

**REVIEW OF dSGEIS AND IDENTIFICATION OF BEST
TECHNOLOGY AND BEST PRACTICES RECOMMENDATIONS**

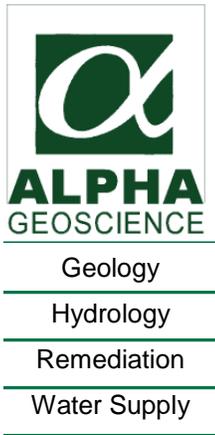
Tom Myers; December 28, 2009

Prepared for:

**NYSERDA
17 Columbia Circle
Albany, New York 12203**

January 14, 2011





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January 14, 2011

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1.0 OVERVIEW

Tom Myers, Ph.D. (Dr. Myers, Myers) provided a review of the water resource and hydrogeologic aspects of the Draft Supplemental Generic Impact Statement on the Oil, Gas and Solution Mining Regulatory Program (dSGEIS) and the following three supporting technical documents prepared by NYSERDA's consultants:

- Alpha Environmental Consultants, Inc., 2009. Chapter 1: Issues related to Developing the Marcellus Shale and Other Low-Permeability Gas Reservoirs, Survey of Regulations in Gas-Producing States, NYS Water Resources, Geology, NYC Watershed, Multi-Well Operations, and Seismicity. NYSERDA Contract No. 11169.
- ICF International, 2009. Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other low Permeability Gas Reservoirs. Agreement No. 9679, NYSERDA, Albany NY. August 7, 2009
- URS, 2009. Chapter 2: Water-Related Issues Associated with Gas Production in the Marcellus Shale, Additives, Flowback Quality and Quantity, NYS Regulations, On-site Treatment, Green Technologies, Alternate Water Sources, and Water Well Testing. NYSERDA Contract No. 10666.

The aspects covered by Dr. Myers' include:

- Contamination of aquifers and surface water sources, including from spills and from the fractured shale;
- Depletion of rivers, streams, and aquifers; and
- The proposed mitigation of these elements

Comment: Dr. Myers states that overall, the dSGEIS is poorly organized.

Response: Alpha understands the dSGEIS is organized consistent with a regulatory framework; however, it can be somewhat difficult for a reader to follow a specific subject throughout the dSGEIS under the present document organization. Alpha suggests the final SGEIS include a detailed and document-wide table of contents in addition to, or lieu of, listing contents only by individual chapter.

Alpha Summary of the GEIS and dSGEIS Related to SEQRA

The following summary of the history and development of the Generic Environmental Impact Statement (GEIS) and dSGEIS is intended to eliminate unnecessary repetition in the responses to Dr. Myers' comments.

The GEIS on the Oil, Gas and Solution Mining Regulatory Program was prepared to review NYSDEC's program for regulating oil, gas, underground gas storage and solution mining wells of any depth, and brine disposal, stratigraphic, and geothermal wells deeper than 500 feet. The GEIS was prepared according to SEQRA, Article 8 of Environmental Conservation Law (ECL), requiring government agencies to analyze the environmental, social, and economic impacts of their actions. This document consists of a draft that was released in 1988 and a final volume that was approved in 1992.

The SEQRA regulations require a GEIS supplement if a subsequent proposed action may have significant adverse environmental impacts that were not addressed by the GEIS and SEQR Findings (6NYCRR 617.10(d)(4)). NYSDEC determined in 2008 that a Supplemental GEIS (SGEIS) was necessary to review the combined practice of horizontal drilling and high-volume hydraulic fracturing. Three primary factors were identified as the focus:

- Water volumes in excess of GEIS descriptions;
- Possible drilling location issues, including:
 - The NYC watershed;
 - In or near the Catskill Park; and,
 - Near the Upper Delaware Scenic and Recreational River; and,
- Longer disturbance duration at multi-well drilling sites

Public scoping sessions held in November and December 2008 and the resulting comments lead to the production of NYSDEC's final scope for the SGEIS. The scoping document was released in February 2009 to address issuing well permits for horizontal drilling and high-volume hydraulic fracturing to develop the Marcellus Shale and other low-permeability gas reservoirs. The dSGEIS was completed and issued in September 2009.

Brief descriptions of the purposes and contents of an EIS, a GEIS, and a supplemental statement are summarized below. It is important to understand the differences among the three types of studies to appropriately evaluate the comments regarding the dSGEIS.

An Environmental Impact Statement (EIS) analyzes the potential significant adverse environmental impacts of a proposed action and measures to avoid or minimize the impacts (<http://www.dec.ny.gov/permits/50602.html>). EISs must be written within the framework presented in 6NYCRR 617.9(b)(5) and should address only those potential significant adverse environmental impacts that can be reasonably anticipated and/or have been identified during the scoping process. EISs should not contain more detail than is appropriate to consider the nature and magnitude of the proposed action and the significance of its potential impacts (<http://www.dec.ny.gov/regs/4490.html>; 6NYCRR 617.9).

A GEIS may be more general and broader than site- or project-specific EISs and should discuss the rationale for the choices advanced. These documents also may include an assessment of specific impacts and may be based on conceptual information in some cases. A GEIS may identify the important elements of the natural resource base as well as the existing and projected cultural features, patterns and character. GEISs may discuss the constraints and consequences of

any narrowing of future options in general terms. GEISs also may present and analyze a few hypothetical scenarios that are likely to occur (<http://www.dec.ny.gov/permits/50602.html>).

A GEIS may be appropriate where:

- a number of separate actions are proposed in an area, and the action may have minor effects separately but may have significant adverse environmental impacts if considered together;
- a sequence of related or contingent actions is planned by a single entity;
- separate actions share common (generic) impacts; or
- a proposed program would have wide application or restrict the range of future alternative policies or projects (<http://www.dec.ny.gov/permits/50602.html>).

When a final GEIS has been filed under 6NYCRR 617.10:

- No further SEQRA compliance is required if a subsequent proposed action will be carried out in conformance with the conditions and thresholds established for such actions in the GEIS or its findings statement;
- An amended findings statement must be prepared if the subsequent proposed action was adequately addressed in the GEIS but was not adequately addressed in the findings statement;
- A negative declaration must be prepared if a subsequent proposed action was not adequately addressed in the GEIS, and the subsequent action will not result in any significant environmental impacts;
- A supplement to the GEIS must be prepared if the subsequent proposed action was not addressed or was not adequately addressed in the GEIS and the subsequent action may have one or more significant adverse environmental impacts.

SEQRA provides that the site-specific impacts of the individual project and, in more general or conceptual terms, the cumulative impacts of subsequent phases be addressed when a project is developed in phases or stages. This element of the GEIS must discuss the elements and constraints in the natural and cultural environment that may affect an agency decision on the immediate project (<http://www.dec.ny.gov/regs/4490.html>; 6NYCRR 617.10).

2.0 CONTAMINATION OF AQUIFERS

2.1 Comments on the Hydrogeology of the Marcellus Shale Area (pp. 5-7)

Dr. Myers' review states that the dSGEIS "lacks a decent discussion of the base hydrogeology on which all of the proposed new gas development would be imposed... [W]ithout it, the dSGEIS cannot explain how the changes wrought by hydraulic fracturing may affect groundwater flows and contaminant transport." Myers states the dSGEIS needs to include:

- Properties of target and intermediate formations;
- Flow properties and rates;
- Formation hydraulic properties;
- Formational groundwater levels;
- Discharge points – springs, seeps, stream, and wetlands;
- Recharge rates and primary zones; and
- Water balance for the area – estimates of recharge, discharge and pumping. (The discussion about the number of wells does not include an estimate of pumping rates.)

2.1.1 Accuracy and Completeness

Dr. Myers’ review of the hydrogeologic analysis of the Marcellus Shale and other black shales in the dSGEIS appears complete and but is not entirely accurate regarding the need for hydrogeologic data. Dr. Myers acknowledges the discussion of black shale properties in Chapter 4 of the dSGEIS. He states that more formational and areal hydrogeologic information would be helpful in evaluating the potential impacts of hydraulic fracturing in any area, but he acknowledges the Marcellus Shale is “notoriously heterogeneous.” This heterogeneity and the fact that there is not extensive core data from black shales in NYS are the reasons that general ranges of permeability and porosity are provided in the dSGEIS. The same is true for the geologic formations between the target formations and ground surface, and the water table and piezometric surfaces at any specific location. A water balance clearly is site-specific and a general water balance for the extent of the Marcellus Shale in New York would not serve the purpose of the SGEIS.

The geology of New York is well-known. There are many published reports, bulletins, investigations and papers regarding the stratigraphy and properties of various formations in New York State that are available through the NYS Geological Survey/NYS Museum and USGS. Figures 4.2 and 4.3 of the dSGEIS depict the stratigraphy of New York State. Hill et al (2002) present a more detailed stratigraphic column of the units overlying the Marcellus shale, including alternating layers of gray and black shale, limestone, and sandstone.

Myers’ position that the data he describes are necessary to evaluate potential effects to ground water flow and contaminant transport from hydraulic fracturing is misguided. The statement implies that the act of hydrofracturing a target formation a minimum of 1000 feet below the deepest fresh water zone may directly impact overlying ground water, presumably by connecting the target formation with existing or induced fractures in overlying formations. Hydrofracturing is a controlled event, focused within a specific zone to maximize production in that local target formation. Two main points to be emphasized are that 1) the target shales exist as an isolated system from the overlying fresh water-bearing units, and 2) proper well construction, including well casings, are the critical mechanism to protect fresh water resources.

The results of ICF International (2009) analysis, although generalized and based on simplified assumptions, indicate that hydraulic fracturing does not present a reasonably foreseeable risk of significant adverse impact to freshwater aquifers (dSGEIS Section 5.18.2 and Appendix 11).

The Marcellus and black shales in areas where shale gas development potential exists are not part of, and are not connected to, the regional hydrogeological systems. The baseline geologic evidence that fluid migration to overlying fresh water aquifers is improbable includes studies that show the Marcellus shale has remained isolated from overlying formations for millions of years. The primary evidence that the rock layers between the Marcellus and relatively shallow fresh water aquifers are sufficiently impermeable and create a barrier between the gas producing target zones and ground water aquifers are the facts that these units are “overpressured” and that natural gas and saline water has remained trapped in these formations for millions of years (API, 2009; GEIS p. 5-4; USDOE, 2009). Overpressuring occurs where fluid pressure cannot be transmitted through impermeable beds to the surface (Selley, 1998) and can be maintained only if there is no hydraulic connection. Even at shallower depths, lithostatic pressures exert sufficient force to effectively close natural fractures. The fact that hydrofracturing is commonly performed in many shallow (<1000 feet) water wells in New York is additional evidence that natural fractures and structures are not necessarily transmissive.

The Devonian shales north of the proximity of the Pennsylvania-West Virginia border are generally considered over-pressured (Billman, 2008). Reservoir pressure data for the Marcellus in New York is limited. Eight research wells were completed in the Marcellus in 1983, which had reported pressure gradients of 0.46 to 0.51 psia/ft, which is greater than the hydrostatic pressure gradient of 0.433 psia/ft (Hill, et al, 2002). Industry representatives report that the Marcellus shale is slightly to moderately overpressured in northern Pennsylvania and anticipate that similar conditions will be found in New York State (Chesapeake, 2009; East, 2009).

The propagation of fractures is controlled by the local rock mechanics. The hypothetical pathway for fluid migration to ground water is along faults and fractures that intersect the Marcellus or induced fractures that extend beyond the target formation. Physical controls that limit the growth of induced fractures include in-situ stresses exerted by the rock mass, which control the orientation of fractures, and the contrast between adjacent rock layers. The extent that the induced fracture will propagate in the vertical direction beyond the target formation is controlled by contrasting physical properties of adjacent stratigraphic units. This contrast limits the vertical growth of a fracture because it either possesses sufficient strength or elasticity to contain the pressure of the injected fluids (API, 2009).

It is acknowledged that fracture growth cannot be completely controlled; however, fracture growth can be predicted and monitored. Fracture growth has been extensively researched and studied by U.S. Department of Energy (DOE), through the Gas Research Institute (GRI). Several direct and indirect diagnostic methods have been verified to predict and monitor the results of hydraulic fracture stimulation. The attached table indicates several of these available tools and methods (GRI/DOE, 2010); these concerns and methods also are presented and discussed in the 2009 ICF report (Sections 1.1.2 – 1.1.5.4). The short-term act of hydrofracturing is the mechanism when fractures are induced; fractures that extend beyond the target zone become part of the shale system and fluids (gas and liquid) within that system are under the pressure gradient from the borehole to the extent of those fractures. After hydrofracturing, induced fractures do not continue to propagate to paleofeatures beyond the point of the hydrofracturing influence.

Hydrofracturing has been used for more than 60 years in the U.S. in nearly one million wells, including approximately 35,000 wells annually. No adverse impacts to ground water quality have been documented from hydrofracturing (Perry and Henry, 2010, and dSGEIS Section 5.18 and Appendix 15). Reported impacts to ground water in PA and the potential for impacts in NY are recognized concerns during drilling and casing/cementing procedures. NYSDEC's extensive drilling and casing procedures are documented within the GEIS and dSGEIS, are available through the NYSDEC website, and are shown to be effective to protect fresh water resources.

Engineering controls to limit fracture growth are discussed in the dSGEIS (Section 5.8.2). Fracture monitoring is required by the Proposed Supplementary Permit Conditions in Appendix 10. Permit Condition #31 requires reporting basic information regarding water, brine, oil and gas shows, and lost circulation prior to fracturing. Condition #33 identifies conditions for conducting hydrofracturing. Condition #34 requires operators to maintain a complete record of every hydraulic fracturing operation through the flowback phase. Condition #45 reinforces data reporting within the required *Well Drilling and Completion Report*. Other and/or additional conditions apply in aquifer areas to further protect ground water resources.

Alpha understands that the NYSDEC can and will consider requiring for any permit, that fracture diagnostics (which may include direct and/or indirect methods of modeling, testing, and/or monitoring) be performed where geologic and pressure conditions are not well-established until fracture behavior is documented. The NYSDEC has the existing authority to impose these additional protections for ground water resources through its Supplementary Permit Conditions for "wildcat" wells where local geologic conditions are not well-established or in areas where high pressure may be expected (<http://www.dec.ny.gov/energy/42744.html>), and for drilling in areas of fresh water aquifers (<http://www.dec.ny.gov/energy/42714.html>). The NYSDEC also might consider specifying in the permit conditions that operators must monitor, document, report, and remediate fracture treatment failures immediately to further protect drinking water.

The potential for impacts related to HVHF is discussed in dSGEIS Section 6.1.4, and mitigation measures are discussed in 7.1.4; these concerns and measures are related to ensuring safe well construction and conditions prior to, during, and following the hydrofracturing process. Responses regarding existing and proposed drilling and casing procedures are contained elsewhere in this document, including well casing integrity and lost circulation, among other topics.

Data collection and reporting are required by the NYSDEC. A synopsis of operations must be provided on the *Well Drilling and Completion Report* form (<http://www.dec.ny.gov/energy/4761.html>). This form directs the operator to identify and submit all logs run, which may include gamma ray, resistivity, density, neutron, mud, directional, induction, temperature, caliper, sonic, and others as specified. The report also requires the operator to complete a "Record of Formations Penetrated" for both unconsolidated and bedrock units, including the depth in feet (TVD and TMD), formation name, description of rock type, and quantity/type of all water, brine, oil and/or gas producing zones. The NYSDEC has the authority to request/require any additional information that it deems necessary, appropriate, or site-specific.

The dSGEIS provides for a minimum of 1000 feet of vertical separation between the top of the target zone and the base of a known fresh water supply. Chapter 3, Section 3.2.3 of the dSGEIS proposes requiring a site-specific environmental assessment and SEQRA determination for projects that fall under any of several conditions, regardless of the formation or number and type of wells. Some of the conditions include those projects where: the proposed top of the target zone for HVHF is less than 2000 feet deep; the vertical separation between the top of the target formation and base of a fresh water supply is less than 1000 feet along any point of the entire proposed length of the borehole; or, any proposed well pad is within 150 feet from certain water supplies, among other resources. The NYSDEC may use the provisions, flexibility, and discretion in Section 3.2.3 to require additional ground water protections and mitigation, or to deny the project, per the required site-specific environmental assessment and determination.

2.1.2 Supporting Information

Dr. Myers provides general information about porosity and permeability. He refers to Hill et al. (2003), Fetter (2001), and Arthur et al. (2008) for this information. Myers also provides Marcellus Shale formation properties, citing Arthur et al. (2008), Engelder et al. (2009), and Boyer et al (2006), to emphasize that the formational properties of the Marcellus Shale are important in assessing the impacts of hydraulic fracturing.

Dr. Myers cites media articles, websites, and other references. None of the referenced items documents impacts to ground water from the act of hydrofracturing or connecting induced fractures in the target formations to overlying fresh-water aquifers.

Dr. Myers' underlying concern of protecting ground water resources is valid, but rock mechanics, research, and field evidence do not support that hydrofracturing will result in ground water contamination.

2.1.3 Mitigation Measures

Dr. Myers does not propose mitigation measures in this section. Dr. Myers' comments are related to the amount and type of information the dSGEIS provides on the topic of the hydrogeology and how it relates to the Marcellus Shale.

2.1.4 Proposed SGEIS Revisions

Dr. Myers proposes that the dSGEIS should discuss the shale's intrinsic properties (including porosity and permeability) and how hydraulic fracturing will affect those properties. He states that the dSGEIS should include data from other states that are developing black shales.

Response:

The dSGEIS discusses the general intrinsic properties of black shales. More data will become available as gas exploration progresses in NYS. Including data from other states where black gas-producing shales are developed may be of limited value due to the acknowledged heterogeneity. Accordingly, the usefulness of information on formations overlying and immediately underlying the black shales at any specific drilling site also is limited, because the geology and hydrogeology varies by location. A water balance analysis would focus on the watershed within the individual drainage basins, so the value of that information also would be limited. The need for specific hydrogeological information can be addressed through permit conditions that are discussed in Section 2.1.1.

Alpha recommends that the required identification of wells proximal to proposed drilling sites additionally include any well, active or inactive, that is listed in the NYSDEC's database, in addition to private and public water supply wells. The NYSDEC database contains locations of more than 35,000 oil, gas, storage, solution salt, stratigraphic, and geothermal wells categorized under NYS Article 23 as Regulated Wells (<http://www.dec.ny.gov/cfm/xtapps/GasOil>).

2.1.5 List of References

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NYSDEC, April 21, 2010. SEQR Handbook, A. General Concepts, <http://www.dec.ny.gov/permits/50602.html>.

NYSDEC, April 21, 2010. 617: State Environmental Quality Review, <http://www.dec.ny.gov/regs/4490.html>.

Perry, R., and Henry, B., July 1, 2010. Letter and attachment, Interstate Oil & Gas Compact Commission to Jeff Bingaman and Henry A. Waxman.

Selley, Richard C., 1998. "Elements of Petroleum Geology." 2nd Edition. Academic Press.

US Department of Energy, 2009. "Modern Shale Gas Development in the United States: A Primer." Prepared by the Ground Water Protection Council and ALL Consulting.

2.2 Comments on Hydraulic Fracturing (pp. 7-8)

Dr. Myers paraphrases information presented in the dSGEIS regarding the details of a typical fracturing operation, including water volumes used; the number and length of fracturing stages required; and pumping rates, pressures, and durations. Myers states that the sources of this information should be documented, because the information associated with these operations obviously varies from well to well.

Dr. Myers also includes a statement from the dSGEIS that he claims is incorrect. A portion of that excerpt is:

[T]he hours spent pumping [fracture fluids into the well] is the only time that fluid in fractures and in the rocks...would move away from the wellbore instead of towards it. ICF International, under contract to NYSERDA, estimated the maximum rate of seepage in strata lying above the target Marcellus zone. Under most conditions evaluated by ICF, the seepage rate would be substantially less than 10 feet per day, or 5 inches per hour of pumping time. (dSGEIS, page 5-93)

Dr. Myers' review of the dSGEIS includes a review of the ICF (2009) report that evaluates the hydrofracturing process. The dSGEIS's discussion of the seepage rates and contamination of aquifers above the target zones is based on the ICF analysis. Myers' review of portions of the ICF report is included as Appendix D in Myer's review of the dSGEIS. Myers asserts that ICF has oversimplified the contaminant flow analysis and has presented erroneous information. It is Dr. Myers' position that some of the injected fluid will move beyond the fracture-propagating zone, i.e., beyond the point where the gradient will reverse and pull fluid back toward the well after stopping the injection into the target formation (Myers Appendix A, page 4).

The USEPA acknowledges, in its 2004 report on the hydraulic fracturing of coalbed methane reservoirs, that "[s]ome portion of the coalbed methane fracturing fluids could be forced along the hydraulically induced fracture to a point beyond the capture zone of the production well." The USEPA's evaluation acknowledges various factors that could reduce flowback recovery, including fluid leakoff, check-valve effect, adsorption and chemical reactions, movement of fluids outside the capture zone, and incomplete mixing (USEPA, 2004, pages 3-12 – 3-15). Additionally, "in any fracturing job, some fracturing fluids cannot be recovered and are said to be 'lost' to the formation" (USEPA, 2004, page 3-23). However, the EPA "concluded that the injection of hydraulic fracturing fluids into coalbed methane wells poses little or no threat to USDWs" (USEPA, 2004, page 7-5) even when the target zone is an aquifer. The chance that hydrofracturing in a target zone 1000 feet below an aquifer will adversely impact that aquifer is even lower. The Ground Water Protection Council (GWPC) testified in June 2009 before the House Committee on Natural Resources and included statements from officials in Ohio, Pennsylvania, New Mexico, Alabama, and Texas confirming that there have been no incidents of ground water contamination due to hydraulic fracturing (GWPC, 2009); the Interstate Oil & Gas Compact Commission also support this position (Perry and Henry, 2010). It is acknowledged that incidents of ground water contamination by thermogenic methane have occurred due to deficiencies in well construction (COGCC, 2010). Pennsylvania cases are presented by Myers and are discussed in this document, Section 2.9.

Dr. Myers states that the use of 10 feet/day for seepage rates throughout ICF's calculations is inaccurate. Myers asserts the 10 ft./day seepage rate is based on an average gradient during injection and does not consider non-steady state conditions or hydraulic conductivities of the various strata (Myers Appendix D, page 4).

Myers identifies an apparent contradiction between fracture fluid flowback volumes as discussed in the dSGEIS compared with volumes presented by Soeder and Kappel (2009) in a USGS fact sheet. The dSGEIS notes that flowback water recoveries from horizontal Marcellus wells in the northern tier of Pennsylvania range from 9 to 35% of the fracturing fluid. Soeder and Kappel (2009) state that "nearly all" of the fracturing fluid injected into a well must be recovered for gas

to be able to flow from the shale. The USGS does not present supporting information for this statement.

Dr. Myers' final comment regarding the hydraulic fracturing coverage by the dSGEIS is that the dSGEIS does not discuss the fate of the fracture fluid that is not recovered as flowback.

2.2.1 Accuracy and Completeness

Dr. Myers' analysis of the hydraulic fracturing discussion in the dSGEIS is complete. His comment requesting documentation of the source data suggests he may have missed some references; the details in the dSGEIS were based on information from permit applications in NYS and published sources. He is correct that the details of fracturing operations vary from well to well. It is because these details may vary by location that the dSGEIS provides typical ranges for parameters such as the length of borehole treated at each stage, the number of fracturing stages, the amount of water and fracture fluid used per stage and per well, pumping rates and duration, and fracture operation durations. The documented source information includes water use ranges based on NYSDEC applications on file and GWPC (2009). Fortuna Energy and Chesapeake Energy supplied the typical wellbore lengths for a single fracturing stage. Pumping rates were based on ICF (2009) and GWPC (2009). Other numbers presented are the result of calculations using these documented numbers, and possible exceptions are acknowledged.

Dr. Myers' position that ICF has oversimplified the discussion of contaminant flow and seepage from the target zone to an aquifer at a depth of 1,000 feet is technically correct; however, the ICF analysis is consistent with their assigned task. NYSERDA specifically tasked ICF with, among other items, estimating (but not computer modeling) the potential time-frame that would be necessary for fracture fluid migration into freshwater aquifers. This estimate would be solely hypothetical and would necessarily entail a number of assumptions, because as Myers acknowledges, there is no hydraulic connection between the target shales and overlying aquifers.

ICF's flow equations are correct, and in Alpha's opinion, a more detailed analysis is not necessary. Myers reviews the ICF report in detail in Appendix D, and summarizes his review in his main text. Appendix A is an interpretive numerical model that Dr. Myers uses to support his opinion that vertical flow from the target zone to a shallow aquifer is possible within the expected range of aquifer parameters. His simulation is based on the concepts of Hill and Tiedeman (2007); however, Myers acknowledges that his model also oversimplifies ground water flow and transport. Myers also assumes that a hydraulic connection exists between the target zone and an aquifer at a depth of 1,000 feet for his modeling exercise. Dr. Myers asserts that contaminant flow from the target zone to an overlying aquifer cannot be ruled out based solely on ICF's analytical calculations; however, the offered alternate model is not technically defensible.

The basic assumption in both ICF's and Myers' analyses of a hydraulic connection between the Marcellus Shale and shallow aquifers contradicts decades of hydrofracturing data and experience in the US. The discussion in Section 2.1.1 of this document supports that hydrofracturing is highly unlikely to hydraulically connect target formations to overlying fresh water resources and

cites various mechanisms to protect ground water resources. Both Myers' model and ICF's analysis are based on the inaccurate assumption that the entire bedrock stratigraphic column is highly fractured and, thus, imitates a porous medium. Myers acknowledges that his model is not calibrated and cannot be used for predictive purposes. He also acknowledges inconsistencies with his simulations. For example, the flowback volume occurring in his scenario was significantly greater than the actual recorded volumes, and his attempts to lower the flowback volume resulted in erroneous hypothetical head values compared with actual reported data. (Myers, Appendix A, page 4).

The excess pressure from hydrofracturing at the well bore is a recognized temporary condition; the local hydrostatic pressure in the well bore is greatly reduced within days. Rock mechanics demonstrate that after hydrofracturing, the pressure is reduced and fluids will migrate toward the wellbore due to the lower pressures in that zone relative to the pressure within the surrounding formations, i.e., the steep pressure differential between the fractures and borehole controls fluid (gas and liquid) flow. Fracture growth cannot be completely controlled; however, fractures that may extend to and connect overlying strata become and remain part of the shale gas system. There is much economic incentive for industry to control and limit hydrofracturing within the target zone. The monitoring performed during each hydrofracturing stage would readily measure a loss of pressure and/or change in flow that would indicate an irregular condition. It is Alpha's opinion that the SGEIS correctly focuses mitigation measures on proper well drilling, construction, and monitoring procedures to protect ground water, including during all phases of hydrofracturing.

Dr. Myers' observation that there is a contradiction between the dSGEIS and the 2009 USGS fact sheet by Soeder and Kappel in regard to the amount of flowback recovered from stimulated shale gas wells is accurate. The contradiction is irrelevant to the dSGEIS; the information contained in the dSGEIS (p. 5-97) is based on fracturing operations in horizontal Marcellus wells in northern Pennsylvania. The GWPC (2009) states that "[i]n various basins and shale gas plays, the volume of produced water may account for less than 30% to more than 70% of the original fracture fluid volume," and flowback can continue for several months after gas production begins. The GWPC (2009) cites numerous operators and service companies in addition to a document regarding flowback analysis. A recent publication prepared for the USDOE (Veil, 2010) supports that flowback from the Marcellus appears to be lower than the reported range of 30-70% and is "often lower than 25%". It is Alpha's opinion that Soeder and Kappel's statement, "For gas to flow out of the shale, nearly all of the water injected into the well during hydrofrac treatment must be recovered and disposed of," is unsupported based on available information.

Dr. Myers' final comment regarding the hydraulic fracturing coverage in the dSGEIS is that the dSGEIS does not discuss the fate of the fracture fluid that is not recovered as flowback. The dSGEIS does acknowledge that some of the fracture fluid remains in bedrock void space, some of the chemicals remain absorbed by and bound to the organic-rich shales, and the proppants from the fracture fluid ideally are left behind to hold those fractures open (dSGEIS section 5.11). Specific percentages or volumes are not available and are not provided in the dSGEIS; however, as discussed in above Sections 2.1.1 and 2.2.1, these target formations are isolated systems. Ground water impacts from the act of hydraulic fracturing have not been identified and are not

anticipated based on the experience and documentation in NY and most other gas-producing states. The mitigation measures for protecting ground water resources are focused on procedures and preventive measures for proper drilling and well construction before, during, and following hydrofracturing.

2.2.2 Supporting Information

Dr. Myers does not document all of his positions and opinions; contradictions to his comments and the referenced sources are discussed in the previous section.

Dr. Myers references Gaudlip et al. (2008) in his *Review of ICF*, which is included in his report as Appendix D. Myers' *Numerical Simulation of Hydraulic Fracturing and Flowback* Appendix A) references Hill et al (2007), a Journal of Hydrology article, and the USGS's user guide to Modflow-2000.

Myers cites a USGS Fact sheet by Soeder and Kappel (2009) when discussing fracture fluid recovery. Other documents and information from gas operators who are developing the Marcellus Shale and other gas shales contradict the statement by the USGS.

2.2.3 Mitigation Measures

Dr. Myers does not offer mitigation measures in this section of his review.

2.2.4 Proposed SGEIS Revisions

Alpha recommends that the SGEIS stress that ICF's model is analytical and not numerical. Both Myers' model and ICF's analysis are based on the hypothetical and inaccurate assumption that the entire bedrock column is highly fractured and is characteristically analogous to a porous medium. ICF's conclusion that "hydraulic fracturing does not present a reasonably foreseeable risk of significant adverse environmental impacts to potential freshwater aquifers." is not refuted based on the numerical modeling performed by Myers. It is Alpha's opinion that the numerical model is not useful due to the heterogeneous nature of the overburden at and between specific locations, and because of the numerical issues that Myers acknowledges.

It is Alpha's opinion that neither ICF's calculations nor Myers' model offers new information that supports modifying existing or proposed measures for protecting ground water resources. Alpha recommends that the SGEIS clarify that the NYSDEC can and will use its existing authority and proposed supplemental permit conditions to require fracture diagnostics (e.g., testing, monitoring) for initial HVHF wells in any formation and at any depth where geologic conditions (including fracture growth) are not sufficiently established to preclude a conclusion that impacts via subsurface migration are not reasonably foreseeable. The permit conditions should require that the operator estimate the anticipated range of pressures and fracture fluid

volumes to be used and record this information in the required *Pre-Frac Checklist and Certification Form (dSGEIS, Appendix 20)*. Alpha recommends that operations should be suspended and the anomalous condition be recorded and reported to the NYSDEC, if conditions are outside one or both ranges, or an anomalous pressure behavior is observed, until the condition is investigated and resolved to the satisfaction of the NYSDEC.

The SGEIS can reference the source data cited in Section 2.2.1 of this document, where those data sources are not specifically identified.

Dr. Myers states that “The NYSDEC must consider the USGS study and explain why there is such a difference between the dSGEIS and USGS fact sheet.” The USGS “fact sheet” by Soeder and Kappel (2009) is not a study but presents an undocumented “fact,” so this suggested revision is unnecessary as explained in this document, Section 2.2.1. It is beyond the scope of the dSGEIS to research inconsistencies in information presented by other agencies.

Dr. Myers’ other recommendation regarding hydraulic fracturing is that “[t]he dSGEIS must discuss the fate of the fracture fluid that does not return to the wellbore as flowback.” No revisions are recommended based on this statement. The dSGEIS provides some information in Section 5.11, and the subject is further addressed by the discussions in Section 2.1 and 2.2 of this document.

2.2.5 List of References

Colorado Oil and Gas Conservation Commission, 2010. Comments to the documentary *Gasland* relating to thermogenic and biogenic methane and alleged contamination of water wells in Colorado from hydrofracturing. Colorado Department of Natural Resources, Denver CO, www.colorado.gov/cogcc

Ground Water Protection Council and ALL Consulting, 2009. Modern Shale Gas Development in the United States, A Primer, prepared for U.S. Department of Energy and National Energy Technology Laboratory (DE-FG26-04NT15455). April 2009.

Hill, M.C., and C.R. Tiedeman, 2007. Effective Groundwater Model Calibration: With Analysis of Data, Sensitivities, Predictions, and Uncertainty. John Wiley and Sons, Inc.

ICF International, 2009. Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program Well Permit issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs. Agreement No. 9679, NYSERDA, Albany NY. August 7, 2009.

Perry, R., and Henry, B., July 1, 2010. Letter and attachment, Interstate Oil & Gas Compact Commission to Jeff Bingaman and Henry A. Waxman.

Soeder, D.J. and Kappel, W.M., 2009. Water Resources and Natural Gas Production from the Marcellus Shale. USGS Fact Sheet 2009-3032. May 2009.

Veil, John A. (Argonne National Laboratory), July 2010. Final Report, Water Management Technologies Used by Marcellus Shale Gas Producers, prepared for USDOE, Office of Fossil Energy, Oil & Gas Technology DOE Award No. FWP 49462

2.3 Comments on Properties of Fractured Shale (pp. 8-9)

Dr. Myers' review of the dSGEIS contains several comments regarding the properties of shale that has been hydraulically fractured. Myers' first comment is that the dSGEIS does not discuss how fracturing will change the shale's properties and affect flow through the system and that the dSGEIS should discuss how the fractures grow.

Dr. Myers also states that there is a lack of actual shale samples and data and suggests that NYSDEC require industry to collect and submit core samples and surface-to-bottom well logs.

The review asserts that fracture modeling errors or the presence of faults and natural fractures may cause hydraulic fracturing to extend beyond the target formation leading to potential ground water contamination. Myers suggests the NYSDEC require that some fracture operations monitor and report the extent of fracturing.

Myers also recommends that the dSGEIS discuss the factors that will control the extent of the Marcellus shale gas fracturing and development.

2.3.1 Accuracy and Completeness

The dSGEIS discusses fracture development in section 5.8.1, stating that fractures form and grow perpendicular to the direction of least stress and propagate in the direction of major and intermediate principal stresses. The dSGEIS cites ICF (2009) stating that Appalachian Basin fracturing is predominantly vertical and in an upward direction below about 2,500 feet and tends to be horizontal at shallower depths due to differential stresses caused by topographic features. The scope of the SGEIS is not intended to present detailed geological principles and rock mechanics. ICF (2009) presents additional information that is not included in the dSGEIS regarding porosity and permeability changes generated by fracturing that allow increases in gas and ground water flow toward the well.

Myers' comment that fractures may extend beyond the target zone is accurate, but his conclusion that it will lead to potential ground water contamination is inaccurate. The argument that the fractures will extend to and connect overlying fractures or paleofeatures contradicts rock mechanics principles and field observations. The remaining comments are accurate and for the most part, are recommendations that are addressed in this document, Section 2.3.4.

The dSGEIS acknowledges there is not an extensive base of shale core samples and data. Whether a permittee should collect and submit core samples and surface to bottom well logs can be evaluated by NYSDEC on a well-specific basis through the EAF and well permit application

process. The NYSDEC has the existing ability and authority to impose supplementary permit conditions where deemed appropriate, based in part on the amount and quality of data previously collected from a specific area, and overlying subsurface (or surface) conditions.

Environmental Conservation Law 23-0305(8)(i) gives the NYSDEC the power to:

Require the taking and making of well logs, well samples, directional surveys and reports on well locations and elevations, drilling and production, and further require their filing... Upon the request of the state geologist, the department shall cause such duplicate samples or copies of records and reports...to be furnished to him.

Further, 6 NYCRR 554.7(b) provides that the required well completion reports be accompanied by “a well log and other such information as the department may specifically require” (<http://www.dec.ny.gov/regs/4463.html#15494>).

Section 2.1.4 of this document identifies several mechanisms for NYSDEC to require such detailed information and discusses engineering controls and data collection. Section 2.1.1 discusses the geologic and mechanical factors that isolate the black shales and limit fracture growth.

Fracture monitoring also can be evaluated on a well-specific basis using the same criteria as the requirement to collect core samples and well logs. It is not efficient or economical for industry to fracture outside the target zone. Fracture growth cannot be completely controlled; however, fracture growth can be predicted and monitored. ICF (2009) presents techniques to assess the vertical and lateral extent and growth of fractures using methods for estimating and measuring (Section 1.1.5.4, Strategies to limit fracture growth). The application of direct and indirect methods also is summarized in the matrix adapted from GRI/DOE, 1997. The NYSDEC may consider incorporating these techniques in the SGEIS as examples of methods to control fracture dimensions in addition to other methods that currently may be used in the industry; however, it is important that the SGEIS remain flexible and not dictate or limit technologies, as industry continues to innovate and develop these and alternative methods.

Myers recommends that the dSGEIS include a discussion of the factors that will control the extent of Marcellus fracturing and development. Such a discussion would include the distance from the bore to the borders of the Marcellus, the nearness to aquifers and other water supplies, economic considerations, and past success with fracturing in the different regions where the Marcellus is present. Fracture monitoring is required by the Proposed Supplementary Permit Conditions in Appendix 10 (#33 and #34). Permit Condition #34 requires operators to make and maintain a complete record of every hydraulic fracturing operation through the flowback phase. A synopsis of the operation must be provided on the *Well Drilling and Completion Report*. There are additional requirements for “wildcat” wells where the stratigraphy is not well established or high pressure is anticipated; the NYSDEC can impose fracture testing and monitoring as permit conditions.

2.3.2 Supporting Information

Dr. Myers cites the ICF (2009) report. Myers comments are based on the dSGEIS.

2.3.3 Mitigation Measures

Dr. Myers proposes that NYSDEC require industry to collect and submit core samples and surface-to-bottom well logs to rectify the acknowledged lack of shale samples and data.

2.3.4 Proposed SGEIS Revisions

It is Alpha's opinion that Myers' recommendations do not require revisions to the SGEIS; however, the NYSDEC might reference the existing GEIS and proposed SGEIS provisions and restate its existing authority to impose additional permit-specific requirements as it deems appropriate, particularly in areas of ground water resources, where wells are proposed at relatively shallow depths, where the target formations may be relatively thin, or where fracture pressures and growth are not well established.

2.3.5 List of References

ICF International, 2009. Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program Well Permit issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs. Agreement No. 9679, NYSERDA, Albany NY. August 7, 2009.

2.4 Comments on Subsurface Contamination: Vertical Transport from Targeted Shale (pp. 9-12)

Myers report (pages 9 through 14, discussed in this document in Section 2.4 and Section 2.5) and Appendices A and D of his review discuss the vertical transport of hydraulic fracturing contaminants. Myers critiques ICF's (2009) conclusions on this topic in this section (*Subsurface Contamination: Vertical Transport from Targeted Shale*) and in Appendix D, which is a detailed review of ICF's technical assistance report (2009). Myers' section titled *Interpretive Numerical Analysis* and Appendix A outline and provide a numerical simulation of transport from the target formation to overlying subsurface layers.

Myers breaks down his analysis of the dSGEIS into sections outlined by the conclusions in the dSGEIS. The conclusions and a summary of Myers' review follows.

- a) *dSGEIS: The shale gas formations are separated from aquifers by at least 1,000 feet of sandstone and shale of moderate to low conductivity.*

Myers: This is true, but there could be fractures, faults, and improperly plugged wells that could aid transport. Advective transport can move contamination from the shale to a shallower aquifer within decades or centuries.

b) dSGEIS: The fracturing pressures are typically applied for less than one day per stage. The travel time for fluid to flow from the shale to the aquifer under those pressures would be measured in years.

Myers: Beyond the point where the shale is affected by the injection pressure, the gradient between that point and the well is unimportant. Once the transient flow and pressure changes drive flow from the shale into surrounding formations, the natural gradient and dispersion can continue to transport the ambient water from the shale and the fracture fluid upward (Appendix A contains calculations). A long-term potential for contaminant transport to overlying aquifers should be a part of the impact study, including head level maps in various formations.

c) dSGEIS: The fracture fluid could only fill a small percentage of the void space between the shale and the aquifer.

Myers: Contaminants disperse into existing fluid and are transported by dispersion and advection. Fluid replacement is not necessary for contamination to migrate.

d) dSGEIS: Some of the fracture fluid chemicals would be adsorbed by and bound to the organic-rich shales.

Myers: Adsorption properties are not known for fracturing fluids. The dSGEIS should not imply that adsorption will diminish contaminant transport without test data.

e) dSGEIS: Diffusion of contaminants throughout the pore volume between the target zone and an aquifer would dilute the chemical concentrations by several orders of magnitude.

Myers: Flow occurs by advection and dispersion. The contaminants will not diffuse throughout the entire groundwater body between the source and receptor. Contaminants will move as a slug advecting along the general flow gradient with dispersion as the plume spreads. Preferential flow paths, heterogeneity, and horizontal flow components cannot be ignored. The shale could also become a brine source to the overlying formations that could endure for a significant period. The gradient toward the well caused by production will not extend far beyond the shale. The natural gradient will take over beyond the influence of the well production.

f) dSGEIS: Fracture fluid flow toward an aquifer through open fractures or an unplugged wellbore would be reversed during flowback and residuals will be flushed back toward the production zone.

Myers: Injection pressure and negative production pressure will not extend beyond the shale. Some contamination may move beyond the influence of the well.

Myers asserts the NYSDEC makes too many assumptions about the natural conditions of the formations between the shale and the aquifer that cannot be verified, and that the intermediate formations can be very heterogeneous even if the average permeabilities of the formations are known.

2.4.1 Accuracy and Completeness

Myers' review of the dSGEIS's and ICF's (2009) discussion of vertical contaminant transport and Myers' supporting *Numerical Simulation of Hydraulic Fracturing and Flowback (Appendix A)* identifies oversimplifications in the dSGEIS and ICF's analysis of contaminant subsurface transport. His review cites Fetter (2001, 1999). Myers asserts that ICF (2009) and the dSGEIS make assumptions that cannot be readily proven; however, Myers does not offer documented evidence to the contrary. Myers acknowledges that his model posed numerical stability problems and that he also made assumptions to compile his model.

[Myers'] model is not calibrated to observed data nor should it be used for predictions. The simulation is not intended to consider all of the complexities of geology, such as very low conductivity aquitards and the fractures that will ruin the aquitard properties (Myers, Appendix A, page 1).

Myers' simulation used MODFLOW-2000 (Myers, Appendix A, page 1); Dr. Myers does not disclose which MODFLOW modules (i.e. additional conditions) were used in his model.

ICF (2009) clearly states that their analysis of contaminant transport is based on assumptions. Assumptions are necessary because of the lack of data, the relative inaccessibility of the deep formations in question, economic constraints (ICF p. 23), and the hypothetical nature of ICF's assigned task. ICF has simplified the contaminant transport analysis through the use of assumptions, but the majority of those assumptions are conservative and are explained in ICF's report. ICF makes the statement:

Although one or more conditions at some future well sites may lie outside of the ranges analyzed, it is considered unlikely that the combination of conditions at any site would produce environmental impacts that are significantly more adverse than the worst case scenarios analyzed (ICF, 2009, p.23).

Myers fails to address the historical data presented by ICF (2009, p.22). The following summary of a discussion in ICF (2009) deals only with the "migration of hydraulic fracturing fluids or their components from the fracture zone to the groundwater aquifer."

A 1998 survey of state agencies by the Ground Water Protection Council (GWPC) documented that there was not a single substantiated case of contamination of drinking water sources by hydraulic fracturing in over 10,000 coalbed methane wells in 13 states. (ICF, 2009, p.22)

The USEPA concluded in 2004 that the injection of fracturing fluids into coalbed methane wells poses little or no threat to coalbed aquifers (ICF, 2009). The USEPA's evaluation acknowledges various factors that could reduce flowback recovery, including fluid leakoff, check-valve effect, adsorption and chemical reactions, movement of fluids outside the capture zone, and incomplete mixing (USEPA, 2004, pages 3-12 – 3-15). Additionally, "in any fracturing job, some fracturing fluids cannot be recovered and are said to be 'lost' to the formation" (USEPA, 2004, page 3-23). However, EPA "concluded that the injection of hydraulic fracturing fluids into coalbed methane wells poses little or no threat to USDWs" (USEPA, 2004, page 7-5) even when the target zone is an aquifer. Coalbed hydrofracturing events approximate conditions where shale hydrofracturing is performed closest to ground water resources. The chance that hydrofracturing in a target zone 1000 feet below an aquifer will adversely impact that aquifer is significantly lower. The GWPC testified in June 2009 before the House Committee on Natural Resources and included statements from officials in Ohio, Pennsylvania, New Mexico, Alabama, and Texas confirming that there have been no incidents of ground water contamination due to hydraulic fracturing (GWPC, 2009); the Interstate Oil & Gas Compact Commission also support this position (Perry and Henry, 2010). It is acknowledged that incidents of ground water contamination from thermogenic methane have occurred due to deficiencies in well construction. Pennsylvania cases are presented by Myers and are discussed in this document, Section 2.9.

ICF's calculations and Myers' model both make the hypothetical assumptions that the act of fracture stimulation will cause hydraulic communication through paleofeatures (fractures, faults, structures); however, the potential hydraulic communication is not supported by rock mechanics, field research, or field observation (Section 2.1.1 of this document). The potential for hydraulic communication is further minimized by the fact that the minimum vertical separation of 1000 feet between the top of any target shale formation and the deepest fresh water zone represents a small fraction of actual conditions that exist in New York.

Induced fractures that may extend into rock units overlying the target zones and which may "communicate" with the target zone will be under the influence of that fracture system, including the gradient toward the borehole. Proppant in fracture fluids may not reach the full extent of some fractures, resulting in fractures not being held open along the full length. A fracture can be pinched, reducing the effective length of the fracture (USEPA, 2004, page 3-13). Fractures and other structural features that exist beyond the hydrofracturing influence will not be connected or "opened" after the fracturing event. The transport of fluids from induced fractures cannot migrate through closed or "healed" features that have existed under confining pressures for millions of years. Accordingly, the suggestion of "head level maps" (and Myers' model) also assumes that continuous, saturated, conditions exist from the top of the target zone to the land surface. This is not the case or the gas would not exist or be trapped in the fractured shales that act as gas reservoirs.

2.4.2 Supporting Information

Dr. Myers' assertions are documented as discussed in the previous section; however, Myers review fails to address data that does not support his positions. Some of this information is discussed in previous sections of this document. Rock mechanics and studies show the

Marcellus shale has remained isolated from overlying formations for millions of years, trapping shale-gas. Research and observations by the Gas Research Institute, USEPA and GWPC, and testimony from officials of gas-producing states support that fracture stimulation events have not impacted ground water resources, even where performed within the same unit such as coal-bed methane aquifers.

2.4.3 Mitigation Measures

Dr. Myers presents his contaminant transport model in Appendix D as a possible alternative to the ICF model that in his opinion is less accurate than his work.

2.4.4 Proposed SGEIS Revisions

Alpha recommends that the SGEIS acknowledge ICF's simplification of contaminant flow between the target zone in a shale gas well and a potential aquifer. Alpha does not recommend relying on either hypothetical ground water model to accurately represent or predict potential vertical transport. The argument regarding potential "worst case" ground water flow and contaminant transport is academic at this time, based on the available data and experience in the U.S. The NYSDEC can consider and institute future modifications or controls to HVHF as the database expands, including soliciting regulatory data and experiences in other gas-producing states.

It is Alpha's opinion that the NYSDEC can best protect ground water resources by enforcing and monitoring its required preventive measures during drilling and casing operations, and before and during hydrofracturing and production development. It is recommended that the survey of existing wells in the vicinity of a proposed well include identifying any well in the NYSDEC oil and gas well database. The EAF and initial permit information are used to determine what proactive controls and conditions should be imposed to protect ground water resources. The NYSDEC can exercise its existing authority and discretion to impose the applicable (and proposed) regulatory/program requirements and conditions in cases where ground water resources are separated less than 1000 feet vertically, geologic conditions and drilling experience are not well documented, where water wells or other wells (Section 2.1.4 of this document) are located within a specified radius of the proposed well or water resources, where high pressures may be encountered, or for other environmental or geological reasons that it deems appropriate.

Many existing and proposed control and monitoring mechanisms available to the NYSDEC are discussed throughout this document or contained in the dSGEIS. For example, Appendices 8, 9, and 10 contain Supplementary Permit Conditions to augment standard construction and cementing practices and further protect and isolate fresh ground water zones. It is recommended that the SGEIS clarify DEC's discretion to require diagnostic methods (such as direct and indirect testing, monitoring, and comparing predictive models) to evaluate the actual growth of fractures where deemed appropriate or necessary by site-specific circumstances, to demonstrate adequate control and appropriate pressures to protect ground water resources. Additional

measures may be imposed and implemented based on the data required to be submitted or reported by the operator as drilling progresses.

2.4.5 List of References

Fetter, C.W., 2001. Applied Hydrogeology, Fourth Edition. Prentice-Hall.

Fetter, C.W., 1999. Contaminant Hydrogeology, Second Edition. Prentice-Hall.

Ground Water Protection Council, 2009. "Statement of Scott Kell before the House Committee on Natural Resources Subcommittee on Energy and Mineral Resources," Washington, D.C., June 4, 2009.

ICF International, 2009. Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program Well Permit issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs. Agreement No. 9679, NYSERDA, Albany NY. August 7, 2009.

Perry, R., and Henry, B., July 1, 2010. Letter and attachment from Interstate Oil & Gas Compact Commission to Jeff Bingaman and Henry A. Waxman.

USEPA, 2004. *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs*, EPA 816-R-04_003, June 2004.

http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_coalbedmethanestudy.cfm.

2.5 Comments on Contaminant Transport (Interpretive Numerical Analysis) (pp. 13-14)

Myers performed an interpretive numerical analysis based on the concepts of Hill and Tiedeman (2007) using the formation and fracturing properties provided by ICF (2009) and the dSGEIS. The model is simple, though more complex than ICF's (2009) model. The numerical simulation report is included in Myers' review as Appendix A. The differences in the Myers and ICF models pertain to the concerns outlined above in Section 2.4. Myers' primary conclusion is:

A simple advective transport analysis assuming various reasonable gradients and sandstone thicknesses, conductivities, and porosity values yielded contaminant transport times ranging from a couple decades to centuries for transport over 4000 feet. It is apparent that any contaminants, fracturing fluid or shale brine, reaching the overlying formations, may reach the freshwater aquifers in a time frame that should concern NYSDEC.

2.5.1 Accuracy and Completeness

Dr. Myers' analysis of ICF's model is sufficiently detailed to support that ICF's analysis contains some assumptions and cannot be the sole support for a conclusion of no reasonable impact to an aquifer more than 1,000 feet above the target zone. Myers acknowledges, however, that his numerical analysis also is an oversimplification of what occurs in nature. Myer's model essentially assumes the entire stratigraphy behaves as a saturated unit from the ground surface through the isolated shale gas formations. Myers's model also is based on many assumptions that are not supported and some which contradict shale-gas research and rock mechanics. This topic is more thoroughly discussed in Section 2.4.1 of this document.

2.5.2 Supporting Information

The theory supporting Myers' model is from Hill and Tiedeman, 2007. He discusses the topics and theories used in his numerical analysis in his main text as discussed in above Section 2.4.

2.5.3 Mitigation Measures

Dr. Myers offers his contaminant transport model in Appendix D as a possible alternative to the ICF model which he believes to be less accurate than his own.

2.5.4 Proposed SGEIS Revisions

These proposed revisions parallel those in section 2.4.4. Myers recommends that the following points should be evaluated in the dSGEIS. Alpha's recommendations are provided beneath each point.

- a) *Fracturing would likely cause contaminant transport beyond the target formation.*

It is acknowledged that hydraulic fracturing may induce limited fracturing in adjacent units; however, decades of hydrofracturing data and experience in the U.S. that demonstrate that there is no hydraulic connection between the Marcellus Shale and shallow aquifers. The discussion in Section 2.1.1 of this document supports that hydrofracturing is highly unlikely to hydraulically connect target formations to overlying fresh water resources and cites various mechanisms to protect ground water resources.

The dSGEIS requires fulfilling *Supplementary Permit Conditions for High-Volume Hydraulic Fracturing* which will include the submission of a *Pre-Frac Checklist and Certification Form* (pre-frac form) at least 48 hours prior to commencement of high volume hydraulic fracturing operations. The pre-frac form will (dSGEIS, page 7-45):

- a. attest to well construction having been performed in accordance with the well permit or approved revisions,

- b. list the depth and estimated flow rates where fresh water, brine, oil and/or gas were encountered or circulation was lost during drilling operations, and
- c. include information about how any lost circulation zones were addressed.

The *Pre-Frac Checklist and Certification Form* is included in the dSGEIS as Appendix 20.

Alpha recommends that the SGEIS acknowledge that hydrofracturing has been shown to induce fractures beyond the target formation (Fisher, August 11, 2010, personal communication). Several diagnostic methods exist to demonstrate that the proposed well construction, casing/cementing, and hydrofracturing plans are appropriate and will provide sufficient barriers (i.e., casings and cement) and vertical and/or horizontal separation between the induced fractures and fresh water or potential receptors, such as water supply wells and other identified wells. Alpha recommends that the SGEIS clarify that the DEC has the authority to require operators to use these diagnostic methods to assure the adequacy of their plans prior to the issuance of a permit when warranted based on site-specific circumstances. Alpha further recommends that the SGEIS require that hydrofracturing operations be stopped immediately and DEC notified, if either the pressures or fracture fluid volumes are outside the anticipated ranges reported on the *Pre-Frac Checklist and Certification Form (dSGEIS, Appendix 20)*, until the cause of the unexpected condition is identified and addressed to the satisfaction of the NYSDEC. This topic is also addressed in Section 2.2.4 of this document.

- b) Natural gradients and properties of the overburden overlying the shale could allow vertical contaminant mobility.*

Dr. Terry Engelder refutes that injected frac water would migrate vertically upward in his slide-presentation review of others (Engelder 2010). Dr. Engelder points out the potential flow from deep ground water that is saline and/or contains high total dissolved solids (TDS) to overlying fresh water is constrained by the lack of buoyancy to drive the denser water upward. The buoyancy force (fresh water overlying saline/high TDS water) is stable as evidenced by the existing conditions, and buoyancy effectively stratifies ground water zones based on density. Dr. Engelder also observes that the principle of viscosity applies to ground water as well as gases. The stability of low viscosity gases that have been contained and have not migrated vertically upward for millions of years strongly supports that a fluid of much higher viscosity also would not migrate upward within generations or hundreds of years.

Sections 2.1.1, 2.1.2, 2.2.1, and 2.3.1 of this document also address this concern. It is Alpha's opinion that Myers' recommendations do not require revisions to the SGEIS; however, the NYSDEC might reference the existing GEIS and proposed SGEIS provisions and restate its existing authority to impose additional permit-specific requirements as it deems appropriate, particularly in areas of ground water resources, where wells are proposed at relatively shallow depths, where the target formations may be relatively thin, or where fracture pressures and growth are not well established.

- c) The potential for flow from the shale into surrounding formations should be analyzed and an accurate risk analysis of the potential for contaminant transport from the shale to aquifer zones should be provided.*

Sections 2.1.1, 2.1.2, 2.2.1, and 2.3.1 of this document address this concern. See item b, above.

2.5.5 List of References

Engelder, Terry, 2010. "Over 1,000,000 Hydraulic Fracturing Stimulations Within the USA Without Compromising Fresh Groundwater: True or False?", Department of Geosciences, The Pennsylvania State University, University Park, PA 16802, Presented to the Ground Water Protection Council.

Hill, M.C., and C.R. Tiedeman, 2007. Effective Groundwater Model Calibration: With Analysis of Data, Sensitivities, Predictions, and Uncertainty. John Wiley and Sons, Inc.

ICF International, 2009. Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program Well Permit issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs. Agreement No. 9679, NYSERDA, Albany NY. August 7, 2009.

2.6 Comments on Surface Contamination: Onsite Surface Storage of Fracturing Fluid and Flowback (pp. 14-15)

Myers makes four comments regarding the onsite storage of fluids:

- 1) that the dSGEIS does not discuss how fracturing fluid will be mixed or stored onsite in preparation for fracturing;
- 2) that flowback flow rates, well depths, and horizontal well lengths should be collected and used to predict flowback rates from New York wells;
- 3) that the dSGEIS lacks discussion about how operators will capture and store flowback and the expected number and size of tanks to be permitted at a well site; and,
- 4) that the dSGEIS fails to disclose how the flowback will be conveyed from the well to the tanks.

Myers states all of these points are important because of the potential for spills during these phases of the fracturing operations.

2.6.1 Accuracy and Completeness

Myers first comment is inaccurate. Section 5.6 of the dSGEIS thoroughly discusses the onsite storage and mixing of fracturing fluid additives. As stated on page 5-69, additive storage time is less than a week, and the additives are stored in the containers in which they are transported and delivered. These containers are described on page 5-70. As stated on page 5-70, "the blended fracturing solution is not stored, but is immediately mixed with proppant and pumped into the cased and cemented wellbore." The dSGEIS contains a detailed description of how the additives

are transferred into the wellbore, and this process will likely be the same for slick-water fracturing even with variations in the specific fluid composition (dSGEIS, pages 5-69 – 5-70).

The SGEIS includes a list and photographs of possible storage containers at any given site during the time between delivery and the completion of fracturing operations. The list is as follows (p. 5-71):

- 220- to 375-gallon plastic totes in metal cages strapped on flat bed trucks;
- Tank trucks for water and hydraulic fracturing acid;
- Palletized, 50- to 55-gallon, plastic or coated paper bags (shrink-wrapped as a pallet unit and wrapped a second time in plastic);
- One-gallon jugs with perforated, sealed twist lids stored inside boxes on the flat-bed trucks; and
- Smaller double-bag systems stored inside boxes on the blending unit.

Photograph 5.25, on page 5-95 of the SGEIS, shows additive trucks for storage and a blender for mixing fracture fluids.

Item 33 of Appendix 10 of the SGEIS, *Proposed Supplementary Permit Conditions For High-Volume Hydraulic Fracturing*, also states that secondary containment for fracturing additive containers and staging areas may be required if the location or operation raises a concern for potential releases that are not sufficiently addressed by the GEIS or SGEIS, inherent mitigation factors, and setbacks. (Also refer to Section 7.1.3.3.) Secondary containment must hold at least 110% of the volume of the single largest liquid container within a common staging area. In this situation, the applicant may have to identify the anticipated number, type, and volume of additive containers onsite in addition to the disclosure requirements on the Environmental Assessment Form (EAF) Addendum.

Item 33 of Appendix 10 also requires that additives be removed from the site if the site is unattended. Additional failure protection and monitoring requirements also are listed under Item 33. (Also see section 7.1.3.3.)

The EAF Addendum also requires information about the number, individual and total capacity, and well pad location of receiving tanks for flowback (p. 7-34, section 7.1.3.4). NYSDEC can then impose a permit condition limiting the number of tanks, if necessary.

Myers' point that flowback flow rates, well depths, and horizontal well lengths should be collected and used to predict flowback rates from New York wells is correct, but Alpha recommends that NYSDEC require that this data be recorded by operators as it becomes available and as NYSDEC deems necessary. Item 34 in Appendix 10 states that well operators must maintain a complete record of a well's hydraulic fracturing history, including the flowback phase. The information required includes the flowback volume and a pressure chart or profile. A synopsis must be included in the Well Drilling and Completion Report, and all information must be provided to NYSDEC upon request.

The third and fourth comments regard the capture, conveyance, and storage of flowback. Myers states that the dSGEIS should disclose how operators will capture, convey, and store flowback and the expected number and size of tanks to be permitted at a well site. These topics are discussed in the dSGEIS on page 5-91. Before fracturing a well, a wellhead, or “frac tree,” is installed, and pipes, manifolds, a gas-water separator, and tanks are connected to the tree. The system is then pressure-tested. Flowback recovery also is included in Appendix 10. Item 41 discusses record-keeping. Items 11 and 42 cover construction, maintenance, spill control, and stormwater pollution prevention practices. Fluid transfer from tanks to tanker trucks must be manned at both ends if the tank is not visible from the truck (p. 7-34).

The detailed Stormwater Pollution Prevention Plan (SWPPP) that is required by NYSDEC’s Multi-Sector General Permit (MSGP) includes additional requirements relative to flowback water tanks. Those requirements are listed on page 7-35 of the dSGEIS.

2.6.2 Supporting Information

This section of Dr. Myers’ review does not require documentation. His recommendations involve the NYSDEC collecting and disclosing more information.

2.6.3 Mitigation Measures

Dr. Myers does not recommend impact mitigation in this part of his review. He does suggest collecting and disclosing more information to ensure that field operations progress more smoothly and safely.

2.6.4 Proposed SGEIS Revisions

Myers presents four recommendations regarding the onsite storage of fluids:

- The dSGEIS should describe in detail how fracturing fluid will be mixed and stored onsite in preparation for fracturing;
- Flowback flow rates, well depths, and horizontal well lengths should be collected and used to predict flowback rates from New York wells;
- The dSGEIS should discuss the number and volume of tanks to be expected and permitted at a well site.
- The dSGEIS should disclose how the flowback will be conveyed from the well to the tanks.

It is Alpha’s opinion that these four topics are already covered by the dSGEIS. Myers’ second point can be emphasized. It is recommended the dSGEIS require that flowback *flow* rates be measured, recorded and reported in addition to the flowback volume rates that operators must include on the Well Drilling and Completion Report.

2.6.5 List of References

The only references used for this section are the dSGEIS and Myers' review.

2.7 Comments on Surface Contamination: Centralized Impoundments (pp. 15-20)

- a. Myers' first statement in this section is:

NYSDEC apparently proposes to allow centralized surface impoundments to serve more than one well pad to store flowback in the longer term prior to treatment or for recycling. Myers' statement is followed by an excerpt from dSGEIS p. 5-113, which includes the first 4 sentences of Section 5.12.2.1.

- b. The dSGEIS (p. 7-51) states that any proposed centralized surface impoundment will be considered with the first well permit application that proposes its use. Myers states that the applicant should be required to disclose the specifics of all the wells that are expected to use the impoundment as part of the initial permitting process. This will allow the analysis of the impoundment design based on the expected flowback volume and rates of flow.
- c. The dSGEIS refers to the "temporary" and "relative short-term" nature of the impoundments (pp. 7-53 and 7-54). Myers indicates that the dSGEIS must define "temporary" in more concrete terms before it imposes design requirements that are less stringent "than usual" (p. 16).
- d. Myers states that NYSDEC should establish regulations making it "illegal for open waters in these ponds to kill wildlife species" (p.16).
- e. The dSGEIS states that the regulations for solid waste management facilities (6 NYCRR Part 360) are most applicable for centralized flowback management facilities because flowback quality compares with landfill leachate and landfill liner requirements provide the requisite level of ground water quality protection (p. 7-52). Myers states these are unsupported claims that do not reference supporting data. He also states flow rates will be higher through a leak in the liner of a fluid-filled pond than flow rates through an identical leak in a liner supporting fluid-saturated solid waste (p.16-17).
- f. The dSGEIS proposes to allow substituting a geosynthetic clay liner (GCL) for the 2-foot thick compacted clay barrier in the composite at the discretion of the design engineer (Subdivision 360-2.14(a)) based on the temporary nature of flowback impoundments and anticipated flowback quality (p. 7-54). Myers identifies that Section 360-6.2 requires specification of the fluid stored, the volume of fluid, and the scheduled removal of the fluid. Myers requests the dSGEIS clarify the definition of "temporary" (p. 17).

- g. Myers states that the proposed double liner system definition in the first paragraph of the dSGEIS Section 7.1.7.3 (p. 7-54) is confusing.
- h. Myers indicates that flow could pass through a two-foot thick layer of compacted clay having a conductivity of 1×10^{-7} m/s (0.028 ft/day) in less than a year. At a unit gradient and no tailwater, fluid would pass through in 71 days (p. 18).
- i. Myers points out that the dSGEIS misquotes the maximum conductivity of the 2-foot compacted low conductivity soil layer in Section 360-6.5 of NYCRR Part 360 as being 1×10^{-7} cm/sec (p. 7-54). He also presents an abstract from Meer and Benson (2007) presenting the high variability of the effective conductivities of GCLs (p. 18).
- j. The dSGEIS discusses a “geocomposite drainage system,” which is a free-flowing, leak detection layer between two geomembranes (p. 7-54). Myers asserts that the dSGEIS is lax in presenting design requirements for the leak detection layer (p. 19). The maximum allowable leakage rate between the two geomembranes, based on a 30-day average, would be 100 gallons/acre/day. The dSGEIS does not require a leak detection system for the lower membrane and underlying GCL. The Part 360 regulations do not specify the maximum liner conductivity; the regulations only require a minimum liner thickness.

Myers’ recommendation, encompassing his many comments on centralized flowback impoundments is:

The preferred alternative for centralized impoundments is to use closed-loop steel tanks and piping systems to minimize the potential for long-term leakage of the stored flowback water. However, if NYSDEC can demonstrate that centralized impoundments, which will store changing volumes of water causing variable heads on the liner, are environmentally preferable, it should require the impoundments to be lined with a dual synthetic liner system and leak detection. Synthetic liners should have permeability of 1×10^{-11} cm/s. If a GCL is used, it must have the equivalent conductivity of two feet of clay compacted to 1×10^{-7} cm/s as specified at §360-2.13(j)(1)(ii) for the secondary liner for the secondary composite liner for a landfill. The leak detection system should limit the leaks 150 gpd for an entire impoundment.

2.7.1 Accuracy and Completeness

- a. Myers’ first comment appears uncertain as evidenced by “NYSDEC apparently proposes....” The excerpt Myers has incorporated in his review refers only to flowback that will be reused or recycled, as noted, and it discusses only what may be proposed by operators based on the information they have provided regarding current practices. The dSGEIS does not approve this method as part of the SGEIS. The dSGEIS is unclear as to what NYSDEC is proposing or approving for the centralized storage of flowback intended for reuse. The dSGEIS clearly states that tanks will be required for *on-site* (i.e. well pad) handling of flowback “unless additional compositional data is collected and provided on a site-specific basis to support an alternate proposal” (p. 5-99, Section

5.11.2). NYSDEC also proposes conservative and strict mitigation measures regarding flowback water handling. The dSGEIS acknowledges the availability of flowback water quality data is limited. Additional data will be required for alternative flowback handling proposals (p. 5-100, section 5.11.3). The dSGEIS contains an abundance of information on centralized surface impoundments, but it is not clear throughout the document that NYSDEC will consider centralized impoundment on a site-specific basis.

- b. Myers' recommendation regarding complete disclosure [upon the initial permitting process] of all future wells that will use a centralized surface impoundment appears well intended, but the information is not necessary for NYSDEC to permit the initial well. NYSDEC only has to analyze the impoundment for the well or wells the applicant wants permitted. It is in the best interest of the production companies to design the impoundment for all the wells they plan to install in the area. NYSDEC can deny future permits for wells proposing to use the impoundment if the impoundment is not sufficient to meet the projected flow rate and volume needs.

Myers' subsequent comments regarding centralized impoundments are based on his interpretation that NYSDEC may allow the use of impoundments as part of the generic conditions. Specific comments c, and e through j, focus on Myers' opinion of shortcomings regarding impoundment design requirements presented in the dSGEIS. The dSGEIS requires closed-loop steel tanks to contain flowback on-site, and the use of centralized impoundments requires a case-specific environmental assessment (EA) determination, regardless of the impoundment location, life-expectancy, or use (e.g., to store flowback for recycling). The dSGEIS is unclear in some places that impoundments will not be approved generically at any location. The dSGEIS also does not define "temporary" in regard to potential impoundments.

The dSGEIS presents the units of *cm/s* in Section 7.1.7.3 for soil conductivity; the correct units are *m/s*, per Section 360-6.5, Part 360. Myers' remaining points may have merit for any specific application; however, impoundment and liner design are required to be performed by a Professional Engineer (P.E.) who is licensed by, or otherwise allowed to practice in, New York State. The NYS-P.E. has the legal authority and liability to design an appropriate impoundment in consideration of multiple site-specific conditions including but not limited to the life-expectancy; volume and characteristics of the stored liquid; soil, surface water, and ground water conditions; topography; and/or other consideration the P.E. deems applicable.

- d. It is Myers' opinion that the responsibility of preventing birds to use flowback impoundments lies with industry. Section 6.4.2 of the dSGEIS states that the banks of impoundments should be kept clear to avoid attracting birds, and if "waterfowl or other birds are attracted to the ponds despite the salinity and lack of vegetation, then some sort of surface cover, such as netting, 'bird balls' or other exclusion measure would have to be considered." The NYSDEC Division of Fish, Wildlife, and Marine Resources is charged with protecting biological resources (among other functions), and can evaluate mitigation measures including consulting with the Division of Water and other NYSDEC personnel. Preventative measures can be required as part of the centralized impoundment design, or may be imposed at any time if the NYSDEC's analysis indicates that wildlife may or will be endangered by open impoundments.

2.7.2 Supporting Information

Dr. Myers' review references relevant regulations in this section of his review.

2.7.3 Mitigation Measures

Myers offers specific recommendations outlined in Section 2.7 of this document, which Alpha identifies as comments c, and e through j.

2.7.4 Proposed SGEIS Revisions

Alpha recommends the SGEIS clarify when and for what purpose(s) the NYSDEC may consider the use of centralized impoundments, and that a site-specific EA will be required for any proposed centralized impoundment.

The conductivity units in section 7.1.7.3 of the dSGEIS should be edited to reflect the correct units of "m/s".

Alpha recommends the SGEIS provide the relative time frame(s) that would be considered "temporary" to distinguish potential surface impoundments that may be used in the oil and gas industry from structures designed and intended for long-term life expectancies or "permanent" use (e.g., dams and landfills).

Alpha does not recommend additional revisions based on the above analysis and discussion.

2.7.5 List of References

NYSDEC, 2010. Regulations and Enforcement: Chapter IV – Quality Services, Subchapter B: Solid Wastes, Part 360: Solid Waste Management Facilities, Subpart 360-6: Liquid Storage. <http://www.dec.ny.gov/regs/4410.html>.

U.S. Fish and Wildlife Service, 2010. Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service; Migratory Bird Treaty Act of 1918 (as amended). <http://www.fws.gov/laws/lawsdigest/migtrea.html>.

2.8 Comments on Aquifer Contamination: Leaks from Wellbores (p. 20)

The dSGEIS emphasizes that leaks from boreholes rarely occur when wells are properly constructed. The dSGEIS does not specify how often wells are not constructed properly. Myers' recommendation is: "The dSGEIS should contain a discussion that estimates the percent of all wells that were not properly constructed" (p. 20).

2.8.1 Accuracy and Completeness

Myers' comment is based on excerpts from pages 6-35 and 6-37 of the dSGEIS. He may have overlooked the last sentence of the paragraph on page 6-35 from which he quoted (Section 6.1.4.2). That sentence states:

Using the API [American Petroleum Institute] analysis as an upper bound for the risk associated with the injection of hydraulic fracturing fluids, the probability of fracture fluids reaching a USDW [underground source of drinking water] due to failures in the casing or casing cement is estimated at less than 2×10^{-8} (fewer than 1 in 50 million wells).

This estimate is repeated in dSGEIS Section 6.1.5.1. As documented in responses to previous comments, the existing NYSDEC requirements and programs for drilling, casing, and cementing are intended to minimize potential leaks from boreholes, and those programs have been demonstrated to be effective based on the lack of incidents in New York States since implementing those programs. Additionally, wellbore construction is reviewed by the NYSDEC and must be approved prior to permit issuance. Finally, the submission of a *Pre-Frac Checklist and Certification Form* is required at least 48 hours prior to commencement of high volume hydraulic fracturing operations, as discussed in Section 2.5.4 of this document and on page 7-45 of the dSGEIS. The purpose of this form to:

- a. attest that well construction is in accordance with the well permit or approved revisions,
- b. record the depth and estimated flow rates where fresh water, brine, oil and/or gas were encountered or circulation was lost during drilling operations, and
- c. include information about how any lost circulation zones were addressed.

2.8.2 Supporting Information

No documentation is needed for this topic.

2.8.3 Mitigation Measures

Mitigation is not applicable to this topic.

2.8.4 Proposed SGEIS Revisions

Myers' recommendation is: "The dSGEIS should contain a discussion that estimates the percent of all wells that were not properly constructed" (p. 20). Alpha does not propose revisions based on this comment.

2.8.5 List of References

The references used for this section are the dSGEIS and Myers' review.

2.9 Comments on Aquifer Contamination: Documented Contamination from Hydraulic Fracturing Operations (pp. 20-21)

Myers summarizes cases of leaks that he asserts “have occurred from fracturing operations”, including a list of gas leak incidents that the Pennsylvania Department of Environmental Protection (PADEP) has documented (Myers, Appendix B). Myers acknowledges most of the incidents he cites occurred due to poor well construction. Myers says coalbed methane development is a different [from shale gas development] but is “representative of the way methane gas can move through groundwater to wells.” Myers states that the dSGEIS ignores the potential for mistakes and accidents. He recommends that NYSDEC “establish an improved inspection regime for well construction” and that “a qualified inspector should be onsite” during casing placement and cementing, and fracturing operations.

2.9.1 Accuracy and Completeness

Dr. Myers' referenced list of gas leak incidents documented by PADEP does not distinguish incidents related to coal bed methane (CBM) from incidents related to deeper shale gas development. This difference is critical, because CBM and the coal bed aquifers occur within the same stratigraphy and are not isolated. Alpha notes that many of the incidents were reported in western PA counties within the “Main Bituminous Field.” Two of the incidents are related to underground gas storage, and some of the gas origins have not been determined. Regardless, none of the cited cases have been attributed to hydrofracturing. Many of the incidents resulted from a lack of casing, poor casing installation, or overpressuring casing. Myers acknowledges that “[m]ost of these incidents have one commonality - the production well construction is not always perfect” (pg. 21).

Myers also states, on page 4, that “[his] review documents incidents from other states, and from New York, where there have been leaks” [from wellbores]. Alpha did not find any New York incidents referenced in Myers' text or appendices.

Dr. Myers' statement that coalbed methane examples are “representative of the way methane gas can move through groundwater to wells” is technically correct under the conditions for CBM development. It does not represent the potential for ground water flow between fresh water aquifers and the isolated black shale formations at much greater depths in NY. The depth to the Marcellus can be more than 6,000 feet in southern NY, and the Utica shale is up to 10,000 feet deep (dSGEIS Chapter 4). The potential for impacts to fresh ground water is further minimized, because the minimum vertical separation of 1,000 feet between fresh water resources and the shale beds represents only a small fraction of the actual conditions in New York State.

Dr. Myers does not specify what qualifications an inspector should have and whether the inspector should be a NYSDEC employee. Myers does not comment on the NYSDEC's established casing and cementing plans and reporting requirements, or the efficacy of those related programs to date. The NYSDEC recognizes that, as Myers states, "[m]istakes occur and accidents happen..." and developed the existing casing and cementing requirements many years ago which have proven effective for protecting ground water resources, as demonstrated by the lack of documented impacts since those programs were implemented.

A state inspector must be present during surface casing cementing operations in a primary or principal aquifer (DGEIS, 1988, p.9-12). The permit condition was reworded in February 1985 to emphasize that cementing may not commence until a state inspector is onsite (DGEIS, 1988, p.9-13). State inspectors must also be present for testing the blow out preventers (DGEIS, 1988, p. 9-21).As noted in the dSGEIS:

Current casing and cementing practices attached as conditions to all oil and gas well drilling permits require notification to the Department prior to any surface casing pressure test. In primary and principal aquifer areas, the Department must be notified prior to surface casing cementing operations and cementing cannot commence until a state inspector is present. These requirements will continue to apply to wells drilled for high-volume hydraulic fracturing. Supplementary Permit Conditions for High-Volume Hydraulic Fracturing will require notification prior to surface casing cementing for all wells, so that the Department staff has the opportunity to witness the operations (pp. 7-47 through 7-48).

These requirements are repeated in Appendix 9 of the dSGEIS which contains *Fresh Water Supplementary Permit Conditions Required for all Wells in Primary and Principal Aquifers* (pp. xcv, xcvi) and in Appendix 10 (p. ci). Appendix 8 contains the *Casing & Cementing Practices Required for All Wells in NY*. These requirements are attached as permit conditions to every permit issued (Sanford, K.; June 10, 2010; personal communication). NYSDEC's current well permit form requires submission of a casing and cementing plan with every well permit application as follows:

On attached sheet give details for each proposed casing string and cement job including but not limited to: bit size, casing size, casing weight and grade, TVD and TMD of casing set, scratchers, centralizers, cement baskets, sacks of cement, cement additives with percentages or pounds per sack, estimated TVD and TMD of top of cement, estimated amount of excess cement and waiting-on-cement time (Sanford, K.; June10, 2010; personal communication).

The proposed casing and cement plan is subject to NYSDEC review when the permit is issued.

Gas migration is discussed in the original GEIS in chapters 9, 10, and 16, and is discussed as a potential impact in the dSGEIS on pages 6-35 through 6-36. The mitigation of gas is thoroughly discussed in the dSGEIS (pages 7-44 through 7-48), including stringent requirements for properly casing and cementing wells that will be stimulated through high-volume hydraulic fracturing in the vicinities of primary and principal aquifers.

2.9.2 Supporting Information

Myers references the PADEP for the presented case histories; however, the PA incidents related to shale gas development are not specifically identified.

2.9.3 Mitigation Measures

Dr. Myers recommends that NYSDEC “establish an improved inspection regime for well construction” and require that a qualified inspector be onsite at least during the casing placement, the cementing of the casing, and fracturing operations. Myers’ recommendation appears reasonable, but it is similar to what NYSDEC already requires throughout well operations. The required state presence, notifications, and plan submittals can be used by NYSDEC to modify or inspect operations as it deems appropriate and acceptable on a case-specific basis, including the pre-hydrofracturing checklist and certification.

NYSDEC’s additional mitigation measures for gas and contaminant migration are thoroughly detailed in Chapter 7 of the dSGEIS.

2.9.4 Proposed SGEIS Revisions

It is Alpha’s opinion that no revisions to the SGEIS are necessary.

2.9.5 List of References

NYSDEC, January 1988. Draft Generic Environmental Impact Statement on the Oil, Gas, and Solution Mining Regulatory Program, Volume I.

http://www.dec.ny.gov/docs/materials_minerals_pdf/dgeisv1ch9.pdf

SRBC, December 31, 2009. Water Quality Impacts Associated with Shale Gas Development.

2.10 Comments on Insufficient Monitoring (pp. 21-23)

The dSGEIS proposes monitoring existing water wells within 1000 feet of the proposed gas well or within 2000 feet, if there are no available wells within a 1000-foot radius. Myers states this proposal is not preventative and that it is “too late to protect drinking water” after contamination is detected (pp.21-22).

Myers also comments that the proposed sampling termination one year after hydraulic fracturing operations cease would miss contamination that has transport times longer than one year. Myers suggests that five years of monitoring would be sufficient, provided a site is closed and no waste is left onsite (p.22). Myers’ recommends that NYSDEC install a monitoring well system around

each well pad, require mitigation to protect water resources, and continue monitoring for five years after a well pad closure.

Myers states that New York's monitoring policy will be to sample for indicators rather than fracturing fluid chemicals and that the URS report lists numerous indicator parameters (TDS, chloride, bromide, barium, etc.) that increase during the first weeks of flowback in the Marcellus and other shales, in Pennsylvania, based on observations. Myers states that the dSGEIS should provide the actual data for these observations made by industry and included in URS (2009) and that the dSGEIS should discuss why these constituents (inorganics) may increase with time (p.22).

Myers outlines what the monitoring system and plans should include and provides a technical memorandum written by him in June 2009, titled *Monitoring Groundwater Quality Near Unconventional Methane Gas Development Projects, A Primer for Residents Concerned about Their Water* (Myers, Appendix C). He recommends that NYSDEC use this memorandum to provide guidance for monitoring plan design.

2.10.1 Accuracy and Completeness

Myers' comment that ground water monitoring is not preventive is partly accurate but is incomplete. His comment regarding the need to increase the monitoring period to five years to allow sufficient time for potential contamination to travel 2000 feet appears misguided and also is incomplete. Dr. Myers' comments appear to be based on the assumption that ground water contamination will occur long after hydrofracturing and after gas wells are in production. Alpha does not agree with this assumption. The NYSDEC recognizes the concern to protect ground water and the dSGEIS provides multiple protections and mitigation measures during well drilling and development activities. The comprehensive measures apply to activities from well pad construction through drilling and hydrofracturing, to production. It is Alpha's opinion that the dSGEIS correctly identifies and focuses the measures for protecting ground water quality on planning, monitoring, inspecting, and reporting during drilling, installing and cementing casings, and during hydrofracturing, as summarized in previous sections of this document.

Ground water quality monitoring is one aspect of those existing and proposed mitigation measures. Other measures include detailed pollution prevention plans (per the SWPP); storage of hazardous materials; plans, programs, and permit conditions for drilling and installing protective casings; certifications and permit conditions prior to hydrofracturing; handling and disposing drilling wastes; and handling, testing, and disposing flowback. The dSGEIS proposes sampling water wells prior to drilling, every three months after reaching the total measured depth of a well, and three months, six months and one year after hydraulic fracturing operations at each well on a pad. It is Alpha's opinion that the proposed sampling period of one year after the last well on the pad is hydraulically fractured is sufficient to monitor potential impacts from drilling and hydrofracturing activities. Operators may elect to sample all or any particular ground water well (or any well) more often, or to include additional laboratory analytes for its own protection, based on the presumption of an impact due to well operations if a parameter is detected by sampling.

Myers' review of the monitoring plan outlined by the dSGEIS is inaccurate. He states that NYSDEC's policy apparently will be to sample for indicators rather than fracturing fluid chemicals. NYSDEC proposes to test for the parameter list that NYSDOH recommends when testing and approving new residential drinking water supply wells. NYSDEC's objective is to analyze the NYSDOH list of parameters (Table 7.3, p. 7-40), prior to hydraulic fracturing to establish baseline water quality. NYSDOH has reviewed fracturing additive and flowback composition data and also recommends testing for the parameters listed on page 7-41. Only three of the 28 parameters listed are considered contaminant indicators; these include barium, TDS and pH (URS, 2009, p. 8-3). It should be noted that fracture additive composition will vary based on location; therefore, the parameter list may vary to some degree.

Myers' recommendation that NYSDEC use his technical memorandum written by him in June 2009, titled *Monitoring Groundwater Quality Near Unconventional Methane Gas Development Projects, A Primer for Residents Concerned about Their Water* (Myers, Appendix C). The memorandum, however, makes many arguable points.

One erroneous statement made by Dr. Myers is that the detection of methane in ground water in the vicinity of a shale gas well is sufficient to prove that a leak, caused by shale-bed methane development, exists. Methane from biogenic sources has been found in drinking water wells (Colorado Oil and Gas Conservation Commission, undated document). Gas in deeply buried shales is thermogenic gas. It is also possible to find naturally occurring thermogenic gas in drinking water supply wells that are in contact with gas-bearing formations.

Myers' technical memorandum also contains a section discussing "Hydraulic Fracturing Issues," that suggests fracturing a shale will affect the flow of an area's ground water (pages 10-11). This idea is not relevant to the flow in aquifers in NYS, because the Marcellus and black shales in areas where shale gas development potential exists are not part of, and are not connected to, the regional hydrogeological systems. The baseline geologic evidence that fluid migration to overlying fresh water aquifers is improbable includes studies that show the Marcellus shale has remained isolated from overlying formations for millions of years. The primary evidence that the rock layers between the Marcellus and relatively shallow fresh water aquifers are sufficiently impermeable and create a barrier between the gas producing target zones and ground water aquifers are the facts that these units are "overpressured" and that natural gas and saline water has remained trapped in these formations for millions of years (API, 2009; GEIS p. 5-4; USDOE, 2009). Overpressuring occurs where fluid pressure cannot be transmitted through impermeable beds to the surface (Selley, 1998) and can be maintained only if there is no hydraulic connection. Even at shallower depths, lithostatic pressures exert sufficient force to effectively close natural fractures. The fact that hydrofracturing is commonly performed in many shallow (<1000 feet) water wells in New York is additional evidence that natural fractures and structures are not necessarily transmissive. Sections 2.1.1, 2.1.2, 2.2.1, and 2.3.1 of this document address this concern further. Furthermore, NYSDEC has the authority to impose additional permit-specific requirements as it deems appropriate, particularly in areas of ground water resources, where wells are proposed at relatively shallow depths, where the target formations may be relatively thin, or where fracture pressures and growth are not well-established.

Dr. Myers cites a 2009 document written by Thyne in his technical memorandum, but Myers' references only include Thyne's 2008 document titled *Review of Phase II Hydrogeologic Study, Prepared for Garfield County*. Myers claims that "Thyne (2009) showed that methane could move vertically along faults and fractures several thousand feet to contaminate near-surface domestic wells." Thyne does suggest that methane could move along faults and fractures from deep gas-producing formations in Colorado to water supply wells, but his main finding regarding petroleum activity impacts on water wells is:

The water quality data is sufficient to establish the range of natural background chemistry and delineate the impact of petroleum activities. Impacts from petroleum activities are not currently present at levels that exceed regulatory limits. The impacts are mainly elevated methane and chloride in groundwater wells (Thyne, 2008, page 2).

Dr. Thyne also claims that there is a temporal trend of increasing methane coincident with an increase in the number of gas wells in Colorado, and "there has been an increase in ground water wells with elevated chloride that can be correlated to the number of gas wells" (page 2). Thyne acknowledges:

...it is not possible at this time to identify if leaking production tubing, leaking top-of-gas casing or uncased Wasatch interval is the primary source of the methane. ...As was the case with the methane the current data do not permit precise identification of the [chloride] source (page 21).

Dr. Thyne likewise acknowledges that domestic wells are not ideal for monitoring ground water quality and that the bulk of his data is from domestic wells.

Dr. Thyne's 2008 document has been reviewed by both S. S. Papadopoulos & Associates, Inc (2009) and Dr. A.W. Gorody of Universal Geoscience Consulting, Inc. (2009). Both reviews point out several shortcomings in Dr. Thyne's data, data analysis methods, and assertions. Their criticisms of Dr. Thyne's report are extensive and are not reviewed here, but their presentations are listed in the references of this document.

The section of Myers' memorandum titled Hydraulic Fracturing (pages 16-17) states that monitoring for fracture fluid additives would be costly because of the "large potential variety of chemical and their variable transport properties." In fact, there are 12 classes of additives, based on their purpose or use. Not all classes would be used at every well, and only one product in each class would typically be used per job. Therefore, no more than 12 products would be present at one time at any given site.

2.10.2 Supporting Information

Dr. Myers does not provide a basis for recommending five years of monitoring. His recommendation apparently conflicts with his ground water model which predicts impacts could occur in as few as 22 years.

Dr. Myers references his technical memorandum included in his review as Appendix C. Myers' references include well known and often-cited textbooks on hydrology, USGS reports, recent presentations, articles from several professional journals, and federal and local government reports. His memorandum is well-researched but presents and organizes basic hydrogeologic information.

2.10.3 Mitigation Measures

Myers' recommendations are preventative measures to safeguard ground water and drinking water supply quality. He recommends installing monitoring systems closer to gas wells, increasing the frequency of monitoring events, and lengthening the duration of monitoring plans.

Myers' suggestions and guidelines appear appropriate for potential application to some hazardous sites, but are misguided and likely cost-prohibitive for application to gas development. It is Alpha's opinion the existing and proposed ground water protections and measures are adequate, based on reported impacts and probable causes from other states, the NYSDEC's authority, experience and history of regulations and implementing programs, and based on the previous discussions of ground water resources related to drilling and hydrofracturing contained in this document.

2.10.4 Proposed SGEIS Revisions

Alpha does not recommend revisions to the SGEIS regarding extending ground water monitoring parameters or time frames.

Alpha recommends minor dSGEIS revisions for reasons of organization and clarity, including changing "Table 7.1" to "Table 7.3" under the heading "*Parameters*" on page 7-39, and changing "Table 7.3 – NYSDOW..." to "Table 7.3 – NYSDOH..." at the top of page 7-40. The sentence on page 7-41 that begins, "As diesel-based fracturing fluid is not proposed ..." is unclear; it is not clear what "its" refers to in this sentence. The URS (2009) report that is referenced states, "...sampling for benzene, which is contained in diesel, could indicate above ground spills" (p. 8-3). It appears the sentence should be "...the primary reason for benzene's inclusion..."

2.10.5 List of References

Colorado Oil and Gas Conservation Commission, undated document. Untitled document regarding the documentary *Gasland*; <http://cogcc.state.co.us/library/GASLAND%20DOC.pdf>

Gorody, A.W., president Universal Geoscience Consulting, Inc., 2009. *Summary Comments on Report by Dr. G. Thyne*.

http://cogcc.state.co.us/Library/Presentations/Glenwood_Spgs_HearingJuly_2009/GlenwoodMasterPage.html

S. S. Papadopoulos & Associates, Inc., July 14, 2009. *Evaluation of Thyne, 2008 "Review of Phase II Hydrogeologic Study"*.

[http://cogcc.state.co.us/Library/Presentations/Glenwood_Spgs_HearingJuly_2009/\(1_D\)_Evaluation_of_Thyne_Report_vers2%20\(dv\).pdf](http://cogcc.state.co.us/Library/Presentations/Glenwood_Spgs_HearingJuly_2009/(1_D)_Evaluation_of_Thyne_Report_vers2%20(dv).pdf)

Thyne, G., 2008. *Review of Phase II Hydrogeologic Study, Prepared for Garfield County, 12/20/2008*. [http://cogcc.state.co.us/Library/Presentations/Glenwood_Spgs_HearingJuly_2009/\(1_A\)_ReviewofPhase-II-HydrogeologicStudy.pdf](http://cogcc.state.co.us/Library/Presentations/Glenwood_Spgs_HearingJuly_2009/(1_A)_ReviewofPhase-II-HydrogeologicStudy.pdf)

URS, 2009. Chapter 2: Water-Related Issues Associated with Gas Production in the Marcellus Shale, Additives, Flowback Quality and Quantity, NYS Regulations, On-site Treatment, Green Technologies, Alternate Water Sources, and Water Well Testing. NYSERDA Contract No. 10666.

3.0 SETBACKS

3.1 Comments on Vertical Setback (pp. 23-26)

The topic of subsurface contamination migrating from the target shale to freshwater aquifers is thoroughly discussed by Myers on pages 9 through 14. His comments from these earlier pages are discussed in this narrative in above Sections 2.4 and 2.5. Myers reiterates in this section regarding vertical setback that it is not possible to specify a setback to guarantee there will be no transport from a target shale to an overlying aquifer, because it depends on the conditions between the shale and the aquifer.

Myers recommends preparing a vertical gradient map for the formations directly above the shale so the possibility of vertical flow can be accurately evaluated prior to fracturing. He asserts there is no safe vertical setback where there is an upward gradient unless the properties of the intervening layers are known and prohibit upward flow.

Myers suggests that NYSDEC require site-specific analyses for all well pads. Data would be collected by drilling and logging a borehole. The head should be measured along the borehole, and in-situ testing could yield permeability estimates. Myers recommends the following precautions if calculations yield a travel time estimate of less than 500 years:

- Design fracturing to end with a sufficient setback from the edge of the shale. Contain the fracturing within the shale.
- Verify the extent of fracturing by monitoring the pressure losses from the producing well. A verification well should be drilled and cored in the adjoining formation and the shale to verify the fracturing results if fracturing may have gone beyond the shale formation.

Myers believes NYSDEC should require an applicant should apply for all the wells planned for a single well pad or series of well pads, so tests run on one or two wells could provide data for a series of wells.

Myers states contamination also can be transported laterally and that tracing a contaminant back to a specific operation may be impossible far in the future. It is Myers' opinion that the potential for drinking water contamination by fracture fluid or formation water should be prevented by implementing a long-term monitoring plan over the developed Marcellus Shale region funded by a long-term bond provided by the industry through permitting fees. Myers outlines his recommended plan on pages 25 and 26.

3.1.1 Accuracy and Completeness

Myers comments essentially reiterate similar concerns regarding potential impacts to ground water quality, and are based on the presumption that ground water will be connected to deep and isolated low-permeability units through hydrofracturing. The accuracy and completeness of Dr. Myers' comments and the presumption of subsurface impacts are discussed in Sections 2.4.1 and 2.5.1 of this document. It is Alpha's opinion that the site-specific analysis of overlying units and detailed hydrological analysis recommended by Myers likely would be cost-prohibitive, and is not necessary to protect fresh water aquifers for the reasons discussed in Section 2.1.1.

Dr. Myers points out alleged shortcomings of the dSGEIS regarding subsurface contaminant transport. His review cites Fetter (2001, 1999). ICF (2009) clearly states that the analysis of contaminant transport is based on assumptions. Regardless, neither simplified analysis performed by ICF nor Myers accurately portrays or predicts potential ground water flow from low-permeability black shales and overlying confining units. Both assume a hypothetical hydraulic connection that does not exist (and which Myers acknowledges does not exist).

Myers does not address historical data presented by ICF (2009, p.22). The USEPA's analysis (2004) included an evaluation of the potential for some fluid to move beyond the zone of capture for the production well and concluded that the injection of fracturing fluids into coalbed methane wells poses little or no threat to coalbed aquifers (ICF, 2009). In June 2009, the GWPC testified before the House Committee on Natural Resources and included statements from officials in Ohio, Pennsylvania, New Mexico, Alabama, and Texas confirming that there have been no incidents of ground water contamination due to hydraulic fracturing (GWPC, 2009). It is recognized that ground water has been impacted through gas migration as a result of faulty well construction. Documented cases in PA are discussed in this document, Section 2.9. Sections 2.8.1 and 2.9.1 of this document summarize multiple existing and proposed mechanisms available to the NYSDEC to protect ground water resources.

NYSDEC's additional mitigation measures to address potential gas and contaminant migration are thoroughly detailed in Chapter 7 of the dSGEIS.

3.1.2 Supporting Information

Dr. Myers' review cites Fetter (2001, 1999). Myers does not include the historical data presented by ICF (2009, p.22).

3.1.3 Mitigation Measures

Myers recommends that the NYSDEC require site-specific analyses for all well pads. A typical analysis would include fracture design with a sufficient setback from the shale borders and drilling and coring a verification well in an adjoining formation prior to starting post-fracturing operations to ensure that fractures have not gone beyond the target unit. Myers also asserts that the NYSDEC should implement a long-term monitoring plan over the developed Marcellus Shale region funded by a long-term bond provided by the industry through permitting fees.

3.1.4 Proposed SGEIS Revisions

Alpha proposes no revisions to the SGEIS based on discussions and references. The proposed measures in the dSGEIS and NYSDEC's existing authority can be used to impose Dr. Myers' recommendations for monitoring and reporting, where the NYSDEC deems necessary. Many of the available and proposed provisions and measures are identified in this document, Sections 2.8.1 and 2.9.1.

3.1.5 List of References

Fetter, C.W., 2001. Applied Hydrogeology, Fourth Edition. Prentice-Hall.

Fetter, C.W., 1999. Contaminant Hydrogeology, Second Edition. Prentice-Hall.

Ground Water Protection Council, 2009. "Statement of Scott Kell before the House Committee on Natural Resources Subcommittee on Energy and Mineral Resources," Washington, D.C., June 4, 2009.

ICF International, 2009. Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program Well Permit issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs. Agreement No. 9679, NYSERDA, Albany NY. August 7, 2009.

3.2 Comments on Horizontal Setback (pp. 26-27)

Dr. Myers' review summarizes all of the setbacks for water sources in the dSGEIS and states the setbacks are not supported by any type of analysis that demonstrates the setback distances

actually provide protection to the resources. Myers notes that none of the setbacks are drilling prohibitions; the setbacks represent thresholds where further analysis will be required and most of the setbacks were adapted from other jurisdictions.

Myers makes the following recommendations:

- NYSDEC should analyze whether the setback regulations have been effective in preventing water resource degradation;
- The horizontal setback from surface water sources should be 2000 feet. There should be a berm around the well with a detention volume of at least 25,000 gallons. Shorter setbacks could be considered if local geology makes the longer setback unnecessary. Local geology and topography might also make longer setbacks necessary.
- The setback from a water supply well should be 1000 feet, but a monitoring system should be installed to detect contaminant migration before it reaches the supply well.

3.2.1 Accuracy and Completeness

Dr. Myers review is incomplete; he suggests new setbacks but provides no rationale for his proposed distances. He is not entirely accurate that there was no analysis of any of the setbacks adapted from regulating authorities. The dSGEIS references SEQRA, NYSDOH, NYC Watershed Rules and Regulations, the Clean Water Protection Act, and public water protection rules from other states. Myers assumes the setbacks proposed in the dSGEIS are not based on analysis; however, the setbacks are supported by practical application, experience, and historical analyses.

The NYSDEC can require alternative setbacks, based on the EAF and in consideration of many site-specific conditions, some of which may include topography, soils, ground and surface water resources, or sensitive receptors.

3.2.2 Supporting Information

Myers does not document or provide a supportive analysis for longer setback distances. Alpha notes that the NYSDEC may impose conditions to any permit where it deems necessary, such as containment berms or longer setbacks.

3.2.3 Mitigation Measures

Myers suggests new setbacks but provides no rationale for his proposed distances. Myers assumes the setbacks proposed in the dSGEIS are not based on analysis; however, the setbacks are supported by practical application, experience, and historical analyses.

3.2.4 Proposed SGEIS Revisions

Dr. Myers has not presented any evidence that the horizontal setbacks proposed by the dSGEIS should be changed. Alpha does not propose any revisions.

3.2.5 List of References

The references used for this section are the dSGEIS and Myers' review.

4.0 DEPLETION OF WATER SOURCES

4.1 Comments on Surface Water (pp. 27-28)

Myers indicates that the dSGEIS provides only a cursory qualitative summary of how aquatic habitat, aquatic ecosystems, wetlands and aquifers may be affected. Myers comments the dSGEIS does not address how aquatic habitat or aquifer recharge relates to stream flow, quantitatively, or provide guidelines for assessing these factors, and that the discussion of cumulative impacts does not consider more than one fracturing event occurring simultaneously.

Myers comments that the discussion of surface water withdrawals in the dSGEIS downplays the potential impacts of the withdrawals. He states that the dSGEIS indicates an estimate of approximately 25 MGD of surface water from the Susquehanna River Basin (SRB) as the maximum consumptive use for natural gas production and that the dSGEIS does not disclose what information was used to derive this estimate.

Dr. Myers' final comment on surface water withdrawals is that the primary impact will be "local and scale-dependent", and "At the local level with smaller basins and lower baseflow, without adequate passby flow requirements, the impacts could be devastating."

4.1.1 Accuracy and Completeness

Myers' critique states that the dSGEIS's coverage of the potential environmental impacts related to surface water withdrawals is "only a cursive qualitative summary" of impacts, and it does not provide guidelines for assessing the impacts quantitatively. The dSGEIS includes an evaluation of the potential significant adverse environmental impacts in Chapter 6 and a description of possible mitigation measures to minimize environmental impacts in Chapter 7, and recognizes via application of natural flow regime methodology that quantitative assessments are site-specific. Both discussions fulfill the requirements of SEQRA. The dSGEIS states:

[The] evaluation of cumulative impacts of multiple withdrawals must consider existing water usage, the non-continuous nature of withdrawals and the natural replenishment of

water resources.... The DRBC and SRBC have developed regulations, policies, and procedures to characterize existing water and track approved withdrawals (p. 6-8).

NYSDEC recognizes the authority and responsibilities of the river basin commissions to monitor and minimize adverse impacts to those surface water systems.

Dr. Myers' review indicates that the dSGEIS text discussing Figure 6.2 needs to be clearer and the reference is incomplete. Myers' is correct; the SGEIS needs to provide more information about this graph. The audio file that accompanies this graph online states that the bar depicting the "current estimate" of daily consumptive water use by the gas drilling industry actually represents the SRBC's estimate of how much the industry will use in the future when gas development companies are operating in the SRB at their full potentials. The presenter notes that a shortage of drill rigs is the current limiting factor to gas production and, thus, to the water use by the gas industry. The basis for this estimate is a study of the current Texas production of the Barnett Shale gas, factoring in, among other things, the land availability, the number of rigs, and expected growth. The estimate represented by the bar graph is 28 MGD. (SRBC, 2008).

Myers is correct when he states that depleting a surface water supply could be devastating at a local level, but the SRBC and the DRBC must approve water use applications. Both entities evaluate withdrawal applications and consider passby flow requirements and potential impacts at all levels and scales throughout the river basins.

4.1.2 Supporting Information

This section of Myers' review does not require any documents other than the dSGEIS.

4.1.3 Mitigation Measures

Dr. Myers' does not propose mitigative measures in this section. He suggests that the SGEIS should contain a more thorough assessment of the possible adverse impacts of surface water withdrawals.

4.1.4 Proposed SGEIS Revisions

Alpha recommends the sources for the figures in Chapter 6 be clearly and completely identified. The label on the bar graph representing consumptive use by gas drilling should be edited from "current estimate" to, for example, "estimate of daily consumptive use when gas companies are operating at their expected peak in the SRB" and the date representing the data (9/11/2008).

Alpha recommends that the final SGEIS be revised to include a map delineating the drainage basins throughout the black shale regions of NYS beyond the Susquehanna River and Delaware River drainage basins, in response to Myer's comment regarding delineating drainage areas.

4.1.5 List of References

SRBC, September 11, 2008. *Gas Well Drilling Update*,
<http://www.srbc.net/programs/WRM/video/gas%20well%20drilling%20update/gas%20well%20drilling%20update.html>.

4.2 Comments on Mitigation of Surface Water Withdrawals (pp. 28-33)

The following summarizes comments from Dr. Myers:

Delaware River Basin Commission (p. 29)

Myers summarizes the DRBC goals:

- To keep aquatic systems in a “safe and satisfactory condition;”
- To regulate diversions to “reduce the likelihood of severe low stream flows that can adversely affect fish and wildlife resources; and
- To maintain water quality.

Myers contends that the DRBC does not have adequate regulations to back up these goals. They do not have a passby flow requirement (dSGEIS, page 7-16) but rather rely on reservoir releases and use the Q7-10 flow for “water resource evaluation issues” (*Id.*).

Susquehanna River Basin Commission (p. 29 - 31)

Myers summarizes that the SRBC requires that a certain amount of water be allowed to pass the diversion for mitigation (passby flow) with three exceptions:

- There is no passby flow requirement when flow in the river or stream is providing sufficient flow so that the diversion cannot harm the river flows (p. 29).
- The diversion will be allowed if the diversion will not prevent maintaining the passby flow requirement. Whenever the stream flow rates naturally drop below the passby flow requirement plus the taking (diversion amount), both the quantity and the rate of the withdrawal will be reduced to less than 10 percent of the Q7-10 low flow (p. 29 - 30).
- SRBC exceptional value waters, withdrawals may not result in more than a 5% loss of habitat with three exceptions that cause up to a 7.5% habitat loss. Withdrawals may not result in more than a 10% loss of habitats for class B, coldwater fisheries waters. Withdrawals may not cause more than a 15% loss of habitats for class C and D, coldwater fisheries waters (p. 30).

Dr. Myers asserts that the dSGEIS should better define and discuss habitat loss, average daily flow, and acid mine drainage. It is Myers’ opinion that the average daily flow should be based on complete data set of year-round flows. Myers also indicates that the SRBC does not have adequate requirements to protect streamflow from surface diversions for hydraulic fracturing.

Great Lakes - St. Lawrence Water Resources Compact (GLC) (p. 31)

Dr. Myers comments that the GLC prohibits the export of any water from the basin in a container that holds more than 5.7 gallons. Water for development elsewhere could, therefore, not be supplied from the basin. It is not clear how this affects the movement of flowback water out of the basin for treatment. The GLC requires consultation for any project with a consumptive average use of 5,000,000 gpd averaged over 90 days. There are no GLC requirements for passby flows. Myers contends that the GLC does not have adequate requirements to protect streamflow from surface diversions for hydraulic fracturing.

Dr. Myers recommends that NYSDEC should limit hydraulic fracturing permits in any area which does not have sufficient passby flow requirements. He asserts that the DRBC, SRBC, and GLC lack adequate requirements to protect streamflow from surface diversions for hydraulic fracturing water supplies.

Natural Flow Regime Method (NFRM) (p. 31 – 33)

Myers comments that surface water withdrawals in areas under NYSDEC jurisdiction are subject to 6 NYCRR 703.2 which is a water quality standard that prohibits any change in flow that would degrade the designated best use of a fresh surface water body. Passby flows are determined on a case-by-case basis, and the new technical operating guidelines (TOGs) necessary to provide guidance for the application of the narrative water quality for flow have not been completed (p. 31). The NFRM is an interim protection measure to determine appropriate and adequate passby flow.

Dr. Myers asserts that a map should be included in the SGEIS that indicates where NYSDEC has jurisdiction over surface water withdrawals (i.e., where NFRM will apply).

The NFRM requires flow statistics determined from a nearby gauging station or that are estimated based on the ratio of area between a station and the diversion point. Myers comments that the dSGEIS should state the assumptions that this method involves, which are:

- The watershed area vs. flow relationship is constant with area.
- The contribution of geology and ecosystem type is the same between the sites.
- Precipitation is constant throughout the area.
- Groundwater storage is proportionally constant throughout the watershed (p.32).

The dSGEIS lacks a reference for the details of this method (p. 33).

Dr. Myers recommends that diversions be allowed only when aquatic habitats will be minimally affected, which he describes as a point when the water level is at or above the point where the wetted perimeter to flow area ratio is at a minimum. He states that the 30% value of the average daily flow is appropriate as long as the minimum passby is 30% of the average monthly flow during wet seasons to protect flows which are essential for channel forming. Dr. Myers

recognizes this limit may prevent diversions through much of late summer and early autumn when aquatic ecosystems tend to be stressed. He offers that diversions made in advance of late summer could be contained for later use by storing in tanks or lined ponds, or in surface or ground water reservoirs.

4.2.1 Accuracy and Completeness

Dr. Myers' is inaccurate, throughout his comments, that NFRM will not apply within the Delaware and Susquehanna river basins. Any proposed surface water withdrawal anywhere in NYS that is not consistent with NFRM will require a site-specific SEQRA review.

Delaware River Basin Commission

Myers' first comment is accurate as quoted from the dSGEIS, but it is incomplete. Carol Collier, Executive Director of the DRBC, declared on May 19, 2009, that natural gas extraction project sponsors

may not commence any natural gas extraction project located in shale formations within the drainage area of Special Protection Waters without first applying for and obtaining Commission approval (DRBC, 2009a).

A "project" includes the drilling pad, well, all related facilities and activities, and all locations of water withdrawals. The part of the DRB located in New York State is all part of the Special Protection Waters drainage area; therefore, this declaration applies to all of the DRB lying in New York State (DRBC, 2010a).

Prior to this declaration, projects that had to be submitted and approved by the DRBC were those that exceeded the "thresholds for the daily average gross water withdrawal during any 30 consecutive day period and by the daily average design capacity of domestic sewage treatment facilities" as established by the DRBC's *Rules of Practice and Procedure* (DRBC, 2009a). Currently, any natural gas extraction project requires approval by the DRBC. Those projects that are located in New York State will also be subject to the review of NYSDEC.

The news release regarding the May 19, 2009, determination states that the DRBC will review all aspects of shale gas projects in the Special Protection Waters drainage area, regardless of the amount of water withdrawn or the capacity of domestic sewage treatment facilities accepting wastewater from hydraulic fracturing. On December 9, 2010, the DRBC started the public review process for its draft regulations pertaining to natural gas development in shale formations in the DRB (DRBC, 2010c). The DRBC will consider specific natural gas well pad applications after the new regulations are in place. (DRBC, 2010b).

Susquehanna River Basin Commission

Dr. Myers comments that the dSGEIS should better define and discuss habitat loss, average daily flow, and acid mine drainage. The dSGEIS discusses maintaining habitat diversity and quality in

section 6.1.1.3 on page 6-5. Myers is correct in stating that the terms “habitat loss,” “loss of habitat,” and “acid mine drainage” are used as part of the mitigation requirements in Section 7.1.1.4, but are not defined completely. Alpha can find no documentation of acid mine drainage in the area of New York State underlain by the Marcellus Shale. There are, however, concerns regarding potential acid rock drainage, which is the acidic and metals-rich discharge from the oxidation and leaching of pyritic shale. These concerns are addressed by Alpha in a letter report prepared for the NYSDEC regarding the USGS’s comments on the dSGEIS (Alpha, 2011).

Myers states that the average daily flow should be based on complete data set of year-round flows. The specific method of calculating average daily flow is not clear in the dSGEIS or the SRBC guidelines.

Myers also indicates that the SRBC does not have adequate requirements to protect streamflow from surface diversions for hydraulic fracturing. The dSGEIS points out that:

The SRBC has been granted statutory authority to regulate the conservation, utilization, development, management, and control of water and related natural resources of the Susquehanna River basin and the activities in the basin that potentially affect those resources. The SRBC controls allocations, diversions, withdrawals, and releases of water in the basin to maintain the appropriate quantity of water.

The programs and requirements that are in effect to achieve the goals of the SBRC are part of the SRBC Regulation of Projects (Electronic Code of Federal Regulations, 18CFR, Parts 801, 806, 807, and 808; June 11, 2010). Additionally, as of October 15, 2008, the SRBC required all natural gas well development projects in the SRB to obtain prior use approval regardless of the amount of water used (SRBC; August 15, 2008).

Great Lakes - St. Lawrence Water Resources Compact (GLC)

The GLC became Public Law 110-342 on October 3, 2008 when it was signed by the President of the United States. New York has not yet established regulations, though future regulations must comply with the GLC’s Decision-Making Standard, Section 4.11 of the compact (CGLG, 2005). The five criteria all water withdrawal proposals will have to meet are listed in the dSGEIS on page 7-6. Until NYS establishes regulations, existing requirements remain in effect under ECL Article 15, Title 16.

Myers is correct in his comment that there are presently no GLC requirements for passby flows; however, the statement does not accurately describe a potential deficiency. NFRM applies to all of NYS to the extent that any proposed withdrawal which is not consistent with NFRM will require site-specific SEQRA review. The GLC has specific authority for reviewing and approving new and increased water withdrawals.

Natural Flow Regime Method

Dr. Myers’ recommends that a map be included in the SGEIS that indicates where NYSDEC has jurisdiction over surface water withdrawals (where NFRM will apply).

Myers comments that the dSGEIS should state the assumptions involved using the NFRM.

Myers notes the dSGEIS lacks a reference for the details of this method.

Dr. Myers recommends that diversions be allowed only when aquatic habitats will be minimally affected. His recommendation is summarized in this document, Section 4.2.

4.2.2 Supporting Information

Dr. Myers does not reference any DRBC, SRBC, or GLC regulations or guidelines. Myers' comment, "Neither the DRBC, SRBC, nor GLC have adequate requirements to protect streamflow from surface diversions to support hydraulic fracturing," is not supported. Myers references only the dSGEIS and Denslinger et al. (1998) (SRBC) on this topic. He references Poff et al. (1997) on the Natural Flow Regime Method (NFRM).

4.2.3 Mitigation Measures

The SGEIS should define how the average daily flow is calculated. The SGEIS should also mention that acid mine drainage is prevalent in PA, OH, WV, VA, KY, and MD. Alpha did not find any documentation of acid mine drainage in the parts of New York State underlain by the Marcellus Shale.

Dr. Myers recommends that NYSDEC limit hydraulic fracturing permits areas which do not have established passby flow requirements to protect aquatic habitats. He recommends a passby flow requirement of 30% of the average daily flow under certain conditions, with diversions and storage allowed for later use.

4.2.4 Proposed SGEIS Revisions

Alpha recommends the following:

It is recommended that the fact that any proposed surface water withdrawal anywhere in NYS that is not consistent with NFRM will require a site-specific SEQRA review be emphasized.

It is recommended the SGEIS include summaries of the May 19, 2009 determination (DRBC, 2009b), the May 6, 2010 news release (DRBC, 2010b), and DRBC's proposed regulations that were released on December 9, 2010 (DRBC, 2010c) (Section 4.2.1 of this document).

It is recommended the terms "habitat loss," "loss of habitat," and "acid rock drainage" be defined and/or referenced in dSGEIS Section 7.1.1.4.

It is recommended that the allowable method(s) of calculating average daily flow be clarified and/or referenced, that the NFRM method be referenced, and that limiting assumptions or conditions in the NFRM be identified.

It is recommended the SGEIS clarify the SRBC requires all natural gas well development projects in the SRB to obtain prior use approval regardless of the amount of water used as of October 15, 2008 (SRBC; August 15, 2008).

It is recommended the SGEIS include that the GLC became Public Law 110-342 on October 3, 2008 and that the Great Lakes-St. Lawrence River Basin Water Resources Council (Compact Council) was established on December 8, 2008, when the Great Lakes-St. Lawrence River Basin Water Resources Compact became State and federal law.

It is recommended that NYSDEC and/or other applicable entities (DRBC, SRBC, etc.) will evaluate the appropriate conditions for surface water withdrawal and potential impacts to aquatic habitats.

It is recommended the SGEIS include a map that indicates where each of the methods for determining passby flow listed in Table 7.2 on page 7-21 will apply).

4.2.5 List of References

Alpha Geoscience, September 13, 2010. Letter response to Ms. Kathy Sanford, NYSDEC, regarding: *Review of USGS Comment on dSGEIS*.

Council of Great Lakes Governors, 2005. Great Lakes – St. Lawrence River Basin Water Resources Compact, December 13, 2005. http://www.cglg.org/projects/water/docs/12-13-05/Great_Lakes-St_Lawrence_River_Basin_Water_Resources_Compact.pdf

DRBC, 2010a. DRBC Special Protection Waters and Marcellus Shale Map. <http://www.state.nj.us/drbc/maps/SPW-MarcellusShale.pdf>.

DRBC, 2010b. DRBC News Release, May 6, 2009: *DRBC Will Review Natural Gas Well Pad Projects After Adoption of New Regulations*. http://www.state.nj.us/drbc/newsrel_naturalgas050610.htm

DRBC, 2010c. DRBC posting, December 9, 2010. *Natural Gas Development Regulations, December 9, 2010, Article 7 of Part III- Basin Regulations*. <http://www.state.nj.us/drbc/naturalgas-draftregs.pdf>

DRBC, 2009a. Determination of the Executive Director Concerning Natural Gas Extraction Activities in Shale Formations within the Drainage Area of Special Protection Waters, May 19, 2009. <http://www.state.nj.us/drbc/EDD5-19-09.pdf>

DRBC, 2009b. DRBC News Release, May 19, 2009: *DRBC Eliminates Review Thresholds for Gas Extraction Projects in Shale Formations in Delaware Basin's Special Protection Waters*. http://www.state.nj.us/drbc/newsrel_naturalgas.htm.

Great Lakes-St. Lawrence River Basin Water Resources Council (Compact Council), June 10, 2010. <http://www.glscompactcouncil.org>.

National Archives and Records Administration, June 11, 2010. Electronic Code of Federal Regulations, Title 18 – Conservation of Power and Water Resources, Chapter VIII – Susquehanna River Basin Commission, Parts 801, 806, 807, and 808.

http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=72fc0084175e978551ee541a01dbc40f&c=ecfr&tpl=/ecfrbrowse/Title18/18cfrv2_02.tpl#800.

SRBC, August 15, 2008. Press Release: *SRBC to Require All Natural Gas Well Development Projects in the SRB to Obtain Prior Use Approval Regardless of the Amount of Water Used*. <http://www.srbc.net/pubinfo/press/docs/ProjectRevNaturalGasDetermination81508.pdf>.

SRBC, 2002. Policy No. 2003-01: Guidelines for Using and Determining Passby Flows and Conservation Releases for Surface-Water and Ground-Water Withdrawal Approvals, November 8, 2002. http://www.srbc.net/policies/docs/Policy%202003_01.pdf.

5.0 DEPLETION OF AQUIFERS

5.1 Comments on Aquifer Depletion (pp. 33-36)

Dr. Myers states that any new withdrawal from an aquifer takes water from other uses, whether it is storage or spring or streamflow. Myers indicates that Section 2.4.8 of the dSGEIS discusses aquifer replenishment but does not point out that every diversion increases deficit and decreases water availability for replenishment. Myers comments that determining the safe yield of a well (dSGEIS on page 2-31) does not protect natural discharges to springs or streams. Myers comments that the dSGEIS should provide water balance information to demonstrate how withdrawals affect the hydrologic system of an area.

Myers notes the dSGEIS reports that the DRBC requires well owners to report their water uses by registering any well or well group that averages 10,000 gpd for more than a month and reporting any ground water withdrawal that exceeds 100,000 gpd (Myers' review contains two typos, reporting the units as gpm for both of the above aquifer withdrawals (DRBC, 2010c)) average for a month; however, Myers states the dSGEIS does not indicate if the DRBC would use this information to protect the aquifer.

Myers makes four main recommendations, as follows:

- a. The dSGEIS should be more specific about the requirements for permitting groundwater withdrawals. Requiring registration and reporting is not regulating. The dSGEIS should

establish limits on the total withdrawals during a given time period, and the limit of water that can be removed from an aquifer should be specified as a percentage of the annual recharge (p. 35).

- b. The dSGEIS should specify conditions under which water can be pumped from an aquifer for use in natural gas development. These conditions should include aquifer properties, antecedent moisture conditions, and the operation's distance from other users (p. 36).
- c. The dSGEIS should discuss whether the water use by a natural gas operation is "unreasonable interference" with the recharge of a "principle natural recharge area" as prohibited under basin-specific regulations, such as the DRBC regulations (p. 36).
- d. NYSDEC should prohibit shale gas operations in recharge areas because of the potential spill contamination from the transport or storage of chemicals (p. 36).

5.1.1 Accuracy and Completeness

Dr. Myers comments appear complete but are not entirely accurate. Myers' comments covered in the first paragraph of section 5.1 above are covered by the dSGEIS in Section 6.1.1.6 (pages 6-6 and 6-7). The section is a discussion of the hydrologic relationship between surface water, ground water, and wetlands, water balance, and the importance of the natural flow regime.

The second paragraph in section 5.1 above discusses the usage reporting requirements of the DRBC. Myers comments that "[t]he dSGEIS does not indicate if the DRBC would use this information to protect the aquifer." The mission of the DRBC, which is part of the vision statement, including (DRBC, 2010d):

We will:

- Provide comprehensive watershed management.
- Act as stewards of the Basin's water resources particularly with respect to:
 - Surface water quality, including both point and nonpoint sources of pollution;
 - Ground and surface water quantity, including water demands, water withdrawals, water allocations, water conservation, and protected areas;
 - Drought management; and
 - In-stream flow management

By:

- Serving primarily basinwide and interstate interests; and national, statewide, regional, and local watershed interests as the need arises....
- Adopting and implementing policies to manage the Basin's water resources in an integrated, planned fashion....

It is clear that the DRBC requires registering wells, obtaining DRBC approval, and reporting withdrawals so the information and restrictions can be used to manage the basin's water resources.

Myers' review includes four recommendations in Section 5.1 of this document. The recommendations have some technical merit, but the recommendations are too limiting for the site-specific considerations required as part of every decision by the river basin commissions and NYSDEC. Dr. Myers' proposed methodology is:

Comparing values such as [withdrawal volumes and annual recharge for an area] with the size of the aquifer being targeted for withdrawals would provide an assessment of how much the aquifer will be affected. The DSGEIS should establish limits on the total diversions that can be made during a given time period.

Dr. Myers' methodology is oversimplified; it accounts for an area's recharge by direct precipitation only. It is Alpha's opinion that aquifer recharge needs to consider all water balance factors and be analyzed on a site-specific basis

In section 7.1.1.1 of the DSGEIS, on page, 7-6, NYSDEC acknowledges that the methodology for determining aquifer withdrawal limits is being investigated.

Concern for aquifer depletion due to increased ground water use in New York currently Is being reviewed and addressed by the DEC. The Department's Division of Water's Pump Test Procedures for Water Supply Applications in conjunction with the SRBC's aquifer testing protocol will be used to evaluate proposed groundwater withdrawals for high-volume hydraulic fracturing.

Additionally, the river basin commissions can withhold approval, and NYSDEC can require a site-specific SEQRA determination or establish permit conditions, for any withdrawal that will interfere with the hydrologic system of an area.

Regarding potential surface spills, the potential impacts and mitigation measures due to potential releases from pits, tanks, and impoundments are discussed in the GEIS (Chapters 8 and 9). The dSGEIS acknowledges the greater volumes of fluids used in HVHF operations (Section 6.1.3). Mitigation measures specific to HVHF operations pertaining to potential spills at the drilling site are discussed in the dSGEIS (Section 7.1.3). The requirements include, where applicable; secondary containment for tanks; manually monitoring fueling and certain related activities; using physical controls and catchments; detailed material requirements for impermeable liners; required tank containment of flowback; closure requirements for pits and impoundments; and detailed spill prevention, response, and reporting requirements in accordance with the Storm Water Pollution Prevention Plan (SWPPP).

The GEIS, Chapter 17, provides specific requirements to mitigate the potential for spills, and provide spill response for activities related to drilling rig fuel tanks and tank refilling, drilling fluids, hydraulic fracturing additives, and production/flowback water. The GEIS includes, tank fluid level monitoring and tank tightness requirements where applicable, enforcement against flowback discharges to the ground, and containment of waste fluids.

Other mitigation measures are identified in dSGEIS Sections 7.1.7 and 7.7 for centralized flow back impoundments; setbacks from surface water resources (Section 7.1.12.2); floodplains

(Section 7.2); wetlands (Section 7.3); and ecosystems and wildlife (Section 7.4). Section 7.2 includes proposing the requirement for closed-loop systems when drilling in floodplain areas to manage fluids and cuttings.

The dSGEIS Sections 5.2.2.1 (reserve pits), Section 5.6 (storage and handling fracturing additives), Section 5.7.2 (centralized impoundments) describe the existing time frames, regulations, and requirements for handling and storing fluids, and constructing impoundments including the comprehensive Dam Safety Regulations (6 NYCRR §673) that apply to surface impoundments.

In addition, Chapter 3, Section 3.2.3 of the dSGEIS proposes requiring a site-specific environmental assessment and SEQR determination for projects that fall under any of several conditions, regardless of the formation or number and type of wells. The NYSDEC may use the provisions, flexibility, and discretion in Section 3.2.3 to require additional surface water protections and mitigation, or to deny the project, per the required site-specific environmental assessment and determination.

5.1.2 Supporting Information

Myers references the dSGEIS and a work authored by the SRBC in 2003 that is not included in his references. He makes a few assertions regarding what the dSGEIS should cover; however, the dSGEIS includes the topics in Chapter 6. Myers does not reference any DRBC documents.

5.1.3 Mitigation Measures

There are no suggested mitigation measures; Myers' recommends limits and requirements that in his opinion, the dSGEIS should impose prior to starting the permitting process.

5.1.4 Proposed SGEIS Revisions

Some information included in the dSGEIS Chapter 6 is identified as lacking by Myers. Alpha recommends (Section 1.0, this document) that SGEIS include a detailed and document-wide table of contents in addition to, or lieu of, listing contents only by individual chapter. Alpha does not recommend additional revisions based on the comments.

5.1.5 List of References

DRBC, 2010c. http://www.state.nj.us/drbc/regs/gw-sw_form0109.pdf

DRBC, 2010d. <http://www.state.nj.us/drbc/vision.htm>

6.0 CUMULATIVE IMPACTS

6.1 Comments on Cumulative Impacts (p. 36)

Dr. Myers' states that the dSGEIS does not sufficiently address cumulative impacts, "because it does not define the overall scope of the potential drilling adequately", and each well is considered a separate project even if it is part of a multi-well pad.

Myers indicates that the DGSEIS ignores three cumulative impacts to resources but lists only two. Those potential impacts are:

- The potential cumulative changes of the Marcellus Shale properties: Every fracturing event changes the formation's conductivity. Industry would position wells to optimize production which would lead to a conductivity change over a much larger area than the area affected by a single well.
- The cumulative impacts of the fracturing fluid that will build up in the target formation: If only 35% of the fracturing fluid is recovered from the shale, there could be a "large potential contaminant source build-up and source of contaminants for future transport."

6.1.1 Accuracy and Completeness

Dr. Myers' first comment in section 6.1 regarding each well being considered a separate project is partially accurate. Each application to drill a well will be treated as an individual project with regard to drilling, construction, hydraulic fracturing (including additive use), and any part of water and materials management. Permits will be individually issued, including any permit conditions. This is necessary because the individual well procedures and aspects may vary between wells on a pad. "[L]ocation screening for well pad setbacks and other required permits, review of access road location and construction, and the required stormwater permit coverage will be for the well pad," and will be assessed for the entire well pad when the first well permit for the pad is submitted. The project scope can also be extended beyond a pad and access road when a new centralized flowback water surface impoundment or a surface water withdrawal is proposed (dSGEIS, p. 3-6).

Applying for separate permits for individual wells does not mean that cumulative impacts are ignored. Environmental assessment is required, in accordance with SEQRA, to evaluate the combined impacts of the existing and proposed conditions. No single well will be approved without considering existing conditions. It would be an unsound business move for a company to apply for the first well at a site, including the pad and access road, without assessing the impacts of their future plans.

Dr. Myers' first recommendation in the above bullet list is generally accurate. His second comment is correct in that drilling and/or fracturing fluids will remain in the subsurface, but his statement in the second comment that implies the fluids will migrate and presumably cause

contamination beyond the target zone is incorrect. These concerns are discussed in Section 2.1.1, 2.2.1, 2.3.1, 2.4.1, 2.5.4 of this document.

The dSGEIS does not address cumulative subsurface impacts, because the data and information from drilling operations and hydrofracturing in New York and other gas-producing states supports that no significant cumulative subsurface impacts have been identified.

Supporting Information

Myers refers to the dSGEIS and a paper by Gaudlip et al. regarding Marcellus Shale water management. His recommendations appear to be based on the assumption that the low-permeability shales will become connected throughout the overlying confining formations to the relatively shallow fresh water resources. The concern for potential contamination through ground water migration has been discussed in this document.

6.1.2 Mitigation Measures

It is Dr. Myers' position that a cumulative impact assessment should occur prior to actual operations.

6.1.3 Proposed SGEIS Revisions

Alpha does not propose revisions based on these comments.

6.1.4 List of References

Gaudlip, A.W., L.O. Paugh, and T.D. Hayes, 2008. Marcellus Shale Water management Challenges in Pennsylvania. Society of Petroleum Engineers paper No. 119898.

NYSDEC, 2009. Final Scope for Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, February 6, 2009.

http://www.dec.ny.gov/docs/materials_minerals_pdf/finalscope.pdf

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