NRDC recommends the Risk Assessment:

- Define the term “unacceptable risk” and include that definition and a process to reach that conclusion in the Risk Methodology Section of the study (Executive Summary Pages 4-7).
- Define and assess “unacceptable risk” from the point of view of the majority of the public that are not likely to yield economically gain from Marcellus Shale exploration and development.
- Include a section on risk tolerance and acceptable risk. This section should and explain that “medium and high” risk probability and “moderate to serious” consequences are not acceptable risks for the public.
- Ensure each chapter arrives at a solid conclusion about whether the risk is or is not “unacceptable.”

Response: The purpose of the Departments’ risk assessment was never to determine what level of risk is acceptable or unacceptable. Specifically, the purpose of the risk assessment is stated “to provide a comprehensive risk evaluation for UGWD in the Marcellus Shale in Western Maryland. Specifically, risks are evaluated through a qualitative assessment of

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probability and consequence to achieve an overall risk ranking. This RA does not seek to determine a single aggregate risk evaluation for UGWD in Maryland. The RA findings are intended for consideration by the State of Maryland and the Marcellus Shale Advisory Commission to determine if UGWD can be conducted safely in Maryland with current proposed BMPs.”

- 2. Risk Reduction Analysis and Recommendation.** The Risk Assessment includes a mix of Best Management Practices (BMPs) that are included in Maryland and federal regulation and proposed BMPs (from Phase II of Maryland's work)⁹ that have not been included in regulation, but does not include many new recommendations to further reduce risk beyond those already identified. There is very little analysis of risk reduction that can be achieved through additional BMP adoption. In these comments, NRDC identifies additional BMPs that could further reduce risk that were not, but should be, examined. For example, the Risk Assessment did not evaluate use of larger setback distances to reduce risk, and instead only examined the setback distances previously proposed in Phase II.

Recommendation: The Risk Assessment should evaluate additional BMPs, beyond those identified by Maryland in Phase II, to further reduce risk.

Response: The Departments used the findings from this risk assessment to identify additional BMPs that help address the highest risk activities. All of the additional BMPs recommended can be found in the Departments' final draft report – see http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Final_Distribution_Draft_11.25.14.pdf.

- 3. Clarity Needed on Mitigation Already in Regulation vs. Proposed.** The Risk Assessment includes a mix of BMPs that are included in Maryland and federal regulation and proposed BMPs that have not been included in regulation. The Risk Assessment is not clear on which mitigation measures are already found in regulation and which are only at the proposal stage.

The Risk Assessment assumes all proposed BMPs will be implemented and enforced, and concludes (in most cases) that risk is low if BMPs are implemented. However, a substantial number of BMPs proposed for UNGDP including Marcellus Shale exploration and development are not included in current regulations and are not guaranteed or enforceable at this time.

Additionally, the Public Health Impact Study appears to have assumed all the BMPs proposed in the Best Practices Study would be implemented. If this is not the case, both the Risk Assessment and the Public Health Impacts Study baseline assumptions about BMPs need to be revised.

⁹ Maryland Department of the Environment, Part II of the Marcellus Shale Safe Drilling Initiative Study (Best Practices for Gas Production in the Marcellus Shale in Maryland), July 11, 2014.

¹⁰ Marcellus Shale Safe Drilling Initiative Study, Part II, Interim Final Best Practices, prepared by Maryland Department of the Environment and Maryland Department of Natural Resources, July 2014.

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Recommendation: Both the Risk Assessment and Public Health Impacts Study should more clearly explain which BMPs are included in Maryland and federal regulation and which are only at are only at the proposal stage. Both studies should clearly explain if they are recommending additional BMPs over those proposed in Maryland's Best Practices Study.¹⁰ The Risk Assessment should identify additional BMPs and make specific recommendations to further reduce risk.

Response: For existing regulations, citations to the appropriate section of the Code of Maryland Regulations (COMAR) have been added for clarity.

- 4. Best Management Practices Should Be Codified in Regulations.** Maryland identified a number of important BMPs; however, it has not yet amended its regulations to include the proposed BMPs. Nor has it provided funding to administer oversight, inspection, or enforcement of the proposed BMPs. For example, Maryland's Best Practices Study report states:

*Maryland regulations **could** be amended to reflect the new best practices or the new best practices **could** be required by provisions in an individual well permit.¹¹ [Emphasis added.]*

The Risk Assessment assumes all proposed BMPs will be implemented and enforced, and concludes (in most cases) that risk is low if BMPs are implemented. However, a substantial number of BMPs proposed for UNGDP are not included in current regulations and are not guaranteed or enforceable at this time. Instead, these BMPs are only listed as ones that "could" be required.

It has been NRDC's experience that a proposed BMP that has not yet been codified is only a proposed BMP, and is not a public guarantee of what will actually be required or enforced. While NRDC supports codification of all proposed BMPs if and when shale development proceeds, we anticipate industry opposition to some of the BMPs and a rigorous debate during the codification process. A Risk Assessment based on an uncertain BMP adoption and codification outcome is premature. For example, if some BMPs are not codified, the Risk Assessment findings would further underestimate the risk.

Without minimum requirements codified in regulations, the public is not assured that Maryland will adopt and enforce all the proposed BMPs and there is the potential for lower standards to be used on individual projects or permits without opportunity for public review. An updated regulatory framework provides operators with clear, consistent rules to work from; regulatory staff with simplified instructions for implementation; a public process for input; and a more orderly and safe exploration and development process for Maryland.

¹¹ Maryland's Interim Final Best Practices Study, July 2014, Page 2.

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Additionally, the Public Health Impact Study appears to have assumed all the BMPs proposed in the Best Practices Study would be implemented. If this is not the case, both the Risk Assessment and the Public Health Impact Study baseline assumptions about BMPs need to be revised.

Recommendation: The Risk Assessment should clearly state that it assumes both full implementation and full enforcement of all proposed BMPs. NRDC recommends Maryland formally include the proposed BMPs (and others recommended in our comments) in revised regulations, along with adequate funding to administer BMP oversight, inspection, and enforcement. The Risk Assessment should also make clear that Maryland would need to complete a revised Risk Assessment if it decides not to fully implement and enforce the proposed BMPs.

Response: The Executive Summary document clearly lays out the Departments' approach in determining BMP effectiveness in mitigating risks. This included a determination that some BMPs (i.e., voluntary and reporting requirements) may not be as effective as others in mitigating risks because they are more difficult to enforce or verify. The risk assessment was conducted with the assumption that current proposed BMPs are in effect and it is the Departments' intention to include those BMPs in regulation. As a result of the public process associated with rule making it is possible that some BMPs may change, which may or may not influence residual risk. The Departments will consider such potential changes to residual risks in any reconsideration of proposed BMPs.

- 5. Risk Assessment Underestimates Risk in Some Categories.** There are inconsistencies between Maryland's Public Health Impact Study and Risk Assessment conclusions. In general, the Risk Assessment underestimates the risk. For example, the Public Health Impact Study concluded UNGDP will negatively impact air quality and will have a negative impact on public health in Maryland (air quality was given a high hazard ranking); yet, the Risk Assessment generally concluded the air pollution risks were low to moderate for most pollutant impact categories.

Recommendation: NRDC recommends Maryland revise its Risk Assessment to include the higher risk findings documented in the Public Health Impact Study.

Response: The Public Health study conducted the risk assessment without Maryland's proposed BMPs in effect. Consequently the mitigating influence of Maryland's proposed BMPs was not considered and resulted in overall higher risk findings in the Public Health study.

- 6. Public Health Impact Study BMP Recommendations.** Maryland's Public Health Impact Study made a number of BMP recommendations to mitigate risk that were not including in the Risk Assessment because the studies were completed in parallel.

Recommendation: NRDC recommends Maryland revise its Risk Assessment to include BMPs recommended in the Public Health Impact Study.

Response: Maryland will consider these additional proposed BMPs for potential inclusion among Maryland's proposed practices.

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- 7. Include Additional BMP Recommendations Contained in these Comments.** Maryland identified a number of valuable BMPs that should be codified. NRDC has been closely following BMPs for UNGDP development, and throughout these comments has identified additional BMPs for inclusion. NRDC has also provided a complete set of our comments provided to New York State (NYS) on the same topic.

Recommendation: NRDC recommends Maryland consider inclusion of the additional BMPs listed in these comments to supplement those already identified by Maryland's study efforts.

Response: Maryland will consider these additional proposed BMPs for potential inclusion among Maryland's proposed practices.

- 8. Risk Ranking Methodology Underestimates Overall Risk.** Table 3 of the Risk Assessment¹² provides a color coded Risk Ranking Methodology formulation that underestimates overall risk. Table 3 assigns an overall risk ranking using the same "low," "moderate," and "high" risk definitions assigned in the risk probability Table 2. Yet, the definitions of "low," "moderate", and "high" risk defined in the risk probability (Table 2) cannot be the same as the definition of a combined, overall "low", "moderate", or "high" risk that considers **both** risk probability and consequence (Table 3).

Take for example a risk with a **low probability** (new gas pipeline weld failure), but a **serious consequence** such as a fire and explosion in a nearby neighborhood (where "serious consequence" is defined as a major adverse impact on people or the environment; could affect the health of persons in a large area; extensive or permanent environmental damage). Table 3 proposes to assign a low probability risk with a serious consequence an **overall "moderate" risk ranking**. Yet, an overall risk ranking of moderate underestimates the risk because it downgrades the potential consequence rating of "serious" to a "moderate" level; yet the consequence severity does not actually change even if the event probability is low. Therefore, it is not appropriate to downgrade the overall risk by combining an event probability with consequence severity.

¹² Maryland Risk Assessment, October 2014, Executive Summary, Page 7.

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Problems with the proposed overall risk ranking methodology (Table 3) is compounded by using the same nomenclature and definitions (low, medium and high) for both probability (Table 2) and overall risk (Table 3). If the Risk Assessment continues to show a combined overall risk, different nomenclature and definitions should be used to describe overall risk that takes into account risk probability and risk consequence. To achieve this end, we recommend use of the terms “acceptable risk” and “unacceptable risk” in Table 3 to describe the overall risk, instead of the terms low, medium and high. For example, the Table 3 matrix should list the term “unacceptable risk” in the red boxes where there is a medium or high risk probability and a moderate to serious consequence for that risk. This approach will aide Maryland in meeting its primary objective of identifying unacceptable risks.

Recommendation: The Risk Assessment should list risk probability and risk consequence and not attempt to combine an overall risk factor, unless that risk factor uses the highest risk element in that combination and reaches a conclusion about whether the risk is “unacceptable.” Table 3 should use the terms “acceptable risk” and “unacceptable risk” to describe the overall risk, instead of the terms low, medium and high.

Response: The Departments concur that combining the probability and consequence into an overall risk ranking does not accurately present the risk assessment findings. This problem is similar to mathematical averaging where wide variations in numerical ranges result in moderate average values. To address this problem, the Departments revised the overall risk assessment results presented in Appendix A to present both the probability and consequence findings while at the same time showing the overall risk assessment score using color-coding. This presentation format provides a much more accurate display of the risk assessment results.

The Departments do not agree that the purpose of the risk assessment is to determine which risks are “acceptable” or “unacceptable” but rather provide risk assessments details to higher level policy makers and elected officials in a position to make that determination.

9. **Risk Ranking Confidence Level.** The text of the Risk Assessment identified a number of risks where there was inadequate or incomplete information to assess the risk level. Yet the Risk Assessment did not include a risk ranking confidence level scale or make recommendations for securing improved data to increase the confidence interval.

Recommendation: The Risk Assessment would benefit from inclusion of a risk ranking confidence level scale of 1-5, or similar (such as the following), and by including a summary list of inadequate or incomplete information that needs to be obtained or further studied.

1. Very High confidence in the judgment based on a thorough knowledge of the issue, the very large quantity, and quality of the relevant data and totally consistent relevant assessments.
2. High confidence in the judgment based on a very large body of knowledge on the issue, the large quantity, and quality of the relevant data and very consistent relevant assessments.

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3. Moderate confidence in the judgment based on a considerable body of knowledge on the issue, the considerable quantity, and quality of relevant data and consistent relevant assessments.
4. Low confidence in the judgment based on a relatively small body of knowledge on the issue, the relatively small quantity, and quality of relevant data and somewhat consistent relevant assessments.
5. Very Low confidence in the judgment based on small to insignificant body of knowledge on the issue, quantity, and quality of relevant data and/or inconsistent relevant assessments.

Response: Estimates of confidence are typically statistically driven and since the risk assessment is qualitative there is no numeric basis to determine confidence levels. In addition, the risk assessment was performed assuming adherence to Maryland's proposed BMPs and establishes a framework whereby BMP effectiveness is factored into the risk ranking. By so doing, some level of confidence in the BMPs is inherent in the overall risk ranking. Lastly, the risk assessment has been revised to include a discussion of uncertainty to more clearly put the findings into context.

- 10. TOP Down Best Available Technology (BAT) Process.** Maryland's proposed BMPs include a "TOP Down BAT Process" for the control of air pollution. Maryland proposes:

The Department of the Environment intends to require top-down Best Available Technology (BAT) for the control of air emissions. This means that the applicant will be required to consider all available technology and implement BAT control technologies unless it can demonstrate that those control technologies are not feasible, are cost prohibitive or will not meaningfully reduce emissions from that component or piece of equipment. BAT emissions control technology will be mandatory for workovers. MDE will analyze top-down BAT demonstrations from applicants and approve the applicants BAT determination before a permit is issued. This builds on the EPA STAR program, and therefore a separate requirement to participate in this voluntary EPA program is not needed. MDE will also require a rigorous leak detection and repair program.

NRDC supports the use of a "TOP Down BAT Process"; however, it has been our experience that the outcome of such a process is highly dependent on how the regulator the terms "feasible" and "cost prohibitive."

Recommendation: NRDC recommends Maryland codify the "TOP Down BAT Process" in regulation and define the term feasible to mean all technology that is commercially available, and define the term cost prohibitive.

Response: Comment noted and will be considered as the Departments develop regulations.

- 11. Industrial Activity Level.** Both the Risk Assessment and the Public Health Impact Study assume a certain amount of industrial activity in the UNGDP (if approved). However, there is no certainty that the maximum industry activity levels assumed would not actually be exceeded, unless Maryland sets industrial activity level limitations. In some cases, the level

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of industrial activity was determined to pose increased risk and potential health impacts, and limitations on the peak amount of industrial activity in any one area could be an important mitigation measure that has not been included.

Recommendation: NRDC recommends Maryland set maximum allowable levels of activity that would prevent “unacceptable” risks.

Response: One of the most important BMPs Maryland is proposing is that companies submit Comprehensive Gas Development Plans prior to any Departmental approvals. This planning process is designed to ensure industry activity levels on the landscape are minimized by providing “an opportunity to address multiple aspects of shale gas development from a holistic, broad-scale planning perspective rather than a piecemeal, site-by-site basis. By considering the entire project scope of a single company, or multiple companies simultaneously, responsible energy development could proceed while minimizing public health conflicts and addressing concerns associated with maintaining the rural character of western Maryland and protecting high value natural resources and resource-based economies. To cite just one example, land disturbance could be minimized if infrastructure were shared or located within the same right-of-way.”

12. Prohibited Activities. Both the Risk Assessment and the Public Health Impact Study assume a certain amount of industrial activity in the UNGDP (if approved), and make assumptions about activities that might be prohibited. However, there is no certainty about the assumed prohibitions for the public until Maryland formalizes prohibitions. For example, both studies assume centralized impoundments would be prohibited, but this prohibition is not codified.

Recommendation: The Risk Assessment should clearly state that it assumes both full implementation and full enforcement of all proposed prohibitions. NRDC recommends Maryland codify a list of prohibited activities and uses to provide public confidence that these “unacceptable” risks are remedied and will be enforced. The Risk Assessment should also make clear that Maryland would need to complete a revised Risk Assessment if it decides not to fully implement those prohibitions.

Response: Maryland's intention is to codify any prohibitions in regulation.

13. Baseline Data Collection. Both the Risk Assessment and the Public Health Impact Study include assumptions about current baseline data. Additional baseline data collection is needed in the areas proposed for UNGDP before completing these study findings.

Recommendation: NRDC recommends the Risk Assessment include a summary list of baseline data that needs to be collected prior to completing the study.

Response: Current best practices require that 2-years of predevelopment baseline data be collected by companies prior to drilling at a site. Standard protocols for this monitoring will be developed to ensure proper information is collected consistently among sites.

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14. Chemical Use Limitations. Maryland has not set limits on the type of chemicals that can be used in hydraulic fracturing, drilling muds, or at gas drilling and production sites that are protective of human health and the environment (with the exception of diesel). Therefore, there is no assurance that the Risk Assessment is based on a representative set of chemicals that would actually be used, representing the worst case scenario or even a representative amount impacts/risk that would actually occur. For example, if hydraulic fracturing treatments are conducted in poorly constructed wells, there exists a potential for groundwater contamination. The use of safe treatment additives provides any extra layer of protection in the event that human error or mechanical malfunction creates a pathway for those additives to reach groundwater. Reducing the toxicity of chemical additives by listing prohibited additives mitigates the impact of both surface and groundwater pollution if it occurs.

Recommendation: NRDC recommends Maryland set chemical use limits and the Risk Assessment and the Public Health Impact Study be revised to incorporate those limits. Maryland should adopt a list of prohibited additives, and a list of non-toxic additives that are acceptable, with supporting toxicological data. The list of prohibited additives should be based on the known list of chemicals currently used and Maryland should institute a rigorous technical and scientific review process to evaluate newly proposed additives to determine if they should be added to the prohibited list.

In addition to a list of prohibited chemicals, Maryland should develop a list of recommended and approved additives that have been scientifically and technically reviewed by the state and confirmed to pose little or no risk to human health or the environment. This list would provide industry with a simplified list of chemicals for use. Any chemical not found on this list, or on the list of prohibited chemicals, could be proposed by industry for future use. New chemicals should be subject to an in-depth scientific and technical justification and risk assessment review process before being added to the approved chemical list for Maryland.

No chemical should be used until Maryland has assessed whether it is protective of human health and the environment, and has determined whether it warrants inclusion on the list of prohibited additives. The burden of proof should be on industry to demonstrate, via scientific and technical data and analysis, and risk assessment work, that the chemical is safe.

Response: Maryland's proposed best practices require permittees to provide a complete list of chemical names, CAS numbers, and concentrations of every commercial chemical product brought to the site. The underground injection of hazardous waste is already prohibited (COMAR 26.13.05.19) in Maryland.

15. Risks Not Assessed. Appendix A of the Risk Assessment provides a "Risk Ranking Summary Chart." A substantial number of risks listed in the chart were Not Assessed (NA); therefore, the Risk Assessment is incomplete. In some cases, the risk was not assessed because it logically didn't apply to that phase of operations (e.g., gathering lines are not present during site preparation); however, in other cases the risk should have been assessed, but was not (e.g., contamination of soil, ground water, or surface water from a fuel or chemical spill during production operations).

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Recommendation: NRDC recommends Maryland revise the Risk Assessment to make clear when risks were not assessed because the risk was not present during that phase of operation, and assess the risk that are currently listed as Not Assessed (NA) that should be assessed for a complete risk assessment.

Response: The risks were not assessed either because they did not apply to that phase of operations or because risks were deemed too insignificant during that phase to assess. The specific risk mentioned in the comment (i.e., contamination of soil, ground water, or surface water from a fuel or chemical spill during production operations) is a good example because the activity level on the site is greatly reduced during production such that a spill is much less likely to occur than during other phases and thus not worth assessing. Either way the Departments are confident that the risks/phases assessed are those most worth considering and that risks not assessed did not rise to a level of concern that merited risk ranking.

Air Pollution

Maryland's Public Health Impact Study concluded there is a **high likelihood** that UNGDP will negatively impact air quality and will have a negative impact on public health in Maryland (air quality was given a high hazard ranking).¹³ The study cites emerging findings in peer-reviewed journals:

*...linking exposure to air pollution associated with UNGDP increased risk of subchronic health effects, adverse birth outcomes including congenital heart defects and neural tube defects, as well as higher prevalence of symptoms such as throat & nasal irritation, sinus problems, eye burning, severe headaches, persistent cough, skin rashes, and frequent nose bleeds among respondents living within 1500 feet of UNGDP facilities compared to those who lived >1500 feet.*¹⁴

Yet, the Risk Assessment recommends setbacks of only 1,000' from homes and public buildings. The Public Health Impact Study concluded:

*The extent of the impact will be based on population vulnerability, proximity to the sites, and the success of public health prevention strategies implemented by the State and local communities and control measures taken by the industry to minimize exposures.*¹⁵

The Risk Assessment concluded air pollution risk was high even with best practice in place:

*There is a high probability of air pollution emissions during all UGWD (Unconventional Gas Well Development) phases even with BMPs in place.*¹⁶

The Risk Assessment also concluded that there was insufficient data to determine consequences:

¹³ Maryland Public Health Impact Study, July 2014.

¹⁴ Maryland Public Health Impact Study, July 2014, Page xx.

¹⁵ Maryland Public Health Impacts Study, July 2014, Page xxi.

¹⁶ Maryland Risk Assessment, October 2014, Appendix B, Page 43.

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...most of these high probability emissions result from multiple, oftentimes overlapping combustion sources that for several sources (mobile sources, hydraulic fracturing pumps, and compressor emissions) have insufficient data or modeling information to reasonable determine consequences.¹⁷

The Public Health Impact Study appears to have assumed all the BMPs for air pollution control and monitoring proposed in Maryland's Best Practices Study would be implemented. The Public Health Impact Study also recommended a number of additional BMPs for air pollution control and monitoring that are not included in the Risk Assessment. A summary is provided in the table below:

Best Management Practice Recommendation (BMP)	Public Health Impacts	Best Practices Study
Hazardous Air Pollutant Mitigation: 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.	X	Not Addressed
Minimum Setback Distance: Require a minimal setback distance of 2000 feet from well pads and from compressor stations not using electric motors. The Risk Assessment assumes 1,000' vs. the Public Health Impacts Assessment that recommends at least 2,000'.	2,000'	1,000'
Fugitive Emissions: 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.	X	Not Addressed
Closed Tanks: Require that all UNGDP materials and wastes be stored in closed tanks; open pits shall only be used for storage of fresh water.	X	X
VOC Storage Tank Emission Control. Require storage tanks for all materials other than fresh water and other UNGDP equipment to meet EPA emission standards to minimize VOC emissions.	X	Not Addressed
Monitoring: Require an air monitoring plan (to collect baseline and operational data). Include source apportionment that allows UNGDP signal to be separated from the local and regional sources. Conduct air monitoring in a manner to capture both acute and chronic exposures, particularly short-term peak exposures.	X	Not Addressed
Odor: Establish a panel consisting of community residents and industry personnel to actively address complaints regarding odor.	X	Not Addressed
Cover Trucks: Require all trucks transporting dirt, drilling cuttings to be covered.	X	Not Addressed
Storage Tank Emission Control. EPA recently updated the 2012 standards for storage tanks. 78 Fed. Reg. 58416 (September 23, 2013). The Departments propose to require that all new natural gas operations in Maryland meet these standards upon startup.	X	X

¹⁷ Maryland Risk Assessment, October 2014, Appendix B, Page 43.

¹⁸ Maryland Public Health Impacts Study, July 2014, Pages xxv through xxvii.

¹⁹ Maryland Best Management Practices Study, July 2014, Pages 41-42.

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Best Management Practice Recommendation (BMP)	Public Health Impacts	Best Practices Study ²¹
Electric Motors: 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.	X	X
Green Completions: Require green completions for new and re-fractured wells.	X	X
Flaring: Flaring is allowed for safety or if the content of the flammable gas is low. Operators must either use raised/elevated flares or an engineered combustion device with a reliable continuous ignition source, which have at least a 98 percent destruction efficiency of methane. No pit flaring is permitted. Flaring may not be used for more than 30-days on any exploratory or extension wells (for the life of the well), including initial or recompletion production tests, unless operation requires an extension. Flares shall be designed for and operated with no visible emissions, except for periods not to exceed a total of five minutes during any two consecutive hours.	X	X
Ultra-Low Sulfur Fuel: All on-road and non-road vehicles and equipment using diesel fuel must use Ultra-Low Sulfur Diesel fuel (maximum sulfur content of 15 ppm).	X	X
Engine Idling: All on-road vehicles and equipment must limit unnecessary idling to 5 minutes. Except for engines necessarily kept in ready reserve, a diesel nonroad engine may not idle for more than 5 consecutive minutes.	X	X
EPA Engine Standards: All trucks used to transport fresh water or flowback or produced water must meet EPA Heavy Duty Engine Standards for 2004 to 2006 engine model years, which include a combined NO _x and NMHC (non-methane hydrocarbon) emission standard of 2.5 g/bhp-hr.	X	X
TOP Down BAT: The Department of the Environment intends to require top-down Best Available Technology (BAT) for the control of air emissions. This means that the applicant will be required to consider all available technology and implement BAT control technologies unless it can demonstrate that those control technologies are not feasible, are cost prohibitive or will not meaningfully reduce emissions from that component or piece of equipment. BAT emissions control technology will be mandatory for workovers. MDE will analyze top-down BAT demonstrations from applicants and approve the applicants BAT determination before a permit is issued. This builds on the EPA STAR program, and therefore a separate requirement to participate in this voluntary EPA program is not needed. MDE will also require a rigorous leak detection and repair program.	X	X

NRDC made a number of important BMP recommendations to New York State (see Appendices A and B for more detail) that Maryland should additionally consider. Those BMPs are summarized in the table below.

²⁰ Maryland Public Health Impacts Study, July 2014, Pages xxv through xxvii.

²¹ Maryland Best Management Practices Study, July 2014, Pages 41-42.

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Best Management Practices (BMPs) not Considered/Included	Public Health Impact	Best Practices Study ²³
<p>Leak Detection and Repair. Ensuring tightly sealed flow connections, and performing leak detection and corrective action should be required and an enforcement program implemented. The following BMPs should be considered:</p> <ul style="list-style-type: none"> • Leak Detection and Repair (LDAR) programs including acoustic detectors and infrared technology to detect odorless and colorless leaks; • Use of low bleed pneumatic instruments, instrument air, electric or solar powered control devices; • Use of dry centrifugal compressor seals; • Use of smart automation plunger lifts for liquid unloading; and • Early installation of pipelines; and 	Not Addressed	Not Addressed
<p>Concurrent Drilling Rig Operations on Same or Nearby Pad. Air pollution impacts could exceed those anticipated in Maryland's Studies if limits on concurrent rig operation are not established in regulation.</p>	Not Addressed	Not Addressed
<p>Chemical Use Limitations: Maryland has not set any limit on the type of chemicals that can be used in hydraulic fracturing. Therefore, there is no assurance that the air quality impact and risk analysis is based on a representative set of chemicals that would actually be used, representing the worst case scenario or even a representative amount of air pollution that would actually occur. Chemical use limits should be set and the risk and health assessment studies should be revised to incorporate these limits.</p>	Not Addressed	Not Addressed
<p>Industrial Activity: Set limitations for peak industrial activity in any one area.</p>	Not Addressed	Not Addressed
<p>Venting: While the proposed TOP Down BAT process may result in venting prohibitions, the proposed BMPs do not include specific prohibitions on direct venting, except for tank venting. Maryland should consider limits on the maximum amount of gas that can be vented per well.</p>	Not Addressed	Not Addressed
<p>Dehydration Unit Emission Controls: While the proposed TOP Down BAT process may result in dehydration unit emission controls, the proposed BMPs do not include specific prohibitions on dehydration unit emission controls, especially for small units that may fall below the federal EPA NESHAP requirements. Please see NRDC's attached comments to NYSDEC for a more detailed list of dehydrator emission controls.</p>	Not Addressed	Not Addressed
<p>HAP Storage Tank Emission Control. The Public Health Impacts Study proposed VOC emission control for storage tanks, but does not include specific proposed standards for Hazardous Air Pollutant (HAP) emission control, but does proposed future study of potential mitigation. NYSDEC's work showed annual HAP emission from flowback fluids could exceed major quantities of HAPs.</p>	Not Addressed	Not Addressed

²² Maryland Public Health Impacts Study, July 2014, Pages xxv through xxvii.

²³ Maryland Best Management Practices Study, July 2014, Pages 41-42.

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Best Management Practices (BMPs) not Considered/Included	Public Health Impact	Best Practices Study ²⁵
Natural Gas Powered Engines vs. Diesel Where Electric Power Grid is not installed. Maryland proposed the use of electric power where installed; NRDC agrees. However, in areas where an electric power grid is not installed NRDC recommends the preferential use of natural gas powered engines over diesel engines.	Not Addressed	Not Addressed
Biofuel Use. In cases where electricity and natural gas cannot be used, the use of biodiesel should be considered. Biodiesel blends of up to 20 percent (B20) can generally be used in diesel engines without any modification, although minor modifications are sometimes required for blends above 5 percent (B5). Higher level blends such as B80 or even full biodiesel (B99 or B100) are currently being used for many applications and should be investigated as well. Biofuel use would achieve much higher GHG reductions, up to 67 percent on average. Priority should be given to biodiesel produced from recycled oils and waste products.	Not Addressed	Not Addressed
Greenhouse Gas Emission Mitigation Plan and Offsets. Maryland is considering whether it is feasible to require permittees to estimate the remaining methane emissions and offset them with greenhouse gas credits. Maryland proposes that if this occurs, the permittees will have to estimate and report emissions to the State annually. ²⁶ However, this BMP is only under consideration and does not include a requirement to implement GHG emission mitigation. Maryland should require a GHG Mitigation Plan that provides for measureable emissions reductions and includes enforceable requirements. The GHG Impacts Mitigation Plan should list all Natural Gas STAR Program best management technologies and practices that have been determined by EPA to be technically and economically feasible, and operators should select and use the emission control(s) that will achieve the greatest emissions reductions. The GHG Impacts Mitigation Plan should be submitted and approved prior to drillsite construction, GHG controls should be installed at the time of well construction, and Maryland should conduct periodic reviews to ensure that GHG Impacts Mitigation Plans include state of the art emission control technologies. Further, the extent of compliance with adopted emission mitigation control plans should be documented throughout the well's potential to emit GHGs.	Not Addressed	Not Addressed
Energy Consumption. The choice of energy efficient systems and practices can minimize electricity consumption, and reduce air pollutant impacts.	Not Addressed	Not Addressed

²⁴ Maryland Public Health Impacts Study, July 2014, Pages xxv through xxvii.

²⁵ Maryland Best Management Practices Study, July 2014, Pages 41-42.

²⁶ Maryland Best Management Practices Study, July 2014, Pages 41-42.

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Best Management Practices (BMPs) not Considered/Included	Public Health Impact	Best Practices Study ²⁸
<p>Additional Flaring Mitigation: Maryland has identified some useful flaring BMPs, however, these additional BMPs should be considered:</p> <ul style="list-style-type: none"> • Minimize the risk of flare pilot blowout by installing a reliable flare system; • Ensure sufficient exit velocity or provide wind guards for low/intermittent velocity flare streams; • Ensure use of a reliable ignition system; • Minimize liquid carry over and entrainment in the gas flare stream by ensuring a suitable liquid separation system is in place; and • Maximize combustion efficiency by proper control and optimization of flare fuel/air/steam flow rates. <p>Maryland should also reconsider the proposal to allow flaring for up to 30-days on any exploratory or extension wells. Exploration flaring can be limited to a few days necessary to safely test the well. NRDC's comments to NYSDEC recommended a maximum of three-days flaring, unless justified for unavoidable safety reasons.</p>	Not Addressed	Not Addressed
<p>Hydrogen Sulfide Detection and Protection: Hydrogen sulfide Require operators to conform to the American Petroleum Institute (API RP49) for Drilling and Well Servicing Operations Involving RP 55 Oil and Gas Producing and Gas Processing Plant Operations Sulfide, both standards include procedures to protect employees and the public. Operators should be required to follow H2S detection and handling procedures to protect employees and the public. Initial H2S testing should be conducted at each drillsite. Subsequent test frequency should be based on the results of initial testing. H2S levels can increase over time as gas fields age and sour. When H2S is present, nearby neighbors, local authorities, and public facilities should be notified, and provided information on the safety and control measures that the operator will undertake to protect human health and safety. In cases where elevated H2S levels are present, audible alarms should be installed to alert the public when immediate evacuation procedures are warranted.</p>	Not Addressed	Not Addressed
<p>Pollution Control for NORM Waste Treatment: Require pollution filters and bubblers) for smelter stacks treating Naturally Occurring (NORM) waste to reduce airborne radiation</p>	Not Addressed	Not Addressed

Recommendation: NRDC recommends Maryland revise the Risk Assessment to match the high hazard ranking determination in the Public Health Impacts Study, and include additional BMPs recommended by NRDC and in the Public Health Impacts Study. NRDC also recommends that Maryland collect additional data and conduct air pollutant modeling it identified as insufficient to understand the potential consequences at this time. The Risk Assessment should make a clear conclusion as to whether or not increased industrial air pollution will be an “unacceptable risk.”

As an example, NRDC completed a more detailed analysis of air pollution control BMPs in the table above to provide Maryland with an example of how BMPs recommended in Maryland's BMP Study, Public Health Impacts Study, Risk Assessment, and those recommended by NRDC to NYS can be compared. This level of detailed analysis was not completed for each risk topic in these comments due to the short time period allotted for public comment.

²⁷ Maryland Public Health Impacts Study, July 2014, Pages xxv through xxvii.

²⁸ Maryland Best Management Practices Study, July 2014, Pages 41-42.

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It would be useful for Maryland to make a similar list for each risk factor in the final Risk Assessment to ensure all viable BMPs were considered and included. Maryland should explain in its final Risk Assessment all BMPs recommended and should either include those BMPs or explain why they were not included.

Response: As mentioned in an earlier response, the Public Health Impacts Study was conducted assuming no best practices in place whereas Maryland Risk Assessment was conducted assuming implementation of all of Maryland's proposed BMPs. Accordingly and as appropriate, the findings from the two studies differ. The Departments concur that additional monitoring data should be collected to determine air emissions impacts and this is planned to occur should UQWD activities go forward. Furthermore, the Marcellus Shale final report and recommendations (http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Final_Distribution_Draft_11.25.14.pdf) suggests that companies should be required to establish centralized fresh water storage facilities which will serve to reduce vehicle traffic and help address associated air emissions risks. As suggested, the Department also plans to require methane emission offsets. The additional BMPs recommended by NRDC will also be considered as the Departments move forward with UGWD regulations. The Departments do not agree that the purpose of the risk assessment is to identify "unacceptable risks" – that is the ultimate decision of the policy makers and state leaders.

Seismic Data Collection

The Risk Assessment concludes seismic data collection risk is low; yet the Risk Assessment does not make clear the amount of seismic data collection that may be required for UNGDP operations in Maryland. Instead, the Risk Assessment was based solely on a single application made by one company in a rural (not heavily forested) area, with the potential for limited landscape disturbance. There was no data included to verify that this single seismic data acquisition study was, or would be, typical of Maryland's seismic data collection needs for UNGDP.

Significant surface impacts can be caused by extensive tree and vegetation removal to create straight cutlines to run seismic equipment. Lines need to be cut to run mechanical vibration equipment or set explosives to generate the seismic waves, and other seismic lines are cleared to set geophones to measure the seismic reflection. The width of each cutline depends on the seismic survey method used, but can be on the order of 20'-50' wide where large seismic equipment units are required. Depending on existing development, infrastructure, and access in the area planned for onshore seismic exploration, a seismic operator may need to build access roads, set up temporary camps and establish helicopter landings to bring in personnel and equipment. While new lower impact seismic data collection procedures are available, some historic onshore seismic operations have resulted in impacts to the environment by:

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- Creating new, wide, straight seismic cutlines. Seismic cutlines involve cutting trees and creating surface disturbance to flora, fauna, soils and watercourses. In some cases, wide roads and clearings are needed for seismic equipment, helicopter landings and work camps, and are created by using bulldozers, hydro axes, and large construction equipment;
- Causing temporary or permanent loss of habitat and ecological populations;
- Disrupting mating, nesting, spawning and migration routes;
- Removing vegetation that results in increased erosion and changes in surface hydrology;
- Siting camps, helipads, equipment storage and cutlines based on logistical convenience, and lowest cost, without consideration for sensitive biological areas, historic and cultural resources, and local community impacts and concerns;
- Creating new and long-term use travel corridors for predators;
- Creating new access routes into the forest for all-terrain vehicles, snowmobiles and off-road trucks that may result in increased hunting and poaching in areas where these activities would otherwise be prohibited or limited;
- Generating noise and light disturbances near animal and human populations;
- Introducing non-indigenous species via seismic and construction equipment;
- Damaging fish and wildlife habitat by surface disturbance and stream crossings;
- Contaminating soils and surface and subsurface water resources due to spills;
- Creating pollution through poor solid waste, human waste and wastewater management practices; and
- Adversely impacting visual aesthetics (“visual scarring”) due to the wide cutlines required to transport in seismic survey equipment.

BMPs are needed to prevent and mitigate these impacts. In 2011, NRDC funded a study of onshore seismic exploration practices and model permit requirements.²⁹ This study is enclosed as Appendix C for Maryland's consideration.

Recommendation: NRDC recommends Maryland revise the Risk Assessment to include a technically supported estimate of the amount and type of seismic data collection that would be required for UNGDP, and estimate the amount of landscape disturbance (e.g., tree and forest removal, soil, crop, and grass damage, etc.). NRDC also recommends Maryland consider the 23 seismic data collection BMP recommendations included in Appendix C of our comments.

²⁹ Onshore Seismic Exploration Practices & Model Permit Requirements, Report to Sierra Club and Natural Resources Defense Council, Prepared by Harvey Consulting, LLC. , January 20, 2011.

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Response: Though the issues raised are legitimate, the Departments believe that, relative to other risks associated with UGWD, the risks from seismic exploration activities are small and do not warrant further analysis at this time. At this point, it is difficult to determine the amount of seismic data collection that would be required for all UGWD operations in Maryland due to lack of information regarding industry plans for testing activities. However, based on the information provided by this commenter, further consideration of potential ecological impacts (water quality, fragmentation) that could be caused by seismic static collection may be included in future studies. Additionally, modifications to the existing MDE application process and BMPS for seismic data can be considered if future impacts identified are identified.

Well Blowouts

The Risk Assessment cited an incident rate for offshore gas well blowouts of 1.2 blowouts per 1,000 wells drilled,³⁰ and concluded the probability of a well blowout was “low”³¹ and the consequences of a blowout would be “minor.”³² NRDC disagrees with this assessment.

Data included in Maryland's own Risk Assessment confirms that blowouts are a reasonably foreseeable significant impact of at least 1.2 well blowouts per 1,000 wells drilled. The blowout data cited does not meet Maryland's definition of a low probability risk (defined as a well blowout that “rarely happens under ordinary conditions; not forecast to be encountered under foreseeable future circumstances in view of current knowledge and existing controls on gas extraction.”)³³ Nor does it meet Maryland's definition of a “minor” consequence (defined as a “slight adverse impact on people or the environment; causes no injury or illness”).³⁴

Additionally, the Risk Assessment did not include a hazard identification analysis that assessed the worst-case scenario for blowout radius along with the associated spill, explosion, and fire hazard impact zone. The Risk Assessment recommends a 1,000' setback in most instances from homes and public buildings, but does not provide scientific and technical justification for the propose setback distance to demonstrate how that distance would protective of the nearby sensitive receptors in a blowout, fire, or explosion at a nearby gas operation.

The Risk Assessment examined well blowout risk using offshore gas well blowout data, rather than onshore gas well blowout data. Using offshore data underestimates the actual number of onshore well blowouts for exploration wells. Data published by the Society of Petroleum engineers shows that, on average, a blowout occurs in 7 out of every 1,000 onshore exploration wells, not 1.2.³⁵ This risk statistic is applicable to Marcellus and other low-permeability gas reservoir drilling exploration and appraisal drilling proposed for Maryland and is 5.8 times higher than the risk factor used in Maryland's Risk Assessment.

³⁰ Maryland Risk Assessment, October 2014, Appendix B, Page 21.

³¹ Maryland Risk Assessment, October 2014, Appendix D, Page 17.

³² Maryland Risk Assessment, October 2014, Appendix A, Table 15, Page 24.

³³ Maryland Risk Assessment, October 2014, Executive Summary, Page 6.

³⁴ Maryland Risk Assessment, October 2014, Executive Summary, Page 7.

³⁵ Rana, S., Environmental Risks- Oil and Gas Operations Reducing Compliance Cost Using Smarter Technologies, Society of Petroleum Engineering Paper 121595-MS, Asia Pacific Health, Safety, Security and Environment Conference, 4-6 August 2009, Jakarta, Indonesia, 2009.

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Blowout rates data collected in California from 1991 to 2005 showed less frequent blowouts for onshore gas production wells (compared to exploration wells) where more information is known about the reservoir, well control is optimized, and personnel are more experienced in site-specific conditions. This study estimated 1 blowout per 2,500 wells drilled.³⁶ However, this study is almost 10 years old, and Maryland should compile onshore blowout data for more recent Marcellus Shale wells drilled on the east coast. For example:

- 2010: Chief Oil and Gas uncontrolled flow-back blowout in Bradford County, Pennsylvania causing more than 1000' radius of dead vegetation around the well pad.³⁷
- 2010: EOG Resources well blowout at the Punxsutawney Hunting Club well in Clearfield County, Pennsylvania, lasting 16 hours, spilling an estimated 1,000,000 gallons of fracturing fluid, requiring evacuation of the areas and contaminating a large area of forest lands.³⁸
- 2011: Talisman Energy well blowout in Tioga County, Pennsylvania, contaminating the well pad and nearby state forest with fracturing fluids.³⁹
- 2011: Chesapeake Energy Marcellus well blowout in Bradford County, Pennsylvania spilled thousands of gallons of fracture treatment fluid over "containment walls, through fields, personal property and farms, even where cattle continue[d] to graze."⁴⁰
- 2014: Chevron well blowout in Pittsburgh in Dunkard Township, Pennsylvania resulting in a major fire.⁴¹

Hydrocarbon reservoirs can contain large quantities of gas and formation water, which can be released into the surrounding environment during a well blowout, resulting in significant damage to nearby properties. For example, California's 1991-2005 blowout study showed that: 25% of the blowouts affected more than 25 acres; the average blowout lasted 18 hours; and the maximum blowout length was 6 months.⁴²

³⁶ Jordan, P.D., and Benson, S. M., Well Blowout Rates in California Oil and Gas District 4- Update and Trends, Summary of Well Blowout Risks for California Oil and Gas District 4, 1991-2005, Table 1

³⁷ Pennsylvania Department of Environmental Protection (2010f) "Marcellus Shale inspections/violations 2010 Inspection comment ID 1887635"
<http://www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm>

³⁸ "Gas Well Blowout Under Control in Clearfield County", WJAC TV, 2010,
<http://www.wjactv.com/news/news/gas-well-blowout-under-control-in-clearfieldcount/nD4kX/>.

³⁹ "Talisman Cited for Gas Well Blowout" <http://thetimes-tribune.com/news/gasdrilling/talisman-cited-for-gas-well-blowout-1.1095503#axzz1doztpMg8>

⁴⁰ Pennsylvania Fracking Spill: Natural Gas Well Blowout Spills Thousands of Gallons of Drilling Fluid, The Huffington Post, April 20, 2011.

⁴¹ Green County Shale Well Continues Burning, Pittsburgh Post-Gazette, February 12, 2014. <http://www.post-gazette.com/local/south/2014/02/11/Gas-well-explodes-in-southeastern-Greene-County/stories/201402110126>.

⁴² Jordan, P.D., and Benson, S. M., Well Blowout Rates in California Oil and Gas District 4- Update and Trends, Summary of Well Blowout Risks for California Oil and Gas District 4, 1991-2005.

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Methods to control a gas well blowout can require significant water withdrawals – from 500,000 to 6,000,000 gallons per day. Well control experts may also use foam and dry chemicals to respond to a blowout. Controlling a well blowout can create large volumes of waste. Rig-deluge operations create large pools of water that can transport oil, chemicals, fuels, and other materials toward lower elevation drainage areas. These risks were not addressed.

Blowout risk is a function of the drilling company's experience in drilling the target formation; equipment quality; personnel experience; and maintenance, testing, and repair practices. The Risk Assessment is silent on these risk factors and is silent on the type and experience of the companies likely to drill Marcellus Shale wells in Maryland.

Recommendation: NRDC recommends Maryland:

- Revise the Risk Assessment to use more current onshore well blowout risk data, specifically for Marcellus Shale wells drilled on the east coast.

- Include a hazard identification analysis that assesses the worst-case scenario for blowout radius along with the associated spill, explosion, and fire hazard impact zone to provide scientific and technical justification for the proposed setback distance to demonstrate how that distance is protective of the nearby sensitive receptors.
- Assess blowout risk at a medium level (defined as a well blowout that “occurs occasionally or could potentially occur under foreseeable circumstances if management or regulatory controls fall below best practices”) ⁴³ and list the consequences of a blowout ranging from moderate to serious (not minor).
- Revise the Risk Assessment to address blowout risks related to a drilling company's experience in drilling the target formation; equipment quality; personnel experience; and maintenance, testing, and repair practices for companies likely to drill Marcellus Shale wells in Maryland.
- The Risk Assessment should make a clear conclusion as to whether or not increased industrial air pollution will be an “unacceptable risk” at the proposed setback distance of 1,000' from homes and public buildings, or whether large setbacks should be used to make the risk acceptable to the public.

⁴³ Maryland Risk Assessment, October 2014, Appendix D, Page 15.

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Response: The Departments believe that the risks of well blowouts are properly characterized in the assessment. Even under the high extraction scenario of 450 wells drilled in Maryland, this is projected to result in a maximum of one blowout given the 1.2 blowouts per 1,000-well rate used. The main public health risks from a well blowout are to workers onsite, which is outside the scope of risk as worker health and safety is not regulated by the Departments. If fracking or other chemicals are released in the rare event of a blowout, the Departments' BMPs for no-spill pads and spill prevention, control and countermeasures are anticipated to mitigate associated environmental risks.

Setback Distances

The Risk Assessment proposes the use of setbacks ranging in distance from 450' to 2,000' (relying only on Maryland's prior 2014 BMP Phase II Study recommendations) without any analysis of the risk associated with using those proposed setback distances or the risk reduction that can be achieved using larger distances (larger setbacks reduce risk). The Risk Assessment did not include scientific and technical justification for each proposed setback distance, nor did it demonstrate how that distance is protective of the nearby sensitive receptors. Nor were setback distances recommended for all sensitive receptors, as shown in the summary table below.

In contrast, the Public Health Impact Study recommended more work be completed to verify if Maryland's proposed setback distances are adequately protective of public health, including consideration of prevailing winds and topography.⁴⁴ The Public Health Impact Study also recommended a larger setback of at least 2,000' from well pads and compressor stations (not using electric motors) to private homes, schools, and public buildings.

The Risk Assessment did not appear to take into account that directional drilling technology enables wells to be drilled to a bottom-hole location at 3-5 miles⁴⁵ away from a wellhead. In directional drilling, it is now common for the horizontal displacement of the bottom hole location to be several times the total vertical depth (TVD) of the well. For example, a well with a vertical depth of 5,000' could have a bottom hole horizontal displacement of 10,000-15,000' from the drill site, or more. A well with a vertical depth of 7,000' could have a bottom hole horizontal displacement of 14,000-21,000' from the drill site, or more. Given the flexibility afforded by spacing units that may vary in shape, from square to rectangular, and that surface drillsites need not be located over the spacing unit, well operators utilizing directional drilling technology have a greater ability to select surface drillsite locations that optimize distance from sensitive public and private resources.

NRDC recommended that Maryland increase a number of setback distances. A complete set of setback recommendations can be found in Appendix B; however, a summary is included in the table below for comparison.

⁴⁴ Maryland Public Health Impacts Study, July 2014, Pages xxv.

⁴⁵ Well step-out distance that can be achieved will depend on well depth.

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Proposed Setback Distance From Edge of Drill Pad to:	Public Health Impacts Study	Best Practices Study ⁴⁶	NRDC Appendix B
Aquatic Habitat (unless otherwise listed below)	Not Addressed	450'	660'
Stream, River, Lake, or other Surface Water	Not Addressed	Not Addressed	3000'
Special Conservation Areas	Not Addressed	300'-600' Note 1	4,000'
Perimeter of a Wellhead Protection Area or Source Water Assessment Area for a Public Water System for which a Source Water Protection Area has been delineated.	Not Addressed	1,000'	4,000'
Private Drinking Water Well.	Not Addressed	2,000'	4,000'
Primary Aquifers that are sources for private water wells.	Note 2	Not Addressed	4,000'
Wetlands	Not Addressed	Not Addressed	300'
Agricultural Lands	Not Addressed	Not Addressed	1,320'
500 Year Flood Plain	Not Addressed	Not Addressed	Well pad prohibited
Private Homes (homeowners who did not sign a lease or consent to drilling nearby)	2,000' from wellpads & compressor stations without electric motors	1,000	1,320'
Schools	2,000' from wellpads & compressor stations without electric motors	1,000	1,320'
Other Public Buildings	2,000' from wellpads & compressor stations without electric motors	Not Addressed	1,320'
<p>Note 1: Appendix F of the Risk Assessment, lists 300' setback from all permanent infrastructure to all cultural and historical sites, State and Federal parks, trails, wildlife management areas, scenic and wild rivers, and scenic byways; whereas, other sections of the Risk Assessment recommend a 600' setback for Special Conservation Areas.</p> <p>Note 2: Prohibit well pads within watersheds of drinking water reservoirs and protect public and private drinking water wells with appropriate setbacks (setback distance not specified).</p>			

Recommendation: NRDC recommends Maryland revise the Risk Assessment to:

- Provide scientific and technical justification for each setback distance proposed to demonstrate how that distance is protective of the nearby sensitive receptor, including blowout radius, spill trajectory,

⁴⁶ Maryland Best Management Practices Study, July 2014, Pages 41-42.

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explosion hazards, other industrial hazards, fire code compliance, prevailing winds, topography, human health, agricultural health, and quality-of-life factors.

- Examine risk reductions that can be achieved by increasing setback distances.
- The Risk Assessment should make clear conclusions as to whether the proposed setback distances present an acceptable level of risk.

Response: Maryland's proposed setbacks were developed to work in concert with the robust suite of additional BMPs being proposed and thus should not be evaluated for effectiveness independently of these other practices. Accordingly, it is a combination of both setbacks and other proposed BMPs that were used to assess overall risk. Where data or modeling formation was available regarding distances at which environmental or public health standards may be exceeded, this information was factored into risk determinations to help identify areas where additional BMPs or setbacks may be necessary. Where no data were available or where setback distances could not be established, for example regarding vehicular traffic and populations, this also influenced risk assessment determinations. Since the combination of proposed BMPs and setbacks have not been empirically tested for effectiveness, rigorous monitoring and adaptive management have been adopted in the final report as fundamental principles for ensuring UGWD activities are conducted safely.

Fracturing Additives and Fluids

The Risk Assessment section on Fracturing Additives and Fluids (Appendix E) concludes risk quantification is difficult:

...because the chemical mixture that composes fracturing fluid is proprietary, there are very few peer reviewed studies that establish relationships between fracturing fluid concentration and effects to ecological or human health.⁴⁷

The Risk Assessment cites recent studies that reported livestock health problems and mortality caused by fracturing fluid spills, as well as health problems to humans and wildlife exposed to fracturing chemicals (because many chemicals are classified as respiratory toxicants, immunotoxicants, and carcinogens). Yet the Risk Assessment concludes it cannot arrive at a specific "risk" factor for these chemicals because the chemical concentrations are not known:

...a specific risk associated with these chemicals cannot be properly quantified because the concentrations of fracturing fluid chemicals are unknown.⁴⁸

⁴⁷ Maryland Risk Assessment, October 2014, Appendix E, Page 4.

⁴⁸ Maryland Risk Assessment, October 2014, Appendix E, Page 4.

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Alternatively, the Risk Assessment assumes that all fracturing additives are harmful to people and environmental receptors, making no effort to examine setting any limit on the type of chemicals that can be used in hydraulic fracturing, drilling muds, or at gas drilling and production sites that are protective of human health and the environment.⁴⁹ The Risk Assessment proposes to allow any chemical to be used, even if it is known to be harmful.

In this case, the Risk Assessment just accepts and assigns a risk, but does not evaluate methods for reducing the risk. For example, the Risk Assessment concludes hydraulic fracturing chemicals spilled to surface water could have “severe” ecological effects, but does not recommend methods to reduce risk such as chemical type and use limits:

If an incident resulted in the release or spill of drilling fluid additives, transporting directly into a stream the contaminated surface water could significantly impair water quality and adversely affect the health of aquatic life.⁵⁰

In another example, the Risk Assessment points out the lack of full disclosure of chemical components of hydraulic fracturing fluid additives may hinder mitigation and remediation actions in the event of accidental spills,⁵¹ but only makes a limited recommendation to improve chemical disclosure requirements to reduce these risks.

In Appendix H, the Risk Assessment proposes to require operators to provide a complete list of chemicals and concentration data, although the operator can request the state to withhold this information from the public if a claim of trade secret is made.⁵² This is an “unacceptable risk” to the public. The public should have access to information on chemicals used that could potentially impact their drinking/groundwater. Lack of access to accurate chemical and concentration data could slow or lengthen the time to detect or confirm contamination, or impede proper medical treatment.

Recommendation: The Risk Assessment states the lack of access to accurate chemical and concentration data can slow or lengthen the time to detect or confirm contamination, or impede proper medical treatment. These risks could result in serious consequences and would not likely be “acceptable” to adversely affected public.

NRDC recommends Maryland set chemical use limits and the Risk Assessment and the Public Health Impact Study be revised to incorporate these limits. Please see Appendices A and B of NRDC's comments for detailed recommendations on chemical use limits and pre-fracture notice and disclosure of chemicals (to both the Department and the landowner).

⁴⁹ Maryland Risk Assessment, October 2014, Appendix E, Page 5.

⁵⁰ Maryland Risk Assessment, October 2014, Appendix E, Page 4.

⁵¹ Maryland Risk Assessment, October 2014, Appendix E, Page 7.

⁵² Maryland Risk Assessment, October 2014, Appendix H, Page 4.

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More specifically NRDC recommends that Maryland:

1. Develop a list of prohibited fracture treatment additives based on the known list of chemicals currently used in hydraulic fracturing.
2. Develop a list of non-toxic additives that are acceptable, with supporting toxicological data.
3. Develop a process to evaluate newly proposed hydraulic fracturing chemical additives to determine whether they should be added to the prohibited or acceptable lists.
4. Require the burden of proof to be on industry to demonstrate, via scientific and technical data and analysis and risk assessment work, that any newly proposed hydraulic fracturing chemical is safe.
5. Prohibit any chemical from use in a hydraulic fracturing treatment until Maryland has assessed the industry's toxicity studies and other documentation concerning the impact of the chemical on human health and the environment and has determined whether or not it warrants inclusion on the list of prohibited hydraulic fracturing chemical additives.
6. Periodically test hydraulic fracturing fluid used on actual stimulation jobs to ensure that the chemicals used are the same ones allowed.

Response: Since data regarding chemicals and human or environmental health impacts are oftentimes lacking or inadequate the Departments focused on requiring BMPs and setbacks that would help prevent/minimize any chemical exposures. This approach coupled with both baseline/site monitoring, adaptive management, and the Department's authority to adopt regulation to address risks to public safety, human health or the environment (Annotated Code §14-123) are deemed to be sufficiently protective. In addition the chemical disclosure requirements allow the Departments to surmise what constituents to monitor for in the environment.

Fracturing Fluid and Produced Water Flowback

NRDC supports Maryland's proposed fracturing fluid and produced water flowback BMPs that require:

- Close-loop systems of above-ground tanks and containers to collect, handle and transport the waste;
- A plan for waste handling, treatment and disposal;
- Use of recycling to the maximum extent practicable;
- A prohibition on Publically Owned Treatment Works (POTW) accepting fracturing fluid and produced water flowback wastewater until EPA has proposed treatment standards; and
- Improved recordkeeping and reporting requirements.

While the Risk Assessment is clear that reserve pits and impoundments will be prohibited at the well pad, it is unclear if Maryland plans to prohibit centralized impoundments (it appears this may be what Maryland intended, however this should be made clear). NRDC supports

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centralized impoundment prohibition, to reduce the risk of air pollution (especially the release of hazardous air pollutants) and to reduce the risk of water and soil pollution.

Recommendation: NRDC recommends Maryland review and include additional BMPs for produced water and flowback found in Appendices A and B of NRDC's comments.

Response: Comment noted and will be considered as the Departments develop regulations. Maryland's BMPs allow for impoundments to store fresh water only – no fracking chemicals or flowback water will be stored in impoundments under these recommendations.

Spill Risk

Spill risk and likelihood is a function of company's experience; equipment quality; personnel qualifications and experience; and maintenance, testing, and repair practices. The Risk Assessment is silent on risk factors associated with the companies likely to operate Marcellus Shale wells in Maryland. More information should be provided on the type and track-record of the companies likely to operate in Maryland.

One method to mitigate risk that was not considered is to require that out-of-state environmental compliance records be disclosed as a condition of permitting (including disclosure of all permit applicants' compliance records, including at a minimum all prior administrative or judicial enforcement actions or criminal proceedings against the applicant and all denials of permits in any state). This BMP will provide Maryland with additional information on the companies' past practices and will allow Maryland to make an informed decision on permit approval, denial, or the need for additional mitigation to reduce risk.

The Risk Assessment assumes there is an 8% likelihood of a spill or leak at every stage of the UGWD resulting in an estimated 12 to 36 spill incidents for the low to high UGWD scenarios.⁵³ Incongruously, in the same section, the Risk Assessment then concludes that soil, surface water, and ground water contamination from drilling wastes will "rarely" occur if best practices are implemented. The Risk Assessment then lists the risk probability of drilling waste contamination as "low" (defined as a spill that "rarely happens under ordinary conditions; not forecast to be encountered under foreseeable future circumstances in view of current knowledge and existing controls on gas extraction.")⁵⁴ NRDC disagrees with this conclusion. A "rare" event would have a probability near 0%, not 8%.

The Risk Assessment did not assess the risk of improper waste treatment and disposal. The Risk Assessment examined the risk of transporting the waste to an "appropriate" treatment facility, but did not examine the very real risk – already being experienced elsewhere, including Pennsylvania – that there are insufficient "appropriate" treatment facilities available, requiring waste to be temporarily stockpiled (with

⁵³ Maryland Risk Assessment, October 2014, Appendix D, Page 10.

⁵⁴ Maryland Risk Assessment, October 2014, Executive Summary, Page 6.

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potential to leak or leach into groundwater), or the risk of improper waste treatment and disposal techniques.

Recommendation: NRDC recommends Maryland:

- Revise the Risk Assessment to include a BMP that requires out-of-state environmental compliance records be disclosed as a condition of permitting.

Response: Comment noted and will be considered as the Departments develop regulations.

- Increase the spill risk from “low” to “moderate” based on an estimated 8% spill frequency; and

Response: Though the spill risk may be 8%, Maryland BMPs for impermeable well pads, volume containment of up to a 25-year storm, and secondary containment for storage tanks is anticipated to reduce risks from spills to low.

- Assess the risk of improper waste treatment and disposal.

Response: No relevant statistics were found in the literature to allow assessment of risk. Further, Maryland's current compliance and enforcement program helps to ensure waste disposal is performed properly.

Drilling Fluids and Cuttings

NRDC supports Maryland's proposed BMPs that require:

- Freshwater aquifer zones to be drilled using air or fresh water;
- Drilling fluids to be contained in a closed-loop tank and piping system;
- No well pads in the watersheds of public drinking water reservoirs;
- Drilling fluids and cuttings to be stored and handled using above ground tanks, surrounded by a secondary containment system capable of holding the largest tank contents; and
- Preparation of site-specific emergency response plans, including experts and equipment, among other things.⁵⁵

Recommendation: While Maryland identified and incorporated a number of valuable BMPs, NRDC recommends Maryland consider including the following additional BMPs, to further reduce risk. These BMPs are further explained in detail in Appendices A and B, including:

- Use of an impervious drill pad liner. Maryland proposes that drill pads be underlain with a synthetic liner with a maximum hydraulic conductivity of 10^{-7} centimeters per second (which is not impervious).⁵⁶

⁵⁵ Maryland Risk Assessment, October 2014, Appendix D.

⁵⁶ Maryland Risk Assessment, October 2014, Appendix D, Page 7.

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- A requirement to use drilling muds with the lowest mercury and heavy metal concentrations commercially available. The most common weighting agent used is barite. U.S. Department of Energy studies show that barite contains mercury (1ppm-10ppm Hg, depending on its origin).⁵⁷ Mercury concentrations can be reduced by using thermal methods, leaching with dilute acids, or selecting barite with naturally occurring lower concentration levels of mercury. Drilling muds may also contain the heavy metal cadmium, leading the EPA to establish cadmium concentration limits in drilling muds for muds disposed offshore.⁵⁸
- The use of compressed air and Water Based Mud (WBM) for drilling through the protected groundwater zones is best practice, as long as Maryland also sets limits on the type of additives that can be mixed in the WBM formulation. WBM additives used when drilling through the protected groundwater zones should be limited to additives that are bio-degradable, are non-toxic, and do not bio-accumulate.
- Provide specific instruction for the proper treatment and disposal of drilling muds and cuttings, especially those containing heavy metals and Naturally Occurring Radioactive Material (NORM). Drilling muds may contain mercury, metals, NORM, oils, and other contaminants. This is especially true for Marcellus Shale operations where NORM is present in the shale drill cuttings and mud mixture.
- Waste should be removed from the drilling location and properly disposed at an approved waste disposal facility capable of handling the quantity and type of waste generated.
- Prohibit drilling mud and cutting spread on agricultural fields.
- Prohibit the onsite burial of drill cuttings and waste muds. Maryland proposes to allow some onsite drill cutting disposal if the cutting do not show elevated levels of radioactivity, sulfates, salinity, and other criteria.⁵⁹

Response: Maryland believes that the current list of proposed BMPs will sufficiently reduce the risk of groundwater or surface water contamination from drilling fluids and cuttings, therefore the implementation of additional BMPs will provide no further benefit.

Plugging and Abandonment of Existing Wells

A known and serious risk factor for groundwater contamination is the potential for a hydraulic fracture to connect (underground) with an improperly abandoned well that could potentially create vertical pathways for contamination to reach Underground Sources of Drinking Water (USDWs). Inadequate bonding, insolvent operators, and limited state funding are typically identified as the reasons for long backlogged lists of existing wells that have not been properly plugged and abandoned.

⁵⁷ <http://www.fossil.energy.gov>, "Mercury Removal from Barite for the Oil Industry."

⁵⁸ U.S. Environmental Protection Agency, Development Document for Effluent Limitation Guidelines and New Source Performance Standards for the Offshore Subcategory of the Oil and Gas Extraction Point Source Category, EPA 821-R-93003, 1993.

⁵⁹ Maryland Risk Assessment, October 2014, Appendix D, Page 27.

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Maryland's Risk Assessment concludes there are serious adverse consequences from chemicals that are mobilized to groundwater through old wells and faults.⁶⁰ However, the Risk Assessment does not provide information on the number of existing wells that have not been properly plugged and abandoned in Maryland, or examine the risk they pose in the areas proposed for Marcellus Shale development. The assessment does not reach a conclusion as to whether this is an "unacceptable risk."

The Risk Assessment does include a BMP requiring operators to include a geological investigation in their applications identifying the location of nearby wells, but does not require those wells (if improperly abandoned or potentially a risk hazard) to be plugged and abandoned before issuing a permit for a new well.

Recommendation: NRDC recommends Maryland revise the Risk Assessment to include:

- Quantitative data on the presence and risk of improperly plugged and abandoned wells in the area proposed for Marcellus Shale gas exploration and development;
- A risk mitigation measure that would require all new operators to verify that all its existing wells that are no longer operational are properly plugged and abandoned before a permit is issued for new Marcellus Shale wells;
- A risk mitigation measure that would require operators applying for a permit to drill a new well nearby an improperly P&A'd well to either locate the well's owner and arrange for the well to be P&A'd or the company to P&A the well before a permit is approved.
- Include NRDC recommendations for properly plugging and abandoning a well (see Appendices A and B).

Response: During RA development, the Departments did not find literature-based risks associated with well plugging and abandonment. As such, these risks could not be assessed. The Department has existing regulations for the plugging and abandonment of oil and gas wells – see <http://www.dsd.state.md.us/comar/getfile.aspx?file=26.19.01.12.htm>. The recommendations provided by the commenter will be considered in any proposed revisions to these regulations.

Noise

The Risk Assessment includes conflicting data on noise impacts. The assessment cites the World Health Organization's recommendation for sound levels to be less than 30 dBA indoors and less than 45 dBA outdoors for intermittent noise, noting noise above these levels can make it more difficult to fall asleep, and resulting in adverse physiological effects.⁶¹ Incongruously, the assessment includes a table that concludes community reaction to noise below 55 dBA "is considered no more important than various other environmental factors" (see Table 2). These data conflict for noises above 30 dBA indoors and 45 dBA outdoors.

⁶⁰ Maryland Risk Assessment, October 2014, Appendix H, Page 14.

⁶¹ Maryland Risk Assessment, October 2014, Appendix F, Page 3.

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Table 7 of the noise assessment shows that the World Health Organization's recommendation for sound levels of 30 dBA (indoors) and 45 dBA (outdoors) cannot be achieved even if human receptors are located 2,000 feet away. Nor can Maryland's daytime noise limit be achieved when high-volume hydraulic fracturing operations are conducted with human receptors located 2,000 feet away, or during nighttime road construction.

The Risk Assessment also cites Maryland's noise standards, explaining there are limits of 55 dBA (night) and 65 dBA day for residential areas and up to 90 dBA for construction and demolition activities during day time. There is no explanation as to why these standards exceed the World Health Organization's recommendation for sound levels of 30 dBA (indoors) and 45 dBA (outdoors).

While NRDC supports Maryland's proposed BMP to require the applicant to submit a noise mitigation plan, and requirement that a company use the lowest noise generating power source, it appears this noise plan would only need to meet Maryland's less restrictive (noisier) standards that are known to disturb human sleep and cause adverse physiological effects.

The Risk Assessment proposes a setback distance of only 300 to 1,000 feet, which would be insufficient to reduce noise impacts below Maryland's regulations. Increased setback distances beyond 2,000 feet would be needed.

The Risk Assessment did not provide compressor station noise data in Table 7. Compressor noise data should be added, especially since the Public Health Impact Assessment found it to be significant for compressors not using electric power.

Overall, the Risk Assessment concludes that most noise impacts have a low to medium probability. This is not correct. Industrial noise types listed in Table 7 are known to occur and are verifiable. Noise risk should be ranked as a high risk (which is defined in this assessment as a risk that "occurs frequently under ordinary conditions"). The Risk Assessment concludes consequences of noise impacts range from low to moderate, and in most cases the assessment rounds the overall combined risk down to an overall "low" risk rating, underestimating the overall risk.

In contrast, the Public Health Impacts Study concluded that:

Environmental noise associated with UNGDP was identified as a top concern among residents of Western Maryland.

While there are not any epidemiologic studies on UNGDP noise, we know from other industries that long-term exposure to environmental noise has been associated with a myriad of health outcomes, including stress and annoyance, sleep disturbances, hypertension, and cardiovascular disease. Noise levels can be reduced by distance, enforcement of regulatory standards, and use of sound reduction technologies.

*Based on prior evidence regarding negative impact of noise exposures and noise monitoring results from UNGDP sites that included our own monitoring results from WV, we conclude that there is a **Moderately High Likelihood** that UNGDP related changes in noise exposure will have negative impacts on public health in Garrett and Allegany Counties.⁶²*

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⁶² Maryland Public Health Impacts Study, July 2014, Page xxii.

The Public Health Impacts Study recommended setbacks of 1,000' for compressor stations using electric motors and sound barriers, and 2,000' for all others. The study was silent on setbacks required for drilling, well pad construction and hydraulic fracturing operations.

There is no impact assessment relating to the risks and consequences for a homeowner that is attempting to sell or rent its property while industrial noise impacts are present. Inability to rent or a sell a home due to nearby industrial impacts (at a price that could have been obtained prior to industrial noise being present), may be an "unacceptable impact" to a property owner.

Recommendation: NRDC recommends the Risk Assessment:

- Recommend the World Health Organization noise limitations be adopted as a BMP for areas impacted by UNGDP.
- Recommend increased setbacks to ensure such noise limits can be met.
- Expand Table 7 to show the distance (beyond 2,000') needed to comply with existing Maryland noise regulations and to meet the World Health Organization's noise limitations, and include noise from compressor stations.
- Recommend restrictions on industrial activities during the evening and night nearby human receptors to improve quality of life for nearby residents.
- Require noise monitoring as a risk reduction measure to ensure noise levels are continuously monitored and maintained below required levels.
- Assess the risks and consequences to a homeowner that is attempting to sell or rent its property while industrial noise impacts are present.

Response: The Departments appreciate your comments and share your concerns on noise impacts of UGWD. The Department concur that Maryland's noise standards are scientifically-based, well-accepted nationwide, and that the Noise Mitigation Plan BMP, setbacks and other proposed BMPs, along with the existing statewide noise standards are adequately protective.

Visual Impacts

The Risk Assessment concludes that most visual impacts are "minor" (defined as only a slight adverse impact on people).⁶³ The visual impact assessment is incomplete and does not address possibility of scenic view blocking, short-and long-term property value loss, and long-term or irreparable visual scarring of wide forest/vegetation cutlines required to transport in equipment and create well pads, roads, and staging pads.

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⁶³ Maryland Risk Assessment, October 2014, Appendix F.

There is no impact assessment relating to the risks and consequences to a homeowner that is attempting to sell or rent its property while visual impacts are present. Inability to rent or a sell a home due to nearby industrial impacts (at a price that could have been obtained prior to industrial noise being present), may be an “unacceptable impact” to a property owner.

There are no BMPs recommended to camouflage industrial structures or equipment (especially equipment that will be installed and operated over long periods).

Recommendation: The visual impact assessment section should be expanded to more accurately describe the visual impacts expected, including photographs of Marcellus Shale drilling operation next to private homes (within the short setback distances currently recommended by Maryland). Photographs can be obtained from other states that have already experienced these adverse impacts.

NRDC recommends the Risk Assessment assess the visual impacts from the point of view of a nearby neighbor that will suffer the visual impacts. BMPs should be recommended to mitigate these impacts.

NRDC further recommends that the Risk Assessment evaluate the risks and consequences to a homeowner that is attempting to sell or rent its property while industrial noise impacts are present.

Response: MDE appreciates your comments and shares your concerns on visual impacts of UGWD. MDE believes that the types and magnitude of visual impacts were adequately described in the RA. The comprehensive gas development planning process will help minimize impacts to local viewsheds and the Departments feel that our characterization is justifiable in that, as detailed in the RA, the more significant visual impacts are temporary. The Departments further note that camouflage measures may also have environmental impacts that would need to be assessed.

Variations

The Risk Assessment is silent on the potential for, and the increased risk associated with, variations. Variations to proposed BMPs and regulations are common in most states. Once regulations are codified to protect human health and the environment, NRDC generally opposes state agencies granting regulatory variations because variations increase risk to humans and other sensitive receptors.

Recommendation: NRDC recommends regulatory variations not be approved. However, if a variance is considered, NRDC recommends a mandatory public hearing, supported by scientific and technical information supporting the reason for the variance and an analysis of any increased risk. This process will allow Maryland and its public to make informed comments and an informed decision on whether to grant the variance.

Responses: Albeit rare, variations are a currently existing option for Maryland's regulatory programs. Variations are conducted on a case-by-case basis and typically time-

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limited to allow phase in of sufficient controls. Variance approvals also require a public process to allow stakeholder input. The Departments do not anticipate that an occasional variance, if allowed, would result in greater risks to public health or the environment.

Storage Tank & Container Risk Mitigation

The Risk Assessment identified closed-loop tank and container systems as an important BMP to reduce the risk of spills, air pollution, and contamination. However, the Risk Assessment did not consider additional risk reduction benefits of alarms, inspections, shut-off devices and leak detection systems.

Recommendation: NRDC recommends Maryland require the follow BMPs to reduce risk: **Tim**

- Storage tank inspections and alarm systems including periodic fuel tank inspections to examine structural conditions and document corrosion or damage;
- Installation of high-liquid-level alarms that sound and display in an immediately recognizable manner;
- Installation of high-liquid-level automatic pump shutoff devices, which are designed to stop flow at a predetermined tank content level; and
- A means of immediately determining the liquid levels of tanks.

Response: Comments noted and will be considered as the Departments develop regulations.

Groundwater Contamination

Groundwater contamination by hydraulic fracturing fluids is a reasonably foreseeable impact that requires mitigation. Well construction failures, engineering design flaws, human error, mechanical malfunctions, and chemical spills all are reasonably foreseeable events, and have occurred at Marcellus Shale operations in other states. The Risk Assessment correctly identifies the vast number of chemicals present in drilling and fracturing fluids and the lack of precise information on composition as a risk factor. The assessment also acknowledges the risk of potential groundwater contamination, and assigns the highest risk factors to chemicals mobilized through natural faults and old wells.

The Risk Assessment correctly identifies the consequences of groundwater contamination as “serious” but assigns a low risk probability. The risk assessment ranking table (found in Appendix H pages 13-14, but not numbered) lists the probability of all groundwater contamination as low, except for methane contamination through failed casing and cement, and contamination due to deep well injection. NRDC does not agree the risk of groundwater contamination is “low.” Groundwater contamination has been attributed to operational failures at various Marcellus Shale gas development operations in Pennsylvania, including operations by Cabot Oil & Gas Corporation, Catalyst Energy, Inc., and Chesapeake Energy Corporation. See Appendix B of NRDC’s comments for more detail and citations. The Risk Assessment should at least assign this

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risk a “medium” probability (defined as a risk that could potentially occur under foreseeable circumstances if management or regulatory controls fall below best practice standards).

Recommendation: The Risk Assessment should increase the risk probability for groundwater contamination or provide scientific and technical data to support the low probabilities assigned.

Additionally, NRDC recommends Maryland compare its list of recommended BMPs for well construction design (casing and cementing practices), hydraulic fracture treatment design, post-drilling and post-hydraulic fracturing well monitoring, confining layer analysis, and groundwater monitoring (baseline and post development monitoring) to those recommended by NRDC in Appendices A and B, which are substantially more extensive, and include a complete set of BMPs based on those recommendations to reduce groundwater contamination risk.

Response: Appendix H states *“Most literature sources indicate that groundwater contamination via migration through faults or old wells would be a rare and site specific occurrence.”*

Based on the literature reviewed, the Departments agreed that a low probability and moderate consequence were appropriate for groundwater contamination due to casing/cement failures or migration through natural or manmade faults. As you have mentioned, there have been instances of groundwater contamination, though the path and source of contamination is not always understood. The purpose of the appendix was to evaluate risk due to the two specific pathways already mentioned, and without specific documentation of the contamination pathway it is unclear how to justifiably increase the probability ranking.

Financial Impact

The Risk Assessment did not examine the financial impact risk to the public of UGWD. While Maryland (in earlier studies) examined the potential to increase bonding and insurance requirements, the proposed increases still do not guarantee that the State of Maryland or the impacted public would be made whole in the event a serious consequence materializes. This is an unacceptable risk.

Recommendation: The Risk Assessment should examine financial risk impacts to both the State of Maryland and the affected public and make recommendations for reducing that risk, including legislation that requires a combination of bonding and insurance that guarantees payment of the full costs and risks of long-term monitoring; publicly incurred response and cleanup operations; site remediation and well abandonment; and adequate compensation to the public for adverse impacts (e.g., water well contamination, medical treatment compensation). Financial assurance amounts set pursuant to the legislative amendments should apply to each well, with no aggregate cap for multiple wells, and the amounts should be indexed to inflation to reflect changes in actual costs.

Response: An economic analysis was conducted by Towson University's Regional Economic Institute and is available at <http://www.mde.state.md.us/programs/Land/mining/marcellus/Pages/economicStudy.aspx>.

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Summaries of economic impact are also addressed in the final Marcellus report – see http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Final_Marcellus_Shale_Report.pdf.

Maryland's recently proposed regulations also set permit fees to cover the costs of the Departments to regulate drilling in the Marcellus shale, including rigorous monitoring and enforcement. Additionally, the legislature passed legislation establishing a presumptive impact area around the gas well in which it is presumed that contamination of a water supply was caused by the activities of gas exploration and production. Also, the legislature passed legislation updating the financial assurance requirements for a holder of a permit to drill for gas or oil. Both of these legislative updates were recommendations in Part I of the Marcellus Shale Safe Drilling Initiative Study.

In the Final Report, the Departments recommended the legislature pass a state level severance tax as well as expansion of the Department of the Environment's penalty authority to include administrative and civil penalties. The state level severance tax would be placed in a Shale Gas Impact Fund to be used for continuing regional monitoring and to address impacts of gas exploration and production that cannot be attributed to a specific operator, or for which there is no responsible solvent entity. The additional penalty authority would serve to further limit risk and compensate for cleanup of any adverse impacts.

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List of Acronyms

API.....	American Petroleum Institute
API RP.....	American Petroleum Institute Recommended Practice
AQ.....	Air Quality
BMP.....	Best Management Practice
BOP.....	Blow-out preventer
BTEX.....	benzene, toluene, ethylbenzene, and xylenes
EPA.....	Environmental Protection Agency
ERP.....	Emergency Response Plan
GHG.....	Greenhouse Gases
H ₂ S.....	Hydrogen Sulfide
HAP.....	Hazardous Air Pollutants
HVHF.....	High Volume Hydraulic Fracturing
LDAR.....	Leak Detection and Repair
NA.....	Not Assessed
NORM.....	Naturally Occurring Radioactive Material
NRDC.....	Natural Resources Defense Council
NYS.....	New York State
NYSDEC.....	New York State Department of Environmental Conservation
P&A.....	Plug & Abandonment
POTW.....	Publically Owned Treatment Works
RDSGEIS.....	Revised Draft Supplemental Generic Environmental Impact Statement
REC.....	Reduced Emission Completions
USDW.....	Underground Sources of Drinking Water
USEPA.....	United States Environmental Protection Agency
UNGWD.....	Unconventional Natural Gas Well Development
WBM.....	Water Based Mud

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Comments Received from Mr. Mark Boling, Southwestern Energy

I have had an opportunity to review the document titled "Assessment of risks from unconventional gas well development in the Marcellus Shale of Western Maryland" (the "Risk Assessment"). The following are my comments/observations on the Risk Assessment.

1. General Observations. The methodology used to perform the risk analysis (i.e. identification of risks; qualitative assessment of probability of occurrence and potential impact of each risk; and proposed strategies to mitigate the risk) is appropriate. In addition, the list of risks identified for assessment is appropriate for conducting a comprehensive assessment of the risks associated with conducting unconventional gas well development operations in the Marcellus Shale of Western Maryland. Except as otherwise mentioned below, I believe (i) the Risk Assessment identified all important assumptions upon which the risk analysis is based, (ii) the Risk Assessment stated all material uncertainties that remain with respect to the subject matter covered by the Risk Assessment and (iii) the conclusions and inferences contained in the Risk Assessment are logically supported by the evidenced presented. Overall, I believe the Risk Assessment is a very thorough evaluation of the risks associated with unconventional gas well development.

2. Specific Comments.

1. Plan Submittals. This Risk Assessment provides that the operator will be required to submit the following plans for approval:

1. Comprehensive Gas Development plan;
2. Site Specific Emergency Response Plan;
3. SPCC Plan;
4. Waste Treatment, Handling and Disposal Plan;
5. Noise Plan;
6. Power Plan;
7. Invasive Species Plan;
8. Well Construction and Operation Plan.

While there is no questioning that the subject matter covered by the various plans is very important, the administrative burden on both the operator and the regulating authority will be significant in this type of regulatory regime. Many states with a history of oil and gas regulatory experience have opted for more detailed regulatory requirements that are applicable to all

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operators, and if the operator wants to vary its operations from those standards in any way, the operator must get the approval of the regulating agency. In this way, the agency spends less time in the office reviewing plan submittals and more time in the field making sure the operator complies with its regulations.

Response: The Departments believe that these general plan requirements provide operators needed flexibility to adopt measures best suited to their business requirements while still meeting the environmental and public health goals of the agencies.

2. Water Handling. The Risk Assessment assumes an average of 5,000,000 gallons will be used for each hydraulic fracturing operation, with 30% flowback recovery. While the 5,000,000 gallons is a fair estimate of water use, our experience in Pennsylvania indicates that the 30% flowback recovery is probably too high. Our experience has been approximately 15% flowback recovery. Of course, this significantly affects the fluid volume for storage and transportation. In addition, if the state requires 90% of the flowback water to be stored in above-ground steel tanks and recycled on site then (i) approximately 35-50 tanks (at a 15% recovery factor) will be required for each location, (ii) the pad location will need to be significantly larger to accommodate the storage tanks, and (iii) the estimated water truck traffic from the pad location will need to be reduced to account for the recycled water remaining on site. It is also important to note that the 90% on-site recycling requirement will likely conflict with an operator's normal project development plan. If the operator planned to drill all six (6) wells on the pad in succession, the on-site recycling would not be an issue. However, this very rarely happens. In most cases, the operator's development plans are guided by geologic considerations, lease expiration issues, drilling rig and completion crew availability and other considerations that require drilling operations to be conducted on other pad locations before full development of the other location(s).

Response: Noted and thank you for this clarification based upon industry experience. For flowback estimates specifically, the Departments found only limited and wide-ranging estimates: EPA indicated that flowback could be anywhere from 15-80% (<http://www.epa.gov/ogwdw000/uic/pdfs/hfresearchstudyfs.pdf>); New York's SGEIS assumed between 9-35%; and internal discussions centered around a 30% flowback rate.

3. Road and Truck Traffic. (a) The Appendix C analysis on Road and Truck Traffic impacts assumes that all fresh water will be moved by truck. This is likely a "worst case" scenario, as many operators are recognizing the benefits of moving fresh water through temporary piping (lay flat pipe rolled out for transfer of water and rolled up afterwards). In addition, operators in some areas are creating pipeline networks for water transfer to minimize truck traffic and road damage. A regulatory regime that incentivizes water movement by pipeline is highly recommended.

Response: Correct – the Departments did assume that all freshwater will be delivered by truck as that is the predominate industry practice.

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(b) The requirement to reuse 90% of the flowback water at the pad location should be considered in the calculation of traffic from wastewater transportation. It appears that the current calculation of traffic due to wastewater transport assumes 100% transport off-site.

Response: This conflicts with your statement above in comment 2 that: "it is also important to note that the 90% on-site recycling requirement will likely conflict with an operator's normal project development plan. If the operator planned to drill all six (6) wells on the pad in succession, the on-site recycling would not be an issue. However, this very rarely happens. In most cases, the operator's development plans are guided by geologic considerations, lease expiration issues, drilling rig and completion crew availability and other considerations that require drilling operations to be conducted on other pad locations before full development of the other location(s)." Given the expressed constraints, the Departments believe that, for risk assessment purposes, it is appropriate to conservatively assume 100% transport.

(c) It is very unlikely that wells will be re-completed every five (5) years.

Response: Comment noted.

4. Fracturing Additives and Fluids. (a) I agree with the overall assessment that the greatest risk in this area is surface spills. While many of the proposed risk mitigation measures are appropriate and can substantially reduce the probability of occurrence and/or impact of the risk if it does occur, the number of required measures may be excessive. For example, instead of requiring the entire well pad to be under laid with a liner, you could require a liner where the drilling rig is located and in those locations where fluids are stored or transferred, etc. Also, having a berm around the entire location may not provide that much additional benefit (on a cost-benefit basis) since steel tanks with their own secondary containment are already required. In addition, the presence of a berm around the location would create a potential driving hazard for all of the truck traffic that must come on and off the site. Finally, it is unclear if the requirement to have a vacuum truck on site at all times would be cost-effective, especially in light of the existing liner and secondary containment requirements.

Response: Rather than have multiple bermed areas for drill rigs and containment areas, the Departments concurred that for compliance, enforcement, and overall spill containment purposes it is more effective to have one large bermed area encompassing the entire well pad and tank storage area.

(b) The frac fluid disclosure requirements seem appropriate, and the "system-based" disclosure regime should minimize non-disclosure requests based on proprietary information claims.

Response: the Departments concur.

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5. Noise and Visual Impacts. It is proposed that an operator be required to use electricity (if available) in place of diesel powered drilling rigs, compressors, pumps and generators. For a number of reasons (e.g. availability of equipment, cost of substitute equipment, etc.), I don't think this mandate is reasonable.

Response: Comment noted and availability is determined on a site-by-site basis and in consideration of practicality.

6. Wells and Formations. (a) I do not agree with the statement on page 2 of Appendix H that "evidence has shown contamination from methane to be a likely occurrence." Contamination from methane (other than naturally occurring methane) in oil and gas producing areas is due to one thing, the failure of well integrity. The risk of a well integrity failure can be minimized by following four (4) steps: (1) evaluating the geologic formations situated between the target hydrocarbon formation and the underground sources of fresh water to ensure they can prevent the hydraulic fractures from reaching the sources of fresh water; (2) constructing the well in accordance with robust well construction standards; (3) evaluating the mechanical integrity of the well before conducting the hydraulic fracturing treatment; and (4) monitoring both the hydraulic fracturing treatment (on a real time basis) and the producing well for abnormal pressure readings and ensure that the well maintains its integrity.

Response: The intent of the statement on p. 2 was not intended to indicate the frequency of contamination from methane, but that contamination from methane was more than contamination from liquids, according to the literature reviewed. The text has been edited to clarify this.

(b) If all four (4) steps to ensuring well integrity are followed, the setback distance can be reduced and allow for a more efficient recovery of the resource without jeopardizing the environment or the health and safety of the citizens in the area.

Response: Noted.

7. Enforcement. Making sure Maryland has a robust set of regulations to address the risks associated with unconventional gas well development is very important. However, Maryland must also ensure that it has an adequate number of trained inspectors in the field to enforce these regulations. Recognizing the reality of limited state budgets, it will be important for Maryland to (i) charge sufficient permitting fees to help support its field inspector needs and (ii) maintain a regulatory regime that minimizes administrative man-hours (i.e. processing permits, conducting hearings, etc.) and maximizes field enforcement man-hours.

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Response: The Departments concur that rigorous enforcement will be critical to ensuring proposed regulations and best management practices are followed. Having an appropriate fee structure in place to support this level of enforcement is paramount.

If you have any questions regarding these comments, please call (281-618-4806) or email (mboling@swm.com) me.

Best regards, Mark

Mark K. Boling President

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Comments from Mr. Michael McCawley, PhD, West Virginia University School of Public Health

I have limited my comments to those areas in which I feel I have the most experience and knowledge as a scientist, engineer and researcher. These comments, therefore, address only Appendix B. The factors considered in Appendix B for risk assessment for air emissions in general, particulate matter more specifically and combustion sources (diesel exhaust) most specifically, are not completely adequate. They do not account for:

- a. Traffic patterns away from the well site;
- b. The difficulties posed by valley stagnations in the region;
- c. Health effects documented for exposure to traffic sources.

In detail those problems with the report are:

a. Traffic patterns away from the well site

The assumption that seems to underlie the particulate air emissions risk assessment category of moderate on pages 28-29 and low, elsewhere, in Appendix B is that there will be a short duration of exposure to diesel exhaust which is further ameliorated by a 1000 foot setback at the well pad. However, consideration needs to be given to the traffic patterns in the affected counties. Having spent a lot of my free time over the last 40 years in the area where the drilling is planned I know that most of the roads are secondary and feed into a few main arteries. This could funnel most if not all of the traffic through the same areas of the counties for all of the well pads. **This would result in persistent exposures throughout the entire period of development of all wells, not just in the short duration and for the limited distance of a single wellpad.** There does not appear to be an objective value that is associated with the risk levels, but it would appear that some re-assessment of the risk level would be appropriate if this alternative approach to traffic burden was taken. If comparison is made to the classification of risk being moderate during hydraulic fracturing when the assuming a shorter duration and limited space, a categorization of "high" would seem to be more appropriate for the longer duration of traffic exposure. At the very least, the State should re-do their analysis to include a more realistic appraisal of traffic patterns and their effect on exposure. In my experience, a traffic study in the center of Montrose, PA would be a worthwhile case study yielding similar traffic patterns though not necessarily similar pollution levels due to differences in topography and meteorology to those I would expect to see in western Maryland.

Response: The Departments concur. This is why during the drilling and hydraulic fracturing phases, risks from combustion and noncombustion emissions associated with vehicle traffic are rated as high probability with insufficient information to determine consequences. Because the Departments do not know the routes of vehicle travel, miles traveled per vehicle, the specific emissions controls on vehicle fleets, and consequently no modeling could be done to estimate associated emissions impacts, risks could not confidently be assessed for these traffic impacts even though there is a high probability of occurrence. Moreover, the Departments also discuss in Appendix B the risks for cumulative and synergistic impacts given the high probability of multiple pollutant emissions during each phase.

b. The difficulties posed by valley stagnations in the region

There is an unacknowledged problem with terrain and meteorology throughout Appendix B. Modeling exercises by the State of New York and by the University of Michigan referenced in Appendix B fail to account for valley stagnations (a condition occurring in a valley consisting of low, i.e. less than 2m/s,

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wind speed and an inversion occurring together at the same time and place) for which the models developed by the EPA and used in those two references do not work. This is by the EPA's own admission. Because the terrain and weather conditions in the two counties are so different than the rest of Maryland it is easy to see how this could have been overlooked. The effect of overlooking valley stagnations is to incorrectly assume that a setback distance will automatically result in dilution of concentration with distance from the source. A valley stagnation allows an entire valley to experience nearly the same concentration due to pollutants emitted in the valley to remain trapped within a valley network and not disperse. This can also cause the actual concentration in the valley network to exceed the concentrations predicted by standard dispersion models. The result is directly analogous to the difference between an automobile idling on the street compared to one idling in a closed garage. The valley stagnation is akin to the closed garage. I pointed out this difficulty, though not in this detail, in the report to the West Virginia DEP referenced by you in Appendix B (McCawley, 2013). It should be noted that, after review, the West Virginia DEP, who should be familiar with problems of valley stagnations (having sued the State of Ohio, with my consultation, over just such problems) allowed to stand my reference to the problems with terrain and meteorology weighing against the use of a setback distance. **I would therefore suggest that using a 1000 foot setback distance as part of the rationale for lowering the risk assessment category for all pollutants is inappropriate and should be eliminated from the risk assessment.**

Response: This is an excellent comment and valley stagnations were not specifically considered during the risk assessment. As indicated in the response above there was insufficient information to assess emissions risks associated with vehicle traffic. The phenomenon of valley stagnations, in addition to the reasons mentioned in the above responses, is yet another good reason why there were insufficient data to assess vehicle emissions risks. It is also acknowledged in the air emissions risk assessment that the 1,000 setbacks were not designed to address emissions impacts from traffic and thus may not be effective in doing so. This is mainly because the setbacks are established from the well pad and thus cannot be determined appropriate for activities occurring off the well pad.

c. Health effects documented for exposure to traffic sources

Prediction of the possible health effects from traffic sources fall victim to the difficulties outlined in the previous two sections. That is, the extent and duration of exposure to at least some of the population may be greater than estimated by the current report and the amelioration of the exposure due to setbacks may not always be as great as estimated due to terrain and meteorology. Rather than a limited exposure time (the duration of a single well pad being drilled) over a very limited exposure area (within the 150 meters modeling distance), **the appropriate comparison of risk should be to populations exposed continuously to highway traffic sources, along the entire traffic route, for the entire duration of all drilling activities, in the kind of terrain and meteorology common to Western Maryland.** This should be scaled to the appropriate level of the volume of traffic once that is better estimated from a more thorough evaluation of the possible traffic patterns and volume that might occur. Factors for air contaminant build up from valley inversions and valley stagnations should also not be neglected.

Response: The Departments do not necessarily concur that the appropriate comparison of risk should be to populations exposed continuously to highway traffic sources, along the entire traffic route, for the entire duration of all drilling activities. However, the Departments do agree that more specific information is necessary, along the line discussed in the above responses before traffic emissions risks can be appropriately assessed.

One final comment alludes specifically to flaring. In the WV DEP study (McCawley 2013) referenced on page 29 of Appendix B the Maryland report mentions the measurement of benzene. The level of benzene during Flaring (noted as Flowback in Appendix B of the WV report) was 85 parts per billion, on average for a total of 72 hours. This is above the NIOSH recommended time weighted average exposure limit of

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100 ppb for 8 hours. This could be ameliorated by the setback distance of 1000 feet from the edge of the disturbed area of the pad. However, I have addressed the issue of setback above and if it is removed from consideration this is an issue with flaring that does not have minor consequences, contrary to the sentence at the end of the third paragraph on page 30 of Appendix B in the Maryland report.

Response: Per personal conversation, it was clarified that the flaring emissions mentioned above resulted from the monitoring station being located right next to the flare where higher emissions would be anticipated. As you indicate above Maryland's proposed 1,000-foot setbacks would be helpful in ameliorating these emissions and this was factored into the Departments' risk assessment for flaring impacts. Also, as mentioned in the above responses, the Departments considered that the 1,000-foot setbacks may not be effective in addressing traffic emissions because these occur away from the well pad. So the risk assessment appropriately considered setback effectiveness differently depending upon whether UGWD activities are conducted on or off the well pad.



Michael McCawley, Ph.D.

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Comments from Miss Hannah Wiseman, Florida State University College of Law

Overall comments: This is a thoroughly-researched, impressive analysis. It appears that the individuals who prepared this report invested copious amounts of time in identifying and analyzing sources and drawing reasoned conclusions from this extensive research. I am very impressed that administrative agency staff, who are generally known for having too many tasks and not nearly enough time or resources to support these tasks, worked so hard to produce such a high-quality product. Few organizations have embarked upon such a comprehensive effort to assess shale gas risks.

1. Is the methodology appropriate for the analysis?

Terminology: At various points you use hydraulic fracturing, hydraulic fracking, or fracking. Perhaps explain near the front of the report that you sometimes use the shortened term “fracking” and why you use it (ease of readership, etc.).

Response: Noted and efforts have been made to use a consistent terminology throughout the main and team reports.

Executive summary's description of methodology of risk evaluation:

It would be helpful for you to define “risk” up front. Do you envision risk as meaning prevalence of a particular event or activity multiplied by the probability and magnitude of harm associated with that event or activity? You suggest under “Purpose and Scope” on page 3 that risk include “probability and consequence”; perhaps elaborate on this at this point. Under “Individual risk assessments” on p. 6 you explain in more detail that probabilities were labeled as low, medium, or high and consequences were minor, moderate, or serious--this might be worth mentioning in the executive summary.

Response: Noted and revision made in the Exec Summary.

With respect to the eight categories of risk (listed in the Executive Summary and again on page 4), I realize that it would be difficult to address every category. However, might habitat fragmentation and wildlife impacts be worthy of having their own category? It appears that these impacts might best be grouped within the “noise and visual” category, but that category should potentially be more broadly named. Later in the assessment you consider fragmentation under “Site Identification and Preparation,” but that's a development phase and not a risk category, I believe.

Response: Habitat fragmentation and wildlife impacts were assessed within all of the relevant Appendices. Even though they may not be specifically given their own risk ranking, these impacts were incorporated under ecological risks. If there are revised drafts of the Risk Assessment in future, the Departments can consider whether specific identification of them in the risk tables is warranted.

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Also, the short names of the categories--at least as listed in the executive summary--sometimes indicate an activity or substance that can create risk (e.g., drill fluids and cuttings” or “water withdrawal”) or the actual risk or impact (e.g., road damage, or hydraulic fracturing fluids and potential impacts to surface or ground waters.”). Perhaps each category could include the activity/substance and a few words that indicate the types of potential risks associated with that category. On page 6 you break these into “risk agent or chemical,” “risk aspect,” and impacted receptor. Clearer definitions of “risk agent or chemical” and “risk aspect” would be helpful.

Response: Noted and revision made in the Exec. Summary.

In the executive summary, you discuss forested landscape fragmentation and partial solutions and water withdrawals in the same paragraph. Perhaps break up for clarity. Also perhaps clarify which risk category forested landscape fragmentation falls under.

Response: Noted and clarified in the Executive Summary.

Purpose and scope, p. 3 of Risk Assessment

What is the difference between “Human” and “Community” receptors? I presume that “Human” relates more to public health/quality of life for individual residents, whereas community relates to, for example, social issues such as quality of roads/overall mobility, the predominant economy of a town, or a shared sense of belonging and connection to a place, but a bit more description would be helpful.

Response: Noted and clarified in the text.

Consideration of best management practices, p. 5 of Risk Assessment

What do you mean by the lack of “data confirming efficiencies of technology-based BMPs”? I think that there are at least two types of data that are not yet available in the literature: 1) data on the efficacy of technology-based BMPs in terms of the degree to which they result in lower harm to receptors when properly deployed; and 2) the expense of the BMPs as compared to their effectiveness in reducing harm/risk.

Response: By efficiencies, the Departments were referring to item 1 and the efficacy of technology-based BMPs in terms of mitigating harm to receptors. This has been clarified in the text.

Table 3, Risk Ranking Methodology on p. 6 of Risk Assessment: Why is a moderate consequence combined with a high probability of risk ranked “High,” as is the serious consequence with a medium probability of occurring? Intuitively, I think this makes sense: something with a “considerable adverse impact on people or the environment” that has a high probability of occurring seems to be high risk, but perhaps further explain.

Response: Noted and clarified in text.

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Risk Assessment for Phases of Unconventional Gas Well Development--Phase 1: Site Identification and Preparation

It is good that the assessment addresses geophysical surveys--these are important for all oil and gas exploration and have risks, albeit relatively small ones compared to certain phases of well development.

p. 10 of Risk Assessment: It is good that the assessment addresses “withdrawals of large amounts of water over compressed periods of time.” Although hydraulic fracturing uses a small quantity of water as compared to industrial and municipal uses, simultaneous withdrawals of water for fracturing, particularly during a drought, can harm aquatic species by causing low stream flows. See, e.g., US Fish and Wildlife Service, Natural Gas and Wildlife, <http://www.fws.gov/northeast/EcologicalServices/energygas.html>; Susquehanna River Basin Commission, 64 Water Withdrawals for Natural Gas Drilling and Other Uses Suspended to Protect Streams July 16, 2012, <http://www.srbcc.net/newsroom/NewsReleasePrintFriendly.aspx?NewsReleaseID=90> (‘Under SRBC’s passby flow restrictions, when streams drop to predetermined protected low flow levels, operators who are required to meet the agency’s passby requirement must stop taking water.’); West Virginia Code § 22-6A-7 (requiring a water management plan that describes how minimum in-stream flow will be maintained immediately below the point of withdrawal and ‘[m]ethods to be used for surface water withdrawal to minimize adverse impact to aquatic life’). It is also good that you recognize that impacts from water withdrawals vary depending on the time of year.

Response: Noted

2. Are important assumptions identified and uncertainties stated?

The report authors are careful to identify the risks not addressed (e.g., downstream pipelines) and to describe the areas in which there was insufficient evidence to support risk-based conclusions.

p. 9 of Risk Assessment: “numerous tank truck loads of water that must be brought to the site for hydraulic fracking.” Perhaps mention that truck traffic is much lower if water is carried to the well site via pipeline, as it sometimes is.

Response: Noted and clarified in text.

Although “best management practices” is a commonly-used term, it’s not clear in oil and gas that anyone has identified the practices that will *best* reduce risk—i.e., there are few assessments of whether the most stringent controls will lead to substantially improved environmental/social performance, or when, whether, and why the most stringent controls (e.g., most sophisticated technology) will consistently lead to better environmental performance than other options. Your discussion of the practices that are likely to lead to the best performance, however, is extremely helpful—I agree that relying on technology and clear substantive standards rather than vaguer “plans” is likely to lead to improved environmental and social performance. Perhaps define “BMPs” in a bit more detail. Some studies have begun to assess whether oil and gas BMPs are

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based on science, which does not indicate whether they produce good results but provides useful initial data for evaluating BMPs. See, e.g., Scott Bearer et al., Evaluating the Scientific Support of Conservation Best Management Practices for Shale Gas Extraction in the Appalachian Basin, Environmental Practice December 2012.

Response: Noted. Discussion of specific BMPs used to mitigate risk are discussed in the appendices. The main report only strives to discuss the general principles used to evaluate BMPs in each team risk assessment.

Appendix B., p. 20: You explain why you use offshore blowout data, but perhaps mention that the blowout rates are likely quite different for offshore and onshore wells. Another blowout source for onshore wells is: <http://www.rrc.state.tx.us/oil-gas/compliance-enforcement/blowouts-and-well-control-problems/>.

Response: Reviewed the cited source and added this to the references. Also, put additional clarifying text in Appendix B.

Appendix B, p. 31: You mention the low rate of blowouts and conclude that the greatest risk is to workers on site, but in your later discussion of spills and releases at the surface, do you mention the blowouts that have occurred during hydraulic fracturing that have thrown pollutants into nearby waters, including rivers that run interstate? See, e.g., <http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=12818&typeid=1>; <http://www.oag.state.md.us/Press/2012/061412.html>.

Response: Yes. Appendix D has a section that specifically evaluates the risk of pollution contamination from well blowouts.

Also, the number of blowouts that have occurred at Pennsylvania Marcellus wells might possibly suggest a blowout rate higher than the Association of Oil and Gas Producers' estimate of 4 blowouts for every 100,000 wells? See also Texas study mentioned above <http://www.rrc.state.tx.us/oil-gas/compliance-enforcement/blowouts-and-well-control-problems/>.

Response: Made a call to Kimberly Dally of the Railroad Commission of Texas to get additional clarification/context for these numbers. Left a message and my call has not been returned to date.

3. Are the conclusions and inferences logically supported by the evidence presented?

The amount of careful and detailed research that you invested in this report is highly impressive, and the report appears to very carefully assess the risk based on sound evidence; the report consistently avoids overstating and does not appear to jump to unfounded conclusions. The report's explanation of how it assessed risk, and its methodology for doing so, seems very reasonable: the authors correctly identify two important risk components, which are the probability of occurrence/probability and the magnitude of harm. The authors also carefully delineate and define different probabilities and magnitudes of harm.

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If you do not reference it already, the report Environmental Impacts of Shale Gas Extraction in Canada would be helpful to your analysis

http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/Shale%20gas/ShaleGas_fullreportEN.pdf, as would the European Commission Impact Assessment: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0021&from=EN>.

Response: Thank you and noted.

On p. 8 of the Risk Assessment, I am not sure that “[c]ontamination of soil, surface or groundwater is generally not a concern” during the site identification and preparation stage. A number of spills at oil and gas sites are from diesel that sits in tanks on sites for use in diesel trucks and other equipment, and diesel equipment is used for site preparation. Further, several problems noted by inspectors at well sites have indicated substantial erosion of soil from well sites, which could perhaps contribute to contamination of surface water. See, e.g., API 05-081-07359.(Colorado tight gas well): “Erosion channels are present around the edge of the pad No storm water BMP’s are present at the pad site” “Failures to minimize accelerated erosion” and to stabilize earth disturbances in watersheds at Pennsylvania Marcellus shale sites for well permit numbers 105-21626, 131-20015, 105-21633. In Michigan, inspectors noted a “badly-eroded” access road at an Antrim shale site, well permit no. 49851.

Response: It is correct that chemical spills can occur during the site preparation phase, but this is generally expected not to be a concern relative to the volume of hydraulic fracturing chemicals on site. Concerning sediment and soil erosion, Maryland already has current sediment and erosion control regulations/enforcement in place and is also recommending prohibitions against constructing well pads on steep slopes.

p. 10 of Risk Assessment: “The stringent controls on well casing and cementing . . . are among the many best practices” comes a bit abruptly because the previous sentences discussed gathering lines specifically. Perhaps start a new paragraph here.

Response: As suggested, a new paragraph was started here so as to be not so abrupt.

p.11 of Risk Assessment: Insufficient data on number of compressors needed. There is available data on compressors needed for interstate natural gas pipelines (see, e.g., the new Sabal Trail proposal--500 miles of pipeline, 5 new compressor stations), but perhaps you’re suggesting that the number of compressor stations needed for smaller pipelines in different geographies varies.

Response: That is correct. The emissions risks from compressors needed for the smaller pipelines could not be assessed because of uncertainties with location, fuel type and number of compressors used. This is stated in the text.

p. 11 of Risk Assessment:--conclusion that water and soil contamination risks related to subsurface leaks is low during abandonment phase. To conclude that the reclamation requirements would be adequate and would indeed ensure low risk of leaks from plugged and abandoned wells, I’d want more up-front information (even in this summary portion) about

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bonding requirements, how wells will be plugged if operators fail to adequately plug them, how proper plugging will be verified before the bond is released, etc. I agree that methane leakage seems to be primarily from old wells that were abandoned before stringent plugging requirements were in place, but I'd want more data on the adequacy of the current and proposed best practices plugging requirements.

Response: The requirement for plugging of wells is very briefly summarized in the Appendix. There are many more requirements for plugging and abandonment in Code of Maryland Regulations 26.19.01.12 and .13.

Appendix B, p. 2: Do Maryland's regulations addressing oil spills have a substantial impact on air emissions? I understand why the gas leak rules apply here, but not so much the oil spills.

Response: Both oil and gas are covered under the same regulation, so that is why they were both referenced in this section.

Appendix B, p. 3: What type of BATs--for tanks? For wellheads? The first paragraph is a bit confusing until one reads table 2 on p. 4. Also, what about controls specific to condensate tanks rather than storage tanks generally? Might those specific controls be needed? Or because Maryland overlies a predominantly dry gas portion of the Marcellus, as you mention later, will condensate levels below and not of concern?

Response: Some additional clarification is provided in the text to hopefully address this confusion. As to the question regarding controls specific to condensate tanks, the Department intends to require top-down Best Available Technology (BAT) for the control of air emissions. This means that the applicant will be required to consider all available technology and implement BAT control technologies unless it can demonstrate that those control technologies are not feasible, are cost-prohibitive or will not meaningfully reduce emissions from that component or piece of equipment. This would include condensate tanks used on the well pad. Since it cannot be determined what specific technologies this will entail and for what equipment, this also makes it difficult to determine the degree to which air emissions risks will be mitigated. This difficulty is what is expressed in the guidelines risk assessors used for determining BMPs effectiveness (see bullets 2 and 3). Finally, you are correct in that mostly dry gas is anticipated in Maryland (see figure 1 and associated discussion).

Appendix D, p. 17: No citation provided for probability of well blowout as 1 in 1,000. Earlier in the report you provided citations for well blow-out rates, both onshore and offshore, and these rates were different (perhaps they involved fracturing rather than drilling). Reconcile this/provide cites.

Response: The well blow-out incident rate in Appendix D has been changed to 1.2 in 1,000 wells to be consistent with the incident rate presented in Appendix B. This rate is applicable for well blowouts during the drilling phase while the incident rate of 4.5 in 10,000 well applies to the production phase. Therefore, different rates have been presented in this report in relation to specific phases within UGWD.

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Throughout Appendix D: Recommendations for using tanks rather than pits make sense to me because a number of releases of drilling and fracturing materials appear to occur from pits and failed or torn pit liners. To the extent that pits are allowed, if at all (which they appear to not be in Maryland), I'd recommend specific requirements such as all pit liner seams must be sealed (25 PA ADC § 78.56), liner material must be compatible with substance in pit (25 PA ADC § 78.56); pit must be kept free of debris that could tear the liner (25 PA ADC § 78.56), and liner edge must be secured to prevent wind damage (Neb. Admin. R. & Regs. Tit. 267, Ch. 3, § 012).

Response: MDE's Best Practices report states that "Maryland does not make recommendations for the construction of pits and ponds, but recommends that they should be used only to collect or store freshwater; all other materials shall be stored in tanks." If a pit is used for the storage of freshwater, current Maryland regulations require pits and ponds to be impermeable and to not allow liquid or solid discharge into the waters of the State. Therefore the specific requirements suggested by the commenter would be addressed.

Appendix E, p. 20: I think that requiring vacuum trucks to stand by in the event of a spill during fracturing is a good recommendation.

Response: Maryland will consider this additional proposed BMP for potential inclusion among Maryland's proposed practices.

4. Are there data, other evidence or additional risks not included that should be considered?

The report is extremely thorough and appears to cover all of the major risks.

Under "Summary of Risks" on p. 8 of the Risk Assessment I don't see discussion of geophysical survey risks, such as soil erosion and compaction from "thumper trucks," vibrations from shot holes or thumper trucks, noise from helicopters if helicopters are used, pollution that can collect in unfilled shot holes. I might have missed this discussion on another page.

Response: No literature could be found identifying impacts from seismic assessment activity, so risks for this activity were not assessed. This has been clarified in the text.

See also comment under item 3 regarding p. 8 of the Risk Assessment, evidence of diesel spills during site construction and erosion/sedimentation from well sites.

Response: Noted.

Appendix B, p. 1: for non-combustion emissions you might want to specifically indicate emissions from condensate tanks. These were the largest single contributor to ground-level ozone problems in the Denver area before Colorado implemented more stringent controls on emissions from these tanks. See, e.g. https://www.colorado.gov/pacific/sites/default/files/AP_PO_Denver-Ozone-Action-Plan-2008.pdf (p. III-6). (But per your analysis in Appendix B p. 8, perhaps because there is more dry

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gas and few NGLs in the eastern portion of the play, condensates are of minimal concern in Maryland.)

Response: Volatile organic compounds are identified on page 1 as a key noncombustion emission which would effectively include condensate tanks. Also, emissions from condensate tanks are specifically evaluated in the section on “Phase 5 and 6: Production/Processing and Ancillary Infrastructure” risk assessment.

Appendix B, pp. 4-5: Would you consider requiring mufflers on all equipment, similar to City of Fort Worth, Ordinance No. 18449-02-2009 § 15-42? You mention air modeling to demonstrate compliance. Would you consider a more specific monitoring program that monitored air emissions near oil and gas sites, as is being conducted in Garfield County, Colorado <http://www.garfield-county.com/air-quality/>?

Response: Mufflers on the stationary sources are one of the technologies that will be considered in op-down BAT. Also, the Department will be requiring expanded air emissions monitoring.

Appendix B, p. 11: You use N/A under Non-Combustion Sources and Accidents, whereas I believe you used NA in the risk table earlier. Perhaps explain the difference between N/A and NA.

Response: Corrected. This is a typo and there is no difference between NA and N/A – the both mean not-assessed.

Appendix B, p. 12: “No literature sources quantifying air emissions from seismic survey assessments were found.” See Oil and Gas Emission Inventory Improvement Plan, Eagle Ford , Technical Proposal:

Equation 0-1 will be used to calculate emissions from seismic trucks operation in the Eagle Ford.

Equation 0-1, Ozone season day seismic trucks emissions

$E_{\text{Seismic.BC}}$ = (NUM_{BC} / WPAD_B) x POP x HP x HRS x LF x EF / 907,184.74 grams per ton / 365 days/year

Where,

$E_{\text{Seismic.BC}}$ = Ozone season day NO_x, VOC, or CO emissions from seismic trucks in county B for Eagle Ford development well type C (gas or oil)

NUM_{BC} = Number of wells drilled in county B for Eagle Ford development well type C, from **Error! Reference source not found.** (from Schlumberger Limited)

WPAD_B = Number of Wells per Pad for county B, **Error! Reference source not found.** (calculated from data provided by the Railroad Commission of Texas)

POP = Number of seismic trucks, 3 (from Marathon Oil Corporation in the Eagle Ford)

HP = Average horsepower seismic trucks, 400hp (based on average hp of seismic trucks from Equipment Manufactures)

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HRS = Hours per pad construction, 2 hours per well pad (from Marathon Oil Corporation in the Eagle Ford)
 LF = Load factor for off road trucks, 0.59 (from TexN Model)
 EF = Emission factor for off road trucks, 3.713 g/hp-hr for NO_x, 0.238 g/hp-hr for VOC, or 1.222 g/hp-hr for CO (from TexN Model)

Emission inventory input factors, non-road, from Oil and Gas Emission Inventory Improvement Plan, Eagle Ford , Technical Proposal:

Stage	Equipm ent Type	Fuel Type	Popul ation	HP	Activity	LF	NO _x EF (g/hp- hr)	VOC EF (g/hp -hr)	CO EF (g/hp-hr)	Eq. Type Percen tage
Exploration										
	Seismic Trucks	Diesel	2	40 0	2 hours / Well Pad	0.59	3.71	0.24	1.22	100%

Response: Thank you for providing this source which has been included in the risk assessment. No change in air emissions risk from seismic assessment activities is projected due to the limited duration and scope of this activity.

Appendix B, p. 12: You mention one drill buggy and thumper truck. I believe that helicopters are sometimes used in the Marcellus to drop off seismic equipment and/or drill shot holes while producing a smaller surface footprint. I’m not sure whether estimates of helicopter emissions associated with seismic activity are available.

Response: The Department relied on information and equipment identified in permit applications, which did not include helicopters.

Appendix B, p. 14: “There was scant literature found on site preparation activities.” See again Oil and Gas Emission Inventory Improvement Plan, Eagle Ford, Technical Proposal.

Response: Noted.

Appendix B, p. 19: Water hauling estimated 6000 truck trips. Note that sometimes water is carried to well sites using a pipeline.

Response: This is correct, but trucks are the predominate method of water transport.

Appendix B, p. 20: “The State of New York Supplemental Generic Environmental Impact Statement . . . is the only study found where modeling of combustion emissions during drilling was performed.” But see Oil and Gas Emission Inventory Improvement Plan, Eagle Ford, Technical Proposal (projected the likely air impacts).

Response: Noted.

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Appendix B., p. 20: You explain why you use offshore blowout data, but perhaps mention that the blowout rates are likely quite different for offshore and onshore. Another blowout source for onshore is: <http://www.rrc.state.tx.us/oil-gas/compliance-enforcement/blowouts-and-well-control-problems/>.

Response: The Departments contacted the Texas Railroad Commission for additional clarification on these data to help determine incident rates, but calls were not returned. Accordingly, the information provided on the Web was of limited use.

Appendix C, p. 1: In risks of traffic, road damage, if you don't do so elsewhere it might be worth specifically mentioning concerns about truck traffic and school buses/children waiting at bus stops. I believe that some municipalities have routed trucks around school bus routes and have limited truck traffic during the beginning and end of school days.

Response: School buses, hours of day, and routes are discussed within the Proposed Best Management Practices section. Associated decisions would be part of transportation planning in the Comprehensive Gas Development Plan.

Appendix C, p. 11: In truck accidents, if you do not mention it elsewhere, perhaps also discuss the CDC report on rates of accidents in oil and gas trucking industry: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5716a3.htm>.

Response: This CDC report was referenced and discussed in the Roadway Accidents section under Risk Mitigation.

Appendix D, p. 7: "State agencies will develop standard protocols for baseline and environmental assessment monitoring and standards for monitoring during operations." You might specifically consider Colorado's requirements for water testing before, during, and after operations http://cogcc.state.co.us/RR_HF2012/Groundwater/FinalRules/FinalRule609-01092013.pdf, as well as Michigan's requirement for the installation of groundwater monitoring downgradient of wells if a monitor is not placed within the secondary containment and a hydrogeological investigation MICH. ADMIN. CODE r. 324.1002(3)(a). (You might have mentioned these elsewhere in the report.) Will both groundwater and surface water resources be tested?

Response: MDE will take into consideration the commenter's suggestion that Maryland refer to Colorado and Michigan water quality monitoring requirements in the development of monitoring protocols and standards. Maryland recommends that the baseline and environmental assessment monitoring will include groundwater and surface water sample collection.

Appendix D, p. 9: Your flow chart indicating whether and how released drilling fluid additives are likely to contaminate surface or groundwater is quite helpful.

Appendix D, pp. 10-11: You mention a number of secondary containment measures. Might you consider requiring that operators place plastic over the entire wellpad before commencing

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drilling operations and cover the plastic with gravel? I believe that Rice Energy might routinely do this in Pennsylvania.

Response: Maryland recommends that the well pad be underlain by an impermeable synthetic liner and protected by decking material. This BMP addresses the commentor's suggestion that the well pad be covered with plastic and graveled. The liner will be composed of a polymeric (plastic) material and instead of gravel, decking material will be placed over the liner to prevent damage during site operations.

Appendix D, pp. 11-12: You mention that storms could cause overflows and berm failures. Did you consider requirements in Pennsylvania and Michigan, in which secondary containment under certain types of pits must be at least 110% of 150% the volume of the largest tank?

Response: Maryland recommends that all tanks and containers be surrounded with a continuous dike or wall capable of holding the total volume of the largest storage container or tank within the area enclosed by the dike or wall. In addition an impermeable berm will surround the entire well pad.

Appendix D, pp. 14-15: At some point do you discuss build-up of radiation in the drilling equipment due to NORM contact and monitoring for this build-up? This would be more of a worker safety consideration, which I believe is not the focus of the report, so it is perhaps not as relevant.

Response: Build up of radiation in drilling equipment due to NORM contact and monitoring for this build-up was not addressed in this Risk Assessment. Appendix D focused on the potential for NORM to contaminate surface water or ground water leading to aquatic life or human health impacts.

Also, I believe that at some point within the drilling and/or fracturing appendices you discuss the transfer of used drilling fluids, flowback from the well to tanks on site. Do you at some point recommend that high-density polyethylene pipe be used to transport substances from the well to tanks? (Marcellus Shale Advisory Commn., recommendation 9.2.23).

Response: The Drilling and Fracturing Appendices state that all fluids will be contained within a closed loop system therefore all fluids will be transferred from the well directly to tanks on site. The report does not specifically mention it is recommended that high-density polyethylene pipe be used to transport substances from the well to tanks. This recommendation would fall under MDE's Best Practices Report.

Appendix D, p. 21: Would you consider requiring that all drill cuttings be placed on an impermeable barrier? See, e.g., Intermountain Oil and Gas BMP Project, <http://www.oilandgasbmps.org/view.php?id=7999> (citing to Bureau of Land Mgmt., Record of Decision – West Tavaputs Plateau Natural Gas Full Field Development Plan: Attachment 2).

Response: Maryland recommends that drill cuttings be tested to determine whether contaminant levels and radioactivity require that the materials be disposed of in a lined

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landfill equipped to handle hazardous waste to ensure these contaminants do not enter the groundwater. Onsite disposal could be allowed if these levels do not exceed standards established by MDE. In this case an impermeable barrier would be unnecessary.

Appendix E: It is worth mentioning somewhere near the beginning of this Appendix that requiring “green” fracturing fluids or prohibiting the use of diesel, benzene, toluene, ethylbenzene, and xylene in fracturing fluids would limit risks at all stages of fracturing, from the transportation of fracturing chemicals through the fracturing of the well. For limits or proposed limits on the types of chemicals used in fracturing fluids, see, e.g., IDAPA 20.07.02.056 (02) (Idaho); 15A NCAC 05H.1604 (North Carolina--proposed).

Response: The proposed regulation 26.19.28(B) states that diesel fuel shale not be used in hydraulic fracturing. On page 5 of the Appendix E it states: “MDE must approve the use of any chemical, and will encourage the use of less dangerous chemicals.” Regarding other requirements for “green” fracturing fluids, an additional statement has been added to the “Suggestions for Additional Mitigation” section of Appendix E. Maryland will consider these additional proposed BMPs for potential inclusion among Maryland’s proposed practices.

Appendix H, p. 11: Induced seismicity. Other important sources include Katie M. Keranen et al., Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injections and the 2011 Mw 5.7 earthquake sequence, *Geology* 2014; Cliff Frohlich et al., The Dallas-Fort Worth Earthquake Sequence: October 2008 through May 2009, *Bull. Of the Seismological Society of America*; Ohio DNR, preliminary report on the Youngstown incident.

Response: Noted.

5. Other observations

P. 5 of Risk Assessment--“Error! Reference Source not found.” comes up for one reference link.

Appendix B, p. 15: extremely minor grammatical point--“the probability of combustion emissions . . . are considered high”; change to “is” because refers to probability.

Response: Correction made.

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Comments Received from Miss Kate Konschnik, Environmental Law Program, Harvard

I submit for your review and consideration my comments on Maryland's Marcellus Shale Risk Assessment (RA). At the outset, I wish to express my deep appreciation to the authors of this report. The document reflects a lot of hard work and improves on other risk assessments, for instance by considering the cumulative effect of actions taken in the Marcellus region of the state (see, e.g., page 41 of Appendix B). I urge Governor O'Malley and Governor-Elect Hogan to rely on this RA for any future decisions regarding shale gas development in Maryland.

In summary, I offer recommendations in the following categories:

- Maryland's Methodology and Structure of the Risk Assessment.
- Maryland's Assumptions and Stated Uncertainties
- Maryland's Conclusions and Inferences
- Additional Data and Evidence to Consider
- Additional BMPs to Consider
- Small Editing Suggestions

Thank you very much for considering these comments. Please do not hesitate to reach out if you have any questions or need further information on any of these points.

Maryland's Methodology and Structure of the Risk Assessment

RECOMMENDATION #1: Consider modest changes to RA methodology and structure.

The RA describes 8 categories of risks, evaluated across five phases of unconventional gas well development. Appendix A lists dozens of risks that do not appear organized by risk category.

- a. **Recommendation 1(a):** Arrange the risks in Appendix A to track the 8 categories of risk. Headings of the 8 categories would be helpful.

Response: Cross-references have been provided in Appendix A.

Page 5 of the core document describes how the report team considered best management practices (BMPs). I strongly support this approach, which places a higher value on prescriptive and well-established BMPs than qualitative, flexible, or unproven BMPs. However, the five bullets are a bit unclear.

Response: Clarified in the text to indicate that effectiveness is in terms of a BMPs ability to mitigate risks to human and ecological receptors.

Table 3 on page 7 of the core document describes the risk ranking methodology. Sometimes the relative risk ranking is not clear. For instance, a moderate consequence with high probability is

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“high risk,” as are a serious consequence with medium probability and a serious consequence with high probability. Are they the same level of “high risk?”

b. Recommendation 1(c): Describe the risk ranking process a bit more.

Response: The risk assessment team took this, and other similar comments, seriously and considered changing the overall risk ranking to better portray these nuances. However, the Departments ultimately decided to keep the overall risk ranking methodology the same for the following reasons:

- 1. The risk assessment is qualitative in nature and does not have the level of resolution (i.e., a solid quantitative basis) to confidently distinguish between the different kinds of overall high risk that you mention in your comment; and,**
- 2. If one wants to get into the details, each appendix documents both the probability and consequence that factored into the overall risk ranking so that reviewers can wade into that level of detail if so desired.**

Clarification along these lines has been provided in the text.

Very few risk rankings change between the low scenario and high scenario. Is that because the number of wells projects under the low and high scenarios are not so different? Is it because the RA is not sensitive to different inputs? Or, as noted on page 43 of Appendix B, reviewers did not have enough information to detect a difference?

c. Recommendation 1(d): Describe in the core document why risk rankings remain the same for most risks under the high and low scenario, and what is different about the handful of risks where the two scenarios drive different conclusions.

Response: There are two reasons the risk assessment generally didn't identify a difference in risk between the two scenarios. The first reason is that for many risks (e.g., spills, well failures, noise, water withdrawals, etc.), increases in the number of wells drilled either did not change either the probability or consequence enough to change the overall risk ranking. For example, a low probability and a minor consequence has the same overall risk ranking (i.e., low) as a medium probability and a minor consequence or a low probability and moderate consequence. The second reason is that in some cases where a numeric value was provided (e.g., the rate of accidents associated with increases in well drilling) it was a flat rate and independent of the number of wells drilled.

Furthermore, and in specific instances like truck traffic, the differences between scenarios were much smaller than the differences between UGWD phases. For example, moving from the Site Identification to the Drilling phase, the increase in truck trips is 15x, about one magnitude, as well as a shorter time frame in which to complete those trips. Between Drilling and Hydraulic Fracturing & Well Completion, there is another 5x increase in trips, about another magnitude, again to be completed within a short time frame. Finally,

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moving from that step to Production, Site Reclamation, & Well Abandonment, there is a drop down of about 1/20th, and two magnitudes. This final step also takes place over a longer duration, making the intensity of truck traffic lower. However, comparing between Scenarios, the difference is not as great. Within each step, Scenario 2 is 3x greater than Scenario 1. Visually, the graph demonstrates that steps are more indicative of truck trip intensity categories than Scenarios. Therefore, steps were used to inform probability designations for each traffic- and road-damage-related risk.

Overall, the only place where risks changed between the two scenarios was for air emissions during flowback and for gathering lines. The difference in air emissions was a result of the second scenario being projected to result in almost year-round emissions, whereas the first scenario was projected to occur for approximately one-third of the year. This has been clarified in the core document.

Page 12 of Appendix B explains that the high/low end scenarios would not drive a different outcome for air pollution from seismic activity because “a single survey application from PA General Energy Company covered an approximately 3.9 mile transect.”

- d. Recommendation 1(e):** Add another sentence to finish the thought – what is the relevance of the 3.9 mile transect? How large is the potential development area? Or is the high end scenario projected to take place over the same area as the low end scenario? (As a related point, page 14 of Appendix B noted a “common assumption” that there will only be one well pad per square mile but did not explain basis for this.)

Response: Clarification has been provided in the text.

For the most part, the report team described the scope of each assessment quite well. However, the scope of the air pollution assessment was a bit unclear. Appendix B discusses a number of different pieces of emitting equipment, but does not specify which are considered in the RA. Page 36 of Appendix B says the RA considers the well pad, one off-site compressor, and on-site gathering lines. Page 37 mentions a line heater and two compressors (one on-site and one off-site). Page 38 reports the results of a New York study regarding glycol dehydrators, and a site visit to West Virginia where authors saw five compressors on a well pad.

- f. Recommendation 1(f):** Clarify the equipment considered in the air emissions risk assessment in Appendix B.

Response: The scope of air emissions for this phase is identified in the scope section of the document, as well as indicated in the risk assessment table (Table 20). Other information provided is a result of the literature search or actual field observations. Where this other information indicates uncertainty with assumptions, this is considered in the risk ranking.

Appendix B broke out “activity duration and scope” from the description. I found this quite useful, since these factors are assumptions relied on for the risk assessment.

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- g. Recommendation 1(g):** Break out “activity duration and scope” across all appendices.

Response: As mentioned in the core document, the duration assumptions are consistent across each risk assessment. The scope varies for each risk assessment, but is fully explained in each appendix. If time permits, staff will specifically break out duration and scope in each assessment.

Appendix G included a “rationale for findings”. I found this to be an incredibly useful format for a reader, to identify quickly the basis for assumptions and conclusions.

- h. Recommendation 1(h):** Include a “rationale for findings” section in the discussions throughout the Appendices.

Response: Since the risk assessment was such a resource intensive effort for the Departments, it was necessary to group risks and the break into teams to develop the appendices that assessed each set of grouped risks. The up side of this approach is that each appendix was independent assessment arguably less prone to any central bias; the down side is that the Departments struggled to maintain complete consistency in formatting and presentation of the findings. Regardless, the Departments are confident that each appendix provides adequate rationale for the risk assessment findings. Where public comments indicate specific areas where full discussion is not provided, the Departments will include additional explanatory language to shore up those areas.

Maryland's Assumptions and Stated Uncertainties

RECOMMENDATION #2: Reconsider the assumption of a 100% compliance rate.

The core document and the Appendices assume a 100% compliance rate with state rules and BMPs. This is highly unlikely.

A [2014 paper reviewing compliance data from Pennsylvania](#) reported that of the 8030 wells targeting the Marcellus shale inspected between 2005 and 2013, 6.3% reported violations based on well barrier or integrity failure. In turn, this paper cited a study of 3533 Pennsylvania wells monitored between 2008 and 2011; of these, there were 85 cases of cement or casing failures (2.4%), 4 blowouts, and 2 examples of gas venting. [NOTE: I provide a description and link to this study on page 7 of these comments.]

Compliance rates in other state oil & gas programs, or compliance rates with existing rules in Maryland (such as storm water runoff) could be used to predict levels of compliance.

This may not change the report's risk conclusions, since it may be difficult to quantify the additional risk posed by a predicted rate of non-compliance. At the very least, the RA could

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observe that risk conclusions appear conservative, given their assumption of a 100% compliance rate which is highly unlikely under the best of circumstances, despite all the best intentions.

Response: This is not entirely correct. In ranking and evaluating the best management practices, the Departments developed the guidelines discussed in the core document and mentioned in recommendation 1(b) above. These general guidelines were used by the teams to determine the degree to which best management practices would mitigate risk and included consideration that some practices are more difficult to enforce. Also, if you look at the definition for “medium” under probability (Table 2 in the core document) it includes a recognition that best practices will fall below standards.

In specific cases, for example well pad construction, it may be reasonable to generally assume design standards will be followed.

RECOMMENDATION #3: Describe Towson's modeling of the “boom and bust” cycle, as basis for intensity assumptions.

Page 5 of the core document provides well and well pad development assumptions for Maryland. These are based on scenarios crafted by Towson University's Regional Economic Studies Institute in consultation with the MDE and DNR. However, there is no explanation of the basis for these assumptions. A brief explanation for the pace of drilling and total wells drilled (what is the basis for thinking 600 wells would be the total number necessary to exploit 100% of the available natural gas resource?) would be helpful.

Response: Clarification provided in the text.

RECOMMENDATION #4: Consider active states for duration of activity assumptions.

The duration of activities for each phase of unconventional gas well development are based on the New York Supplemental General EIS and draft permit applications submitted to Maryland. Meanwhile, large scale unconventional gas production is occurring in other Marcellus shale states, including West Virginia and Pennsylvania. Where possible, it makes sense to rely on data in active drilling states for these assumptions, rather than data from states with a moratorium on high volume hydraulic fracturing.

For instance, it is very helpful when the RA relies on a Pennsylvania spill study (page 10, Appendix D), or a tour of West Virginia sites to assess traffic volume (page 10, Appendix C), since these neighboring states share characteristics with Western Maryland and its dry gas Marcellus shale play. For this reason, I suggest that the report team consult the Pennsylvania studies I've cited below, in Recommendations #9 and #10.

Response: In developing their EIS, NY used data from both the Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission on the “events, regulations, enforcement and other matters” associated with UGWD. They also used information provided on industry both the Independent

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Oil and Gas Association of New York. Maryland supplemented this with information from the Environmental Protection Agency and draft permit applications submitted to Maryland Department of the Environment. The Departments are confident with their duration assumptions given the multiple sources of information and, where appropriate, use of duration ranges.

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RECOMMENDATION #5: Explain the assumption about drilling rig size.

On Page 18 of Appendix B, the RA assumes drilling rigs will be 5,400 hp. However, later on page 18 (and on page 20 of Appendix D), the RA assumes that two drilling rigs will be used at a site – one large, and one small. Does the 5,400 hp size represent both rigs, or does it represent one size of rig? Meanwhile, Argonne National Lab has assumed rigs will be 2,000 hp. The report team might consider explaining the basis for this assumption.

Response: A 5,400 hp rig drill was assumed for emissions modeling purposes in New York’s Supplemental Generic Environmental Impact Statement (SGEIS). Maryland used these same emissions estimates when discussing criteria pollutant impacts associated with drill rigs. However, New York (page 5-25) also indicates that multiple sized drill rigs can be operated simultaneously on site where a small rig is used to begin drilling the vertical portion of one well while a larger rig is being used to finish the horizontal portion of a previous well. Accordingly, an assumption of two (one large and one small) simultaneously operating drill rigs was assumed as a more conservative assumption for the risk assessment. This has been clarified in the text.

RECOMMENDATION #6: Explain the assumptions of “simultaneous emissions.”

On Page 14 of Appendix B, the RA assumes site preparation would occur simultaneously at multiple well pads under the low end scenario, which projects an average of 2.5 well pads developed each year, or an annual maximum of 4 well pads over 16 weeks of activity. On page 27 of Appendix B, the RA assumes hydraulic fracturing would occur simultaneously at different pads under the low end scenario, which projects a maximum 75 days of activity each year. The report team may need to explain the basis for assuming that site preparation will occur during the same 16 weeks, and that fracturing will occur over the same 75 days.

Response: The Departments could not determine that emissions would not occur simultaneously and thus conservatively assumed they would.

Maryland’s Conclusions and Inferences

RECOMMENDATION #7: Explain the discrepancy between the conclusions for air pollution from trucks during different phases of development.

Below is an excerpt from Appendix A, making risk conclusions about air pollution from truck traffic during different phases of development:

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Aspect	Agent/ chemical	Impact on	Phase				
			Site identification/ preparation	Drilling, casing and cementing	HVHF / Well completion	Production	Well abandonment/ reclamation
Truck trips	Dust/PM	Human	Moderate	Insufficient data	Low for Scenario 1, Insufficient for Scenario 2	Moderate	Low
Truck trips	NOx, benzene, PM	Human	Low for Seismic Assessment, Moderate for Site Preparation	Insufficient data	Insufficient data	Moderate	Low

As an initial matter, the reference to pm in both rows of the table is confusing. The text that accompanies this table distinguishes between Combustion and Non-Combustion emissions; consider including this distinction in the rows to clarify matters.

Page 12 of Appendix B says air pollution risk from combustion sources is low during seismic activity, and makes no mention of the risk from non-combustion sources. The table scores air pollution risk from non-combustion sources as moderate during seismic activity and site preparation. Should risk conclusions distinguish between seismic and site preparation, as they were in the second row? Otherwise, the narrative should support the finding of a moderate risk of air pollution from non-combustion sources in both phases, which would appear to be inconsistent from the text accompanying this table.

Finally, the paper notes there is insufficient information in the literature about air pollution from trucks. Below in my comments, I provide citations and hyperlinks to papers that should provide helpful additional information. However, if the data is truly insufficient, it is unclear why Maryland is nonetheless able to reach a risk conclusion in some cases and not in others. An explanation would be useful to justify the different outcomes. (The same holds for the conclusions in Table 20, page 40 of Appendix B.)

Response: Dust is a form of particulate matter, so that is why it was depicted as “duts/PM”. Appendix A has been revised to differentiate non-combustion from combustion emissions and to show a moderate (High/Minor) risk for non-combustion sources during site identification/preparation. The Departments concur that there are insufficient data to assess truck traffic and have revised the risk assessment accordingly for consistency.

RECOMMENDATION # 8: Clarify the Probability of Risk of Drilling Fluid Spills, and Explain Conclusion that this Probability is Low.

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Appendix D assesses an 8% probability factor that spills will occur at multiple steps in the drilling process (drilling fluid preparation; drilling operations; drilling cuttings separation/ storage/transfer). Each drilling step is described in a separate row in the risk conclusion table (Table 1, pages 31-32). Does this mean that the probability of spill in each step is summed to determine the risk of spills for the drilling phase? The report team should clarify this.

Response: The Summary Assessment section in Appendix D states that there is a low probability for a spill or release at all stages of the drilling process. The probability is assessed individually for all stages therefore a summation of the probability overall for the entire drilling process has not been defined.

In addition, the RA assigns a low probability to the risk of spill from transport of drilling fluid additives to the well pad, because the incident probability for highway transportation of hazardous materials is 0.005% (page 6 of Appendix D). The RA also assigns a low probability to the risk of spill from drilling fluid preparation, drilling operations, and drilling cuttings separation, storage, and transfer, based on a Pennsylvania study indicating spills occurred 8% of the time (pages 10, 14, and 20 of Appendix D). Finally, the RA assigns a low probability to the risk of spill from a blowout, assuming a blowout rate of 1 per 1,000 wells (page 17 of Appendix D). A brief explanation for concluding that all of these rates drive low risk would be useful (particularly if the 8% spill rate is additive, as discussed in the previous paragraph).

Response: Please refer to the above comment. The probabilities of accidental spills or releases associated with these phases of the drilling process have been assessed individually therefore no conclusion has been made that all incident rates drive low risk for the overall drilling process.

Additional Data and Evidence to Consider

RECOMMENDATION #9: Consider Additional Data/Evidence Available to Assess Air Pollution Risk from Heavy Truck Traffic.

Page 9 of the Risk Assessment notes that during the drilling phase, “insufficient consequence data were available to assign a risk ranking to air emissions associated with truck traffic.” Page 22 and Table 15 of Appendix B (page 24) reflect this lack of data. Page 9 notes that “[t]ruck traffic is most intense” during the hydraulic fracturing/ completion stage, yet the summary fails to mention air pollution consequences. Page 30 and Table 18 of Appendix B (page 32) reports “insufficient data” exists to determine consequence or risk from truck traffic during the completion stage. Page 12 of Appendix B similarly remarks that Maryland did not locate literature sources quantifying air emissions from seismic survey assessments.

However, a number of studies are available that estimate air emissions from truck traffic associated with shale gas development. For instance:

- An *Environmental Research Letters* article published in 2011 entitled, [Life Cycle Greenhouse Gas Emissions of Marcellus Shale Gas](#), assessed the carbon dioxide, methane and nitrous oxide emissions associated with shale gas preproduction and production

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processes. Table I on page 4 of the article lists and provides hyperlinks to the underlying sources of data that the authors relied on for their assessment. As noted in this table and the article itself, several papers were consulted to estimate emissions from truck traffic during the drilling and fracturing/completion stages. Page six of the paper provides an explanation of the author's selection of an energy intensity value for truck transportation of liquids and a diesel fuel emission factor.

- An *Environmental Research Letters* article published in 2013 entitled, [Estimation of Regional Air-Quality Damages from Marcellus Shale natural gas extraction in Pennsylvania](#), estimated emissions of volatile organic compounds, nitrous oxides, and fine and coarse particulate matter from Marcellus shale production. Pages 3-4 and Table 2 summarize the approach taken with truck traffic.
- An *American Society of Civil Engineers* article published in 2013 entitled, [Transport of Hydraulic Fracturing Water and Wastes in the Susquehanna River Basin, Pennsylvania](#), used GIS to estimate actual travel distances of trucks (finding that actual miles traveled are greater than those used in prior life-cycle analyses) and then estimated carbon dioxide, methane, and nitrous oxide emissions associated with that travel.
- The Alamo Area Council of Governments prepared an "Oil and Gas Emission Inventory Improvement Plan" for the Eagle Ford play in 2012. This inventory includes truck emissions during the seismic, drilling, fracturing, and production phases.

These studies also provide useful information about air pollution from drilling and from compressors, other areas where the RA noted there was a lack of evidence to support a robust conclusion (for instance, page 20 of Appendix B).

Response: One of the primary reasons the Departments concluded there were insufficient data to assess air impacts from trucks is because no Maryland-specific modeling was conducted to predict photochemical ozone formation. Ozone is a key criteria pollutant for which certain areas of Maryland are already in non-attainment. In addition, Maryland gets a fair amount of ozone transport from out of state that would have to be accounted for in any modeling efforts. Due to this information gap there were insufficient data to assess air emissions risks from truck traffic. None of the studies referenced above address this gap or change the risk ranking.

RECOMMENDATION #10: Consider Additional Data/Evidence Available to Assess Water Contamination Risk from Spills.

On pages 10 and 13-14 of Appendix E, the RA presents scant literature on the probability and consequence of fracturing fluid spills. While more research needs to be done in this area, a few existing studies could provide Maryland with more information on this point: **Tim**

- A 2013 *Environmental Science & Technology* article entitled, [A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States](#), maps (Figure 5) and describes Pennsylvania

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violations resulting in a spill or leak of fracturing fluids, drilling cuttings, or other materials. The data was found at <http://www.fractracker.org/downloads/>. (NOTE: This paper is in the bibliography for Appendix E but is not discussed in the prevalence portion of the Appendix.)

- As noted under Recommendation #2, this [2014 paper reviewed compliance data from Pennsylvania](#) and includes incident data that could be useful here.
- Another 2013 *Environmental Science & Technology* article on [Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania](#) measures and describes potential impacts to surface water quality.
- A [2012 MIT study on the potential impacts on groundwater quality from surface spills of hydraulic fracturing](#) describes the frequency of spills and designs a model to determine probability of harm to groundwater resources.
- A [reporter for EnergyWire compiled 2013 spill incident data from 15 states](#). His database of spills is available online, through this article.

Response: Thank you providing these additional sources. The Department feels that the current probabilities and consequences provided in Appendix E are justified given that we are assuming the proposed BMPs will be implemented and any accidental releases that do occur will cause “localized or temporary environmental damage” as defined in Table 2 of the Executive Summary.

RECOMMENDATION #11: Consider Additional Data/Evidence Available to Assess Contaminant Migration through Faults and Old Wells.

According to page 9 of Appendix H, “[m]ost literature sources indicate that groundwater contamination via migration through faults or old wells would be a rare and site specific occurrence.” Maryland’s landscape may not have these features and/or the Comprehensive Gas

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Development Plan may avoid spatial overlap of new development with these features, in which case this pathway might indeed be rare. However, if there is any risk of this pathway, the report team may want to consult data that has been analyzed and reported on in EnergyWire, including:

- [A story reporting 103 downhole communications in New Mexico between 2007 and 2014](#), with at least one resulting in surface contamination;
- [A story indicating a 5,000 gallon spill in Colorado may have been due to a “frack hit” into another well](#); and
- [A story cataloguing ten downhole communication incidents that resulted in spills or blowouts](#) between 2010 and 2013.

Response: Noted.

RECOMMENDATION #12: Share Data across RA Teams about Blowout Incidents.

Sometimes data used to assess risk in one step or phase in the RA was notably absent from other assessments. For instance, page 20 of Appendix B and Table 14 (page 21) derives blowout probability from offshore wells – the average of the data presented is 1.2 blowouts per 1,000 wells (0.12%). Page 31 of Appendix B and Tables 18 and 19 (page 32-33) rely on data from the Association of Oil and Gas Producers, suggesting an average of 4.5 blowouts per 10,000 wells drilled (0.045%). Page 17 of Appendix D cites an OGP study of a blowout incidence rate of 1 blowout per 1,000 wells (0.1%). (Meanwhile, in a [2013 paper published in Environmental Geosciences](#) noted above (as a study cited in a 2014 paper), a study of 3,533 wells in Pennsylvania revealed a 0.17% rate of blowouts.) The report team may want to review these sources and select the same evidence across all phases assessed in the RA.

Response: The well blow-out incident rate in Appendix D has been changed to 1.2 in 1,000 wells to be consistent with the incident rate presented in Appendix B. This rate is applicable for well blowouts during the drilling phase while the incident rate of 4.5 in 10,000 well applies to the production phase. Therefore, different rates have been presented in this report in relation to specific phases within UGWD.

In some cases, such data-sharing did take place in the RA. For instance, page 3 of Appendix E referenced truck incident rates from Appendix B. However there, it was not clear whether distance traveled with the chemicals was factored into the 0.005% rate.

Additional BMPs to Consider

Before recommending additional BMPs, I wanted to note how impressed I am with many of the practices Maryland has in place or proposes to adopt before allowing unconventional oil and gas activity to proceed. For instance, while a number of state laws require oil and gas well operators to share data about the chemicals present on site in the event of an emergency, the requirements place the burden on the first responders to track down this information after an emergency has begun. Maryland's proposal to require permittees to prepare a list of chemicals and provided them

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to first responders before beginning operations would ensure that first responders are ready to respond the moment an emergency occurs.

I'd also suggest that Maryland consider using the term "Leading Practices" rather than "Best Management Practices" which implies that all current practices are optimal.

RECOMMENDATION #13: BMPS

The BMPs listed in each Appendix do not clearly delineate between what is already required by Maryland and what is being proposed.

- a. **Recommendation 13(a):** Color-coding of BMPs would make it clearer which are in place and which are proposed. For instance, the industry has begun to move from diesel- to natural gas-powered engines and compressors on site, and Maryland could consider requiring this to reduce air emissions associated with production. However, I could not tell from the BMP description in Appendix A whether the Power Plan could achieve this, or whether the Power Plan is currently required.

Response: Additional clarifications have been provided in the text to address this comment.

According to page 10 of the core document, "gathering lines are long term features on the landscape (spanning the production life of the well) and the likelihood of stream crossings is high." Yet operators do not need permission to lay gathering lines (page 2 of the core document).

- b. **Recommendation 13(b):** Consider whether Maryland has authority to regulate gathering line siting in sensitive ecosystems or through streams. Meanwhile, page 10 of the core document implies that Maryland's landscape-based planning technique, the Comprehensive Gas Development Plan, could direct or encourage responsible siting. Discuss how the Plan could mitigate impact.

Response: Maryland's CGDP can help direct or otherwise influence the location of gathering lines, but site-specific constraints can limit the degree to which siting can be strictly regulated.

- c. **Recommendation 13(c):** Reconsider Maryland's preemption analysis for purposes of setting air pollution standards on compressors (page 38 of Appendix B). I have not conducted a full-blown preemption analysis here, but would be happy to think this through for Maryland on a longer time line than is allowed by this comment period. The Clean Air Act explicitly authorizes states to set stricter standards for stationary sources. It is possible that a compressor that remains in place for at least twelve months could be considered a stationary source under the Clean Air Act.

Maryland may be preempted from setting air pollution standards on diesel engines in drilling equipment (page 22 of Appendix B), because these sources are more likely to be considered mobile sources. However, Maryland should consider non-regulatory approaches for achieving the same controls; for instance, by directing DERA funds to equipment used for unconventional oil and gas development.

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On page 5 of Appendix E, the RA notes that “MDE must approve the use of any [fracturing] chemical, and will encourage the use of less dangerous chemicals.”

- d. Recommendation #13(d):** Describe further up (in the “Scope” section of Appendix E) the particular chemicals of concern – for instance, the BTEX compounds (benzene, toluene, ethylene, and xylene). [NOTE: Page 3 of Appendix H lists “chemicals that are human health hazards” – the list could be used for this purpose as well.] The report team should explain that by reducing use of these chemicals, the consequences and therefore the overall risk posed by fracturing fluid spills can be reduced across the board. This BMP should be noted in each BMP section of Appendix E.

Finally, the RA could describe how Maryland plans to encourage the use of less dangerous chemicals. Several states require notice and approval of certain chemicals (Wyoming, potentially Nevada) or outright ban the use of certain chemicals (Alabama and Idaho, Wyoming if fracturing will occur into drinking water). [NOTE: Page 4 of Appendix H notes that Maryland may ban diesel fuel from hydraulic fracturing fluids – this should be noted in Appendix E as well.] Expedited permitting or lower bonding requirements could be used to encourage greener formulations, although to my knowledge states have not adopted these types of mechanisms.

Response: The additional statement from Appendix H has been added to the scope. An additional statement has been added to the “Suggestions for Additional Mitigation” section in Appendix E. The Department will consider further requirements when drafting the final regulations regarding green chemical alternatives.

Appendix I, relating to waste disposal practices, briefly mentions but does not describe the recycling of waste water for future fracturing jobs. Although this may not technically be a disposal practice, it would reduce the volume of waste needing to be disposed.

- e. Recommendation # 13(e):** Describe and conduct a risk assessment of recycling waste water for future fracturing events.

Response: It is likely that the risks posed by recycling wastewater are significantly lower than the risks and adverse impacts of not recycling waste water. Moving forward the Departments will consider whether this should be assessed and, if necessary, addressed in BMPs and other requirements.

Small Editing Suggestions

RECOMMENDATION #14: Consider small edits

Page 42 of Appendix B lists the four “most important” GHGs.

- a. Recommendation 14(a):** Consider describing more precisely what these four GHGs are – the biggest drivers of climate change? The most prevalent GHGs?

Response: Clarified in the text.

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Page 43 of Appendix B concludes by stating, “Looking across the risk assessments for each phase”

- b. Recommendation 14(b):** Since this is just about air pollution, consider including “of air pollution for” to the sentence, so it reads, “Looking across the risk assessments of air pollution for each phase”

Response: Corrected in the text.

Page 13 of Appendix B, the second paragraph reads oddly as if it were lifted from an instruction manual.

- c. Recommendation 14(c):** Consider changes to this paragraph so it tracks the format and style of the RA.

Response: Paragraph revised accordingly.

Page 4 of Appendix D, the last sentence concludes that waste drilling fluids “will be transported and disposed of properly.” While we hope that is what happens, we do not know this.

- d. Recommendation 14(d):** Consider ending this sentence, “will be transported for disposal.”

Response: Edits have been made to the document to address this comment.

On page 10 of Appendix D, under “Risk Mitigation,” all lines are bulleted.

- e. Recommendation 14(e):** The first two lines should not be bulleted.

Response: Edits have been made to the document to address this comment.

Page 11 of Appendix D refers to “a previous section (Drilling Fluid Preparation),” but the cited text is in the same section.

- f. Recommendation 14(f):** Consider striking the start of this sentence and replacing it with, “As noted above, it will be assumed”

Response: Edits have been made to the document to address this comment.

Page 10 of Appendix G describes the risk tables, which is unnecessary given the discussion in the body of the RA and the use of these tables throughout the material.

- g. Recommendation 14(g):** Consider striking the following sentence: “The rightmost column includes the Risk Ranking, which combines the probability and consequence findings into a single finding according to the matrix in Section III of the core document.”

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Response: This change has been made.

Thank you again for considering my comments.

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Comments Received from Mr. Alan Krupnick, PhD, Center for Energy Economics and Policy

This document represents a tremendous effort to understand and rate all of the risks associated with shale gas development (why not call it that?). But the Executive Summary and particularly the main report, does a poor job of conveying what was learned. Short and sweet is a good watchword, but I would start over. The first thing I would do is present the high risks in a graphic in the main report and ES. I would, as an aside, also make the report congruent with the graphic in the Appendix A, which lists accidents and seismic activity as high risk, but is not mentioned in this category in the report. Also, receptors are not mentioned in the ES. Scenarios are not introduced or defined in the ES, but appear in a sentence. The main report should also give a flavor for the surprises that came out of the research – try to advance the state of knowledge, not just check off a box, which is how it reads. In this regard, I think the lack of high risk categories is big news.

Response: This is a good comment and the summary of findings report and Appendix A has been revised accordingly.

I have a few issues with the paradigm, although am grateful the report refers to our work. I don't think a clean distinction is made between accidents and risks from normal operations. There are also some strange classifications, like calling drilling muds a risk.

Response: Drilling muds have been defined as a risk due to the potential ground water or surface water contamination from accidental releases or spills during transportation or on the well pad. Drilling muds may contain chemical additives depending on the fluid type and could potentially contain contaminants such as heavy metals and radioactive elements from cuttings and formation fluids in which the muds have come into contact with during the drilling process.

I like the attempt to define risks *after* regulations are taken into account. Because the report is specific to Maryland, you can do this better and more specifically than we were able to do in our expert survey. Still, there is a certain amount of hubris here that should be acknowledged. Enforcement and monitoring are just as important as having regulations on the books. The report should also offer some examples (not just buried in the Appendix) of how specific regulations reduce risks. Since Maryland has a moratoria and hasn't been updating its regulations, it is somewhat surprising that the regulations would be thought to be so successful at reducing risks. Also, there are some very complicated rubrics for BATs and BMPs that need more explanation and industry voluntary standards seem to be given equal footing to regulations.

Response: The Executive Summary document lays out the general approach to evaluating BMP effectiveness. This approach acknowledges that BMPs such as voluntary efforts and reporting requirements are less effective than, for example best available technology-type approaches, because they are difficult to enforce and do not have proven efficiencies. These considerations were taken into account in all the appendices when evaluating BMP mitigation effectiveness.

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The main report gives no feeling for what the risk judgments are based on, how various tradeoffs and comparisons are made. Even the appendices leave me wondering about these calls.

Response: The purpose of the main report is to summarize key risk assessment findings and not go into risk assessment details. The appendices provide the most detailed discussion of how the Departments' came to overall risk assessment findings.

One key decision made is to define two scenarios to address scale issues. I think this is a good idea. However, lost in this is the fact that at its greatest development level, we are talking about very few wells being developed, i.e., 450. Even this small number could be significant if they were developed in a very compact area and one with sensitive ecosystems, cities nearby, etc. The report should add this context.

Response: These considerations were taken into account for each team's risk assessment provided in the appendices. Generally, given the best management practices of the comprehensive gas development plans, public health and environmental setbacks, many risks associated with development density were expected to be mitigated. However, in some cases, such as with truck traffic and air emissions, risks remained high or indeterminate, respectively.

Here are the high risk elements:

□□Drilling leading to road damage. Really? Because the rig is heavy? I don't see how this rates a high risk of road damage. Also, in many jurisdictions the companies pay for damage they cause. So this is easily mitigated. Perhaps Maryland doesn't have such a system. But this nuance needs to be included.

Response: The number of truck trips required during the drilling step is based on estimates provided by the industry (ALL Consulting 2010). When categorized by step, drilling was the second-most truck-intensive, behind hydraulic fracturing/well completion (Figure 3, Appendix C). In addition to rig mobilization, other transports during drilling include drilling fluids, non-rig drilling equipment, and drilling (rig crew, etc.) as specified in Table 1 of Appendix C. Second, companies' payment for their road damage is discussed in the Proposed Best Management Practices – Road Agreements section, as well as the Risk Mitigation – Road Use Agreement Issues section.

□□Fracking leading to noise, vibration and road damage from trucks. This makes more sense because of the water transport. It should be noted, however, that companies do try to pipe water in or recycle to save trucking costs. As noted above, in the report, you do not include the accident costs to life and limb and give this impact pathway a moderate designation. [Actually you give it a high risk in Appendix A.] If you mean a moderate risk

I question that choice, particularly if you give noise and vibration from the trucks a high risk.

Response: Piping water as a means to reduce truck trips is discussed within Appendix C section Proposed Best Management Practices – Fewer Trips. Injury and death from truck accidents is a main risk discussed in Appendix C sections Traffic – Traffic Accidents and

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Risk Mitigation – Roadway Accidents. The consequence of this potential risk, across all steps in the hydraulic fracturing process, is maintained as Serious. The probability of this potential risk varies by step, depending on the intensity of trucking per step. The combination of varying probabilities with the serious consequence results in risks varying from Moderate to High. The format of the risk table in Appendix C is being changed to clearly state the probability and consequence designated to each risk.

□□Fracking leading to air emissions. What is going on here is not clear in the report and a bit confusing in the appendix. Is it human health effects that are of concern? Are there significant numbers of people at risk? I would be tempted to just give a high to all air emissions and not split by activity (actually, I don't think a high is justified).

Response: Yes, air impacts assessed related to human exposure as federal air quality standards exceedance is the measure used to determine risk. This is discussed in the “Regulatory Framework to Address Air Emissions” section where it indicates that National Ambient Air Quality Standards “establish levels of pollutants in the air that are protective of human health and welfare”.

□□Production leading to fragmentation (basically a gathering lines issue). This is interesting. In our study, experts linked fragmentation to site development. This may be just a classification issue. The high rating because of a lack of regulation is an important conclusion and should be in the ES and the main report, since it implies that the state should set such regulations. I am not even sure I believe the point, though. Wouldn't these gathering lines be subject to an EIS?

Response: The Departments concur that the high risk associated with gathering lines should be mentioned in the main report and this has been added. As to the question regarding gathering lines being subject to an EIS, the response is no, gathering lines are not subject to an EIS either in federal or Maryland law or other requirements. In fact, even FERC-regulated natural gas transmission lines are not all subject to an EIS. The decision to whether to conduct an EA or an EIS for FERC regulated lines is handled case by case based on a standard set of parameters in coordination with NEPA requirements.

One last point is how performance standards are being addressed. Are they being discounted as risk reducing regulations? This point also goes to the lack of transparency on how calls were made and how regulation is treated

Response: When evaluating performance standards the teams reviewed the scientific literature to make an informed decision on whether proven technologies were available to achieve specific performance standards. This information was then used to evaluate overall BMP effectiveness in reducing risks. Where no scientific information was available, each team used their best professional judgment in determine whether an individual or suite of BMPs could reasonably be expected to achieve a performance standard.