Review and Response to "Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed"

By Hazen & Sawyer, P.C.
and Leggette, Brashears& Graham, Inc.
December 22, 2009

Prepared for:

NYSERDA
17 Columbia Circle
Albany, New York 12203

January 26, 2011

ALPHA GEOSCIENCE

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Geology

Hydrology

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Water Supply

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1.0 OVERVIEW

The joint venture of Hazen and Sawyer, P.C. and Leggette, Brashears, and Graham, Inc. (collectively referred to as HS&LBG) prepared a report on behalf of the New York City Department of Environmental Protection (DEP), to evaluate the potential impacts to the NYC water supply resulting from the development of natural gas resources in the Marcellus and Utica shales within the NYC West-of-Hudson (WOH) watershed. The report presents a discussion of potential pathways for subsurface migration of fracturing chemicals and deep formation water into overlying shallow drinking water sources; estimates of rates of gas well development; and an assessment of cumulative impacts.

The New York City WOH and Skaneateles Lake watersheds have been exempted from the federal USEPA water filtration requirements and must comply with the requirements of the Filtration Avoidance Determination (FAD), which focuses on closely and comprehensively managing existing activities within the watersheds. The NYSDEC has excluded the NYC WOH and Skaneateles watersheds from the SGEIS on the basis that there are distinct and unique issues in these areas which are unrelated to the environmental safety of high volume hydrofracturing. For this reason, Alpha's review and response to HS&LBG's comments addresses those concerns that can be applied state-wide regarding the environmental safety of high volume hydrofracturing.

2.0 COMMENTS ON GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

Chapter 2 and Appendix A of the HS&LBG report present a summary of geologic and hydrogeologic conditions in the WOH watershed. HS&LBG contend that there exists a "reasonably foreseeable risk to water supply operations from methane, fracking chemicals, and/or poor quality saline formation water migrating into ground water, watershed streams, reservoirs, tunnels, and other infrastructure."

2.1 Accuracy and Completeness

The HS&LBG report states that "the saline water and methane seeps encountered at grade and in shallow formations near NYC infrastructure during the construction of water system tunnels provide the most reliable evidence that existing fracture systems and pressure gradients will transmit fluids from deeper formations." Their comment is based on:

- Observations made during the construction of the West Delaware Tunnel,
- The proximity of mapped brittle structures near the observed methane and saline ground water seeps, and
- A critique of ICF's evaluation of the potential for hydraulic fracturing fluids to migrate from the Marcellus to shallow fresh ground water aquifers.

The statement is not supported by the data and sources they present, and does not represent reasonably foreseeable conditions. HS&LBG's conclusions concerning hydrofracturing, and their analysis of hydrogeologic conditions contain flawed assumptions regarding potential ground water flow and the relationships between fresh water and underlying saline ground water.

2.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential impacts to the NYC Water Supply System via migration into surface water bodies and into system tunnels. The NYC watershed is removed from the SGEIS because the watershed is governed by a Filtration Avoidance Determination (FAD) from the USEPA; however, the concerns relating to impacts to ground water and surface water quality can be applied statewide.

2.3 Supporting Information

HS&LBG's argument is based on the three bullet points listed above. Their supporting data and the response to their comments and inferences is summarized below.

HS&LBG's statement is based on data from the construction of the NYC water supply tunnels that document the presence of fractures and joints that intersect the tunnel, observations of saline water inflow into the tunnel at some of the fractures and joints, and the presence of methane seeps. The presence of natural gas and/or saline ground water has been well documented in water wells drilled in the northeastern portion of New York (McPherson, 1993; Frimpter, 1972; Soren, 1963; Berden, 1954). Natural gas also has been encountered in the younger Devonian shales of the Genesee, Sonyea, and West Falls Groups (dSGEIS Figure 4.2), through which the NYC's West Delaware Tunnel was constructed. Based on the documented natural conditions of saline water and natural gas in these formations, the presence of saline water and/or methane cannot be used as conclusive evidence of a direct hydraulic connection via brittle structures between the Marcellus shale and shallow ground water. The tunnel itself represents a zone of relatively lower pressure, to which natural gas and/or saline ground water may flow from adjacent and immediately surrounding formations, where pathways exist.

HS&LBG reference New York State's Brittle Structure Map (Isachsen & McKendree, 1977). The brittle structure map includes known faults and fractures, as well as linear features interpreted from topographic maps and aerial and satellite imagery. The topographic and "tonal" linear features may be indicative of brittle deformation features (Isachsen & McKendree, 1977). The maps are designated as "preliminary" in nature, for purposes that include the "aid in the selection of exploration targets for oil, natural gas, and economic mineral deposits" and to "identify major fracture conduits for ground water recharge and circulation." Dr. Terry Engelder, Pennsylvania State University (2010) points out that the use of lineaments to map crustal faults is highly controversial. Dr. Engelder states that outside the Clarendon-Linden fault zone in western NY, vertical, curved ("listric") faults are

extremely rare in outcrop. These lineaments cannot be assumed to represent vertical features that propagate from basement rocks through the Devonian section.

The supposition is flawed that the act of hydrofracturing a target formation a minimum of 1000 feet below fresh water may/will connect 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 and cement, are the critical mechanism to protect fresh water resources.

The results of ICF International (2009) analysis, though generalized and reliant on oversimplified assumptions, shows 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 are not part of, and are not connected to, the regional hydrogeological systems where shale gas development potential exists. 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 approximately 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). 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.

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.

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 induced fracture system, including the pressure gradient toward the borehole. Excess pressure that is shut in after well stimulation will dissipate and equilibrate to the same pressure as the surrounding formation until the well is put into production. Fractures and other structural features that exist beyond the short-term hydrofracturing influence will not be connected or "opened" after the fracturing event. The transport of fluids from induced fractures does not occur through closed or "healed" features that have existed under confining pressures for millions of years. This is not the case or the gas would not exist or be trapped in the fractured shales that act as gas reservoirs.

Producers have an economic incentive to contain induced fractures within the target formation (DOE, 2009). Containing induced fractures within the target formation includes avoiding large interconnected faults and fractures that cross multiple formations. 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. Engineering controls to limit fracture growth are discussed in the dSGEIS (Section 5.8.2).

HS&LBG's report states that "the net hydraulic conductivity of a formation must be considered, including the influence of faults and fractures, not just the bulk properties of the rock matrix." Their report presents values for hydraulic conductivity of Devonian shales

which are consistent with the values used by ICF (10^{-8} cm/s to 10^{-4} cm/s) in their analysis (dSGEIS Appendix 11). ICF does consider flow through fractures, faults, or unplugged boreholes and concludes that such a pathway is theoretically possible, but extremely unlikely to occur (ICF 2009). Regardless of the parameters, the hypothetical debate is not supported by several decades of hydrofracturing data and experience in the U.S.

The assertion that hydraulic fracturing will connect deep, paleo-features to overlying fresh water resources and provide a pathway for upward contaminant migration is not supported by the existing data and basic hydrogeologic principles. Dr. Engelder identifies several issues with HS&LBG's arguments that are summarized in their report Figure 4-1. Dr. Engelder's comments are based on the underlying principles and relationships of ground water flow (velocity, area, and gradients which are influenced by permeability, viscosity, and flow paths) and the differences in fluid densities that naturally stratify ground water.

The following mis-interpretations depicted in Chapter 4, Figure 4-1, by HS&LBG are paraphrased below, based on Dr. Engelder's 2010 presentation:

1) There must be an effective pressure differential in hydraulic head to drive ground water migration. Although the Delaware Tunnel represents a depressed pressure head, Dr. Engelder states, "to create an effective pressure difference on this scale, the tunnel and the fault must be coaxial." The vertical faults presented by HS&LBG are not coaxial (i.e. parallel) to the horizontal tunnel, so the hydrogeologic scale needed to produce the necessary difference in pressure head would not be effective [to drive ground water flow];
2) Figure 4-1 (HS&LBG) indicates upward flow along a vertical fracture within the area depicted by HS&LBG as having downward regional flow paths; therefore, the regional flow indicated by HS&LBG must be downward and away from overlying fresh water;
3) The potential flow from deep ground water that is saline and/or contains high 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.
4) 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.
5) The properties of the shales overlying the Marcellus are ductile enough to adsorb an expansion of 1% volume, the estimated net volume that may be produced by development of the Marcellus shale through hydrofracturing.
6) The immediate drop in pressure following hydraulic fracturing relieves the temporary differential pressure that occurs during the act of hydrofracturing;
7) The same drop in pressure within the borehole causes the flow of gas and fluid toward and into the well from the Marcellus, not conversely. Excess pressure that is shut in after well stimulation will dissipate and equilibrate to the same pressure as the surrounding formation until the well is put into production.

The potential for fluids to migrate and impact ground water and surface water resources as a result of natural gas drilling activities is discussed in the existing GEIS in Chapters 9, 10, and 16. Gas migration also is discussed in the existing GEIS in chapters 9, 10, and 16, and is discussed as a potential impact in the dSGEIS Section 6.1.4, pages 6-35 through 6-36. Mitigation measures are discussed in dSGEIS Section 7.1.4; the concerns and measures are related to ensuring safe well construction and conditions prior to, during, and following the hydrofracturing process. The mitigation of gas is 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.

A webpage from the Cornell University Cooperative Extension (2010), (http://cce.cornell.edu/EnergyClimateChange/NaturalGasDev/Pages/OtherStates.aspx) further states that regarding water well contamination resulting from natural gas development, "All instances of contamination that have been found thus far have not been caused by hydro-fracturing chemicals, but have been instead caused by improper well casings that have resulted in methane migration into aquifers or the turbidity that results from methane migration or ground vibrations." The NYSDEC recognized the importance of well construction and casing integrity when it implemented its existing casing and cementing program many years ago, and proposes additional protections in the dSGEIS.

The existing casing program and the additional protections afforded by the proposed supplemental conditions and other requirements that can be imposed by the NYSDEC are extensive. The current NYSDEC well permit form requires submitting a casing and cementing plan with every well permit application. Every plan is reviewed and must be approved by NYSDEC prior to issuing each well permit. Some of the required information in the casing and cementing plans includes providing the details for each proposed casing string and cement job. These details include but are not limited to the 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). There also are required notifications to the NYSDEC prior to cementing surface casing, and a NYSDEC representative must be present onsite during these operations within a primary or principle aquifer.

Although wellbore construction is addressed in the existing GEIS, enhancements to well construction are proposed in the dSGEIS due to the volume of fluid pumped during hydraulic fracturing and the duration of the operation . The amended casing and cementing requirements are outlined in dSGEIS Section 7.1.4.2 (Sufficiency of As-Built Wellbore Construction). These requirements are repeated in Appendix 9 of the dSGEIS (*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).

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.

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 make and maintain a complete record of every hydraulic fracturing operation through the flowback phase. The monitoring performed during each hydrofracturing stage would measure a loss of pressure and/or change in flow that would indicate an irregular condition.

Condition #45 reinforces data reporting and a synopsis of the operation must be provided within the required *Well Drilling and Completion Report* form (http://www.dec.ny.gov/energy/4761.html) which 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 other 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. Appendix 20 contains a proposed "Pre-Frac Checklist and Certification" that must be signed. 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 anticipated (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).

2.4 Mitigation Measures

Several mitigation measures were proposed by HS&LBG (Appendix D). Two of the mitigation measures are relevant to this comment.

- *HS&LBG proposes that the buffer zone surrounding NYCDEP infrastructure be expanded from 1,000 feet to seven miles, based on a statistical evaluation of the length of brittle structures within the watershed. HS&LBG proposes that the setback should apply to the lateral extent of the gas well and not just to the well head location.*

It is Alpha's understanding that this mitigation measure is not being considered in light of the NYSDEC's decision to exclude the NYC WOH and the Skaneateles watersheds from the SGEIS on the basis that that there are distinct and unique issues presented in these areas which are unrelated to the environmental safety of high volume hydrofracturing. A separate environmental analysis is required for wells proposed within the WOH watershed, and site-specific concerns can be addressed individually, as applicable.

From a technical perspective, the proposed mitigation measure is not reasonable based on the available data. The Preliminary Brittle Structure map should not be used as a basis for precluding or permitting drilling considering its stated preliminary basis, scale, and intended use (Isachsen & McKendree, 1977). The map could be useful in circumstances where DEC determines that more detailed evaluation of geologic and hydrogeologic conditions should be conducted to aid in design of gas wells and high-volume hydrofracturing.

- *HS&LBG supports provisions requiring complete chemical composition and usage data for all drilling and fracturing additives used in the watershed and for the use of additives that are non-toxic or which toxicity is well understood (p. D-2).*

The dSGEIS discloses all chemicals currently proposed to be used. It is Alpha's understanding that others are addressing legal issues that may arise with respect to protecting trade secrets. Alpha also understands that evaluation criteria for future proposed additives are being considered.

The SGEIS does address the issue of alternative additives that could be used (dSGEIS Section 9.3.1). In summary, some alternative additives are available and approved for use in European countries; however, a reliable process for evaluating the "greenness" of such chemicals is not currently in place in the US. The oil and gas industry is very aware of the issues and concerns, and private companies are continuing to innovate new fracturing techniques, develop less toxic chemicals, and also are working to reduce the volume of chemicals through recycling, treatment, and re-use. These measures benefit both the environment and the companies by reducing costs and potential environmental liabilities.

2.5 Proposed SGEIS Revisions

Alpha does not propose technical revisions to the SGEIS based on HS&LGB's comments; however, clarifications to existing items may be considered as discussed in the fifth, sixth and seventh paragraphs of this section 2.5.

It is Alpha's opinion that the dSGEIS and existing GEIS adequately address casing and cementing requirements for the Marcellus Shale and other low permeability gas reservoirs. NYSDEC's requirement for submitting a casing and cementing plant with each permit application allows complete control of casing and cementing requirements on a well by well basis. The GEIS and dSGEIS discuss the importance of and mitigation factors to maintain well casing integrity. The requirements for conductor, surface, intermediate, and production casing and cementing are addressed in the GEIS in Section 9 and in the dSGEIS (Appendix 8). Proposed permit conditions specific to HVHF are included in the dSGEIS (Appendix 10), including cement bond logging requirements for intermediate casing (if installed based on specific conditions), and production casing. The GEIS also specifies the requirements, conditions, and specifications for casing installation inspection, monitoring, and documentation prior to continuing drilling operations (Chapter 17). Chapter 17 (GEIS) and Section 7.1.4.2 (dSGEIS) describe the provisions and requirements for ensuring wellbore integrity, including lost circulation.

The potential for loss of circulation is relevant during the drilling phase. Loss of circulation can result in the local release of drilling fluids into the formation, which is a particular concern when drilling through fresh water aquifers if not mitigated. Supplemental permit conditions are included in the dSGEIS in Appendix 9 for all wells drilled in principal and primary aquifers to provide additional protections for those areas. Air or fresh water-based drilling mud is required when drilling through freshwater aquifers (GEIS Section 9). Surface casing is cemented in place below the base of the fresh water zone to seal fresh water zones and prevent the introduction of drilling fluids and deep formation water into fresh water zones.

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 SEQR 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 in proximity to a private water wells or springs, 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. Other considerations where additional requirements may be imposed can include proximity to NYC water supply infrastructure, areas of unknown or unproven geologic conditions, or areas of potential or anticipated high pressures.

Fracture monitoring is required by the Proposed Supplementary Permit Conditions in Appendix 10 (#33 and #34). The NYSDEC might consider specifying in these permit conditions that operators must document, report, and remediate fracture treatment failures

immediately to further protect drinking water, subject to NYSDEC review and approval of any such plan.

The NYSDEC may consider incorporating direct and indirect methods to assess the vertical and lateral extent and growth of fractures 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. The NYSDEC also could consider using data from fracture testing and related experience to review designs and for implementing subsequent treatments, in addition to collecting and monitoring fracture data. It is recommended that the SGEIS clarify that diagnostic methods (such as direct and indirect testing, monitoring, and comparing predictive models) may be required to evaluate the actual growth of fractures 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.

Some of these issues already are included in the dSGEIS as permit conditions. Permit applicants likely will implement some measures for exploratory techniques and the NYSDEC could consider imposing fracture testing and monitoring as permit conditions for initial wells in any area, similar to the requirements for "wildcat" wells where the stratigraphy is not well established or overpressure is anticipated. Some of these permit conditions could be omitted in the future, as the database increases regarding the behavior of low-permeability shales.

3.0 COMMENTS ON RATES AND DENSITIES OF NATURAL GAS DEVELOPMENT

Chapter 3 and Appendix B of HS&LBG's report presents an estimation of the rates and densities of natural gas drilling that could be developed within the NYC's WOH watershed.

3.1 Accuracy and Completeness

HS&LBG's estimate of rates and density of natural gas drilling appears reasonable based on the data sources and assumptions used and the NYSDEC's spacing unit requirements for drilling covered under the SGEIS, but is not complete. The actual rates and density also will depend on economic conditions, advances in technology, and other production factors that cannot be determined until drilling occurs (SGEIS Scoping document).

3.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential development within the NYC Water Supply System; however, natural gas development rates and the associated cumulative impacts are concerns statewide. HS&LBG's estimated development rate may differ if applied statewide,

because it is assumed that 32 percent of the land in the NYC WOH water shed is controlled and would not be developed for natural gas. It also is noted that large portions of the Marcellus and Utica shales in New York will not be attractive targets for development. The "fairways" where development likely will focus are discussed in the dSGEIS, Chapter 4. Fairways are that portion of the formation that specific geologic and geochemical criteria indicates the potential to produce gas; however, other factors, such as formation depth and terrain, make only portions of the fairway favorable for drilling. Operators consider a variety of factors in addition to the extent of the fairway when making a decision on where to drill for natural gas.

3.3 Supporting Information

The HS&LBG estimates rely on evaluating rates of natural gas well completions that have been experienced in other shale gas plays in the Barnett (Texas), Fayetteville (Arkansas), Haynesville (Louisiana), and the Marcellus (northeastern Pennsylvania). Their estimation approach is most comparable with the Marcellus in PA, and is based on the experience in the other referenced shale plays which relies on publically available data provided by the regulatory agency in the respective states. The resulting estimate of 20 to 500 well completions per year per 1,000 square miles and 3,000 to 6,000 wells potentially drilled within the WOH watershed may be reasonable for discussion purposes; however, the estimates do not account for other factors such as economic and market conditions, potential technology advances, actual production factors or incremental costs associated with additional regulatory jurisdictions and requirements in the WOH watershed. Other factors may influence the pace of shale-gas development, including local and regional conditions and access, availability of drilling resources and equipment, and the availability, cost, and capacity for treating, recycling, and/or disposing wastes which must be identified in advance as part of the permitting process.

3.4 Mitigation Measures

No mitigation measures were proposed by HS&LBG regarding this comment.

3.5 Proposed SGEIS Revisions

HS&LBG's report recommends using the estimates of drilling rates and densities to expand the SGEIS' discussion of regional cumulative impacts (dSGEIS Chapter 6.13.2). As stated in the dSGEIS, development rates are dependent on many variables, including availability of resources, economic conditions, and the permitting processes, among others.

4.0 COMMENTS ON CUMULATIVE IMPACTS AND QUANITFICATION OF GAS WELL DEVELOPMENT ACTIVITIES

Section 4.1 of HS&LBG's report quantifies the cumulative impacts of natural gas development within the NYC's WOH watershed.

4.1 Accuracy and Completeness

The impacted parameters were estimated based on HS&LBG's estimates of drilling rates and development (Section 3.0 of this narrative), and information presented in the dSGEIS. HS&LBG's estimate of cumulative impacts appears reasonable based on the assumptions used, and the NYSDEC's spacing unit requirements for drilling covered under the SGEIS to estimate drilling rates, as discussed in this report (Section 3.0); however, estimates of cumulative impacts due to handling, transport, and disposing flowback water likely are not realistic or representative of actual conditions. HS&LBG does not consider reuse/recycling of flowback water in their estimate and uses a conservatively high (50%) value for flowback recovery.

4.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential development within the NYC Water Supply System; however, the approach can be applied statewide. HS&LBG's estimated development rate may differ if applied statewide, because it is assumed that 32 percent of the land in the NYC WOH water shed is controlled and would not be developed.

4.3 Supporting Information

The comment is made based on what HS&LBG identifies as "known" pathways for chemical contamination of ground water and/or surface water supplies The responses to their comments are discussed in detail in Sections 2.0 and Sections 6.0 through 10.0 of this document.

4.4 Mitigation Measures

HS&LBG did not propose any mitigation measures that are specific to this comment.

4.5 Proposed SGEIS Revisions

Alpha does not propose revisions to the SGEIS based on this comment.

5.0 COMMENTS ON CUMULATIVE IMPACTS RELATED TO LAND DISTURBANCE, SITE ACTIVITIES, AND TRUCK TRAFFIC

Section 4.2 of HS&LBG's report discusses cumulative impacts within the NYC WOH watershed related to land disturbance, site activities, truck traffic, and other drilling related infrastructure. Alpha understands that comments regarding impacts related to surface disturbance, site activities, and truck traffic are being addressed by others under the direction of the NYSDEC.

6.0 COMMENTS ON CUMULATIVE IMPACTS RELATED TO WATER WITHDRAWALS

Section 4.3 of HS&LBG's report discusses cumulative impacts within the NYC's WOH watershed as related to water withdrawal. HS&LBG estimates that one to two billion gallons per year of additional demand could be placed on the watershed's resources. HS&LBG asserts that the additional surface water demand for hydraulic fracturing could reduce inflow to the NYC's reservoirs, potentially requiring the expansion of the storage system to maintain safe yields.

6.1 Accuracy and Completeness

Cumulative water withdrawals were estimated by HS&LBG based on estimated rates of drilling and development within the WOH watershed. The per-well water use rates (4 million gallons) are consistent with those reported in the dSGEIS (Section 5.7). HS&LBG's calculations of cumulative water use rates (80 million to 2 billion gallons per year) are accurate, based on the per-well use rates and their estimated development rates; however, their extrapolation of cumulative impacts may not be representative of water needs within the watershed or statewide, because actual development rates across the state (including in the NYC watershed) will vary as discussed in Section 3.0 of this document.

The statement does not appear accurate or complete, that the surface water demands for hydrofracturing could reduce the reservoir inflow supply to the extent of necessitating expanding storage, either for the WOH watershed or in other major watersheds where shale gas may be developed. HS&LBG does not consider the potential hydrofracturing demand in relation to the existing reservoir capacity, the current daily and annual water supply use, regulatory programs in place that restrict withdrawals, potential reduced demand as a result of flowback water recycling/reuse, potential alternate sources and other factors that indicate the water demand from hydrofracturing is/will be dwarfed by existing demands that currently and historically have been met, including throughout drought periods.

6.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential development within the NYC Water Supply System and the potential need to expand the storage capacity of the city's reservoirs to accommodate demands on surface and ground water resources. The concern regarding depletion of surface water and ground water resources could be applied statewide; however, the extrapolation of the cumulative impacts may not be representative of water needs if applied statewide, since development rates across the state will vary, as discussed in Section 3.0 of this narrative.

6.3 Supporting Information

HS&LBG's report references a television news report that streams in western Pennsylvania were depleted because of natural gas drilling activities in the absence of [regulatory] control mechanisms (Parsons, 2008). Although further information regarding the western Pennsylvania issue was not found, it is acknowledged in the dSGEIS that depletion of water resources is a potential concern.

Regarding the potential decrease in water supply to the NYC reservoir system, the total storage capacity of the Catskill and Delaware systems alone is approximately 460 billion gallons. At a rate of 2 billion gallons per year (gpy), the cumulative annual water demand for hydrofracturing estimated by HS&LBG represents less than one-half percent (0.43%) of the storage in those two systems, without any recharge. The metropolitan NYC area uses more than one billion gallons of water each day, so it is clear that the NYC water system receives appreciable recharge to supply more than 365 billion gallons of water per year. At drought conditions of 50% (NYC DEP 2010) and HS&LBG's estimated HVHF demand, Alpha calculates the total water demand from hydrofracturing (2 billion gpy) represents less than 1% (0.87%) of the available storage capacity, without considering recharge.

The DEP also recognizes and currently is undertaking a multi-year project to address leakage from the NYC water supply infrastructure, which is estimated at approximately 36 million gallons per day. This annual leakage rate (more than 13 billion gallons) represents approximately 2.8% of the reservoir storage capacity, or based on HS&LBG's assumed HVHF water demand, 6.5 times the annual hydrofracturing demand. Another perspective is that the estimated yearly hydrofracturing water demand represents 15% of the estimated annual leakage from the reservoir system alone, so even a small reduction in the water system leakage will more than make up for the annual withdrawal from hydrofracturing. It is intuitive that the NYC water supply volume will not be adversely impacted.

Soeder & Kappel (2009) make the general observation that under drought conditions or in locations with already stressed water supplies, obtaining the millions of gallons needed for a shale gas well could be problematic. The dSGEIS addresses the potential environmental impacts of reduced surface water flow in Section 6.1.1. Mitigation measures are provided in the dSGEIS (Section 7.1.1) to address degradation, reduced flow, and impacts to aquatic

ecosystems and wetlands. The proposed EAF Addendum (dSGEIS Appendix 6) requires operators to identify the water source used.

It is true that depleting a surface water supply could be devastating at a local level, but the Susquehanna River Basin Commission (SRBC) and the Delaware River Basin Commission (DRBC) must approve water use applications in those watersheds. These interstate commissions evaluate withdrawal applications and consider passby flow requirements and potential impacts. 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. Both discussions fulfill the requirements of SEQR. NYSDEC recognizes the authority and responsibilities of the DRBC and SRBC to monitor and approve withdrawals and minimize adverse impacts to those surface water systems. 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).

Regarding the DRBC, Executive Director Carol Collier 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).

The May 19, 2009 news release 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. The DRBC intends to adopt regulations pertaining to the subject matter and in the meantime, the DRBC will apply this determination in combination with its existing regulations (DRBC, 2009b).

DRBC defines a "project" as 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). Currently, any natural gas extraction project requires approval by the DRBC. Those projects in the DRB that are located in New York State also will be subject to the review of NYSDEC. To simplify matters further, the DRBC announced on May 6, 2010, that it will draft regulations for natural gas well pad projects in shale formations in the DRB and consider specific natural gas well pad applications after the new regulations are in place (DRBC, 2010b).

Regarding the SRBC, 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).

Dr. James Richenderfer (2010) stated that the Susquehanna River Basin can accommodate the anticipated water withdrawal demand for hydrofracturing during his recent presentation at an environmental conference in Massachusetts. Dr. Richenderfer offered for comparison that the water demand for shale-gas development (less than 30 million gpd) is approximately half the current consumptive demand used solely for recreational purposes (e.g., golf courses, snow-making), and that just one (proposed) power plant in the watershed will require more water per day (36 million gpd) than the cumulative use from shale gas development in the watershed.

A further comparison was made that the SRBC permitted withdrawals of 3.44 billion gpd by the energy industry sector alone (Riha, 2009), so it is clear that shale gas development, estimated at 28 million gpd, will not strain the watershed resources.

The Great Lakes - St. Lawrence Water Resources Compact (GLC), became Public Law 110-342 on October 3, 2008. New York has not yet established regulations, although 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. There currently are no GLC requirements for passby flows; however, the GLC has specific authority for reviewing and approving new and increased water withdrawals.

Under the SdGEIS, the Natural Flow Regime Method (NFRM) would apply to all surface water withdrawals in NYS for high-volume hydraulic fracturing, including those that are otherwise not subject to other authorities/jurisdictions.

6.4 Mitigation Measures

HS&LBG's report recommends that withdrawal of surface water from the Delaware River and tributaries for the exploration, development, or operation of natural gas wells be prohibited when the Delaware River Master is directing releases from NYC reservoirs to meet the flow objective at the USGS gage at Montague, New Jersey. Similarly, HS&LBG

proposes that withdrawals from the Esopus Creek and tributaries be prohibited when NYC is making required releases in compliance with NYSDEC regulations and permits.

. Regardless of the scale of withdrawals discussed above, both the Delaware and Susquehanna River Basin Commissions are cognizant of water-related concerns, among which include potential impacts to streams and surface and ground water supplies. DRBC's authority in maintaining and regulating surface water flow and withdrawals would apply to proposed withdrawals from the Delaware River and tributaries, and mechanisms exist for DEC to consider impacts and concerns regarding withdrawals from Esopus Creek prior to approving any such withdrwal

6.5 Proposed SGEIS Revisions

Alpha proposes no revisions to the SGEIS based on this comment.

The dSGEIS acknowledges and addresses the potential environmental impacts of reduced surface water flow (dSGEIS Section 6.1.1). Mitigation measures are provided in the dSGEIS (Section 7.1.1) to address degradation, reduced flow, and impacts to aquatic ecosystems and wetlands. The mitigation measures include those existing jurisdictions and regulatory programs that already are in place to address cumulative impacts of significant surface water withdrawals for any purpose. Identification of water sources is a requirement of the permit process. The dSGEIS also outlines the methodologies for mitigating surface water withdrawal impacts. The DRBC and SRBC have authority over water withdrawals in those major watersheds, and the NFRM is proposed to demonstrate appropriate withdrawals for high-volume hydraulic fracturing .

7.0 COMMENTS ON CUMULATIVE IMPACTS RELATED TO CHEMICAL USAGE

Section 4.4 of HS&LBG's report discusses cumulative impacts related to chemical usage within the NYC's WOH watershed. HS&LBG estimates that 82 tons of hydraulic fracturing chemical additives are needed for each well. Their comment focuses on three aspects of chemical usage:

- Estimates of amounts of chemicals used, by class
- Toxicity of the chemical additives to human health and environment
- Protection of proprietary fracturing fluid additives under trade secret laws limits full disclosure

Alpha understands that comments regarding human health are being addressed by the NYSDOH and the NYSDEC. Alpha also understands that comments regarding chemicals used during the hydraulic fracturing process and legal issues regarding whether fracturing fluid mixtures are protected under trade secret laws are being addressed by the NYSDEC.

7.1 Accuracy and Completeness

The per-well fracture fluid use rate (82.2 tons) was calculated based on 4 million gallons of water (dSGEIS Section 5.7) and 1% fracturing additives (dSGEIS Section 5.4) per well. The calculations of annual chemical use rates (1 million to 8 million tons per year) are based on the per-well use rates and estimated development rates (HS&LBG report Chapter 3). The calculations appear accurate based on the data and sources used, and their calculations are based on weight.

7.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential development within the NYC Water Supply System. Concern about the chemical composition of hydraulic fracturing fluid is applicable statewide; however, extrapolating the cumulative impacts may not be representative of actual chemical usage if applied statewide, since development rates across the state will vary as discussed in Section 3.2 of this document.

7.3 Supporting Information

HS&LBG references toxicological information for hydraulic fracturing fluid additives identified in the dSGEIS and by The Endocrine Disruption Exchange (TEDX) (http://www.endocrinedisruption.com). Alpha did not review TEDX's website for accuracy and understands that comments related to chemical toxicity will be addressed separately by the NYSDEC and the NYSDOH.

7.4 Mitigation Measures

HS&LBG recommend two mitigation measures to address chemical usage (Appendix D).

- Eliminating or limiting the introduction of large volumes of hazardous and potentially hazardous chemicals into the watershed.
- Requiring operators to share complete chemical composition and usage data (by mass) for all drilling and fracturing fluid additives

Many companies already have disclosed chemical use information in response to the NYSDEC's requirements. Halliburton recently announced it would disclose the chemical composition of its products (Houston Business Journal, 2010). Alpha understands that comments regarding chemicals used during the hydraulic fracturing process and legal issues regarding whether fracturing fluid mixtures are protected under trade secret laws are being addressed by others under the direction of the NYSDEC.

Eliminating or limiting chemical usage as a mitigation measure is not needed. Existing and proposed mitigation measures relating to the handling and storage of chemicals to prevent impacts to water resources are included in Section 7.1 of the dSGEIS. The requirements include, where applicable; secondary containment for tanks; manually monitoring certain activities; physical controls and catchments; detailed material requirements for impermeable liners; conditions for tank containment of fluids; closure requirements for pit/impoundments; and detailed spill prevention, response, and reporting requirements in accordance with the SWPPP. In primary and principal aquifers, pit fluids must be removed from the site immediately when operations are suspended or the site is unmanned, or within seven days of drilling and/or stimulation operations.

The GEIS also provides in Chapter 17, 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, prohibition and enforcement against flowback discharges to the ground, and containment of waste fluids, at all locations including in primary and principal aquifer areas.

The transportation and use of chemicals in any watershed will be limited by the number of wells at each pad, the sequence of fracturing operations, site storage space, and other considerations. The operators typically only bring and use chemicals as needed for the short period during which hydrofracturing takes place. Industry practice indicates that all the chemicals needed for all wells on a given pad will not be stored on-site contemporaneously due to scheduling, staffing and coordination, controls and equipment requirements, space limitations, and the recognized environmental liability.

Outside of shale-gas production, many dangerous chemicals are used routinely (such as gasoline) and are transported in bulk quantities over state and local roads every day. Similarly, the shale-gas industry is very aware of the many issues regarding its chemical use, liability, and long-term business strategies. Halliburton recently proposed a “chemical scoring index” to apply to their global operations to identify, rank, and develop chemicals that are less toxic as a practical business policy. Other companies also continue to seek, innovate, and develop new and “greener” products to reduce chemical volume, use, and toxicity. Private industry continues to assess new and modified methods to achieving fracturing with reduced fluids and/or chemical use. It is anticipated that the industry will continue to respond to regulations, market forces, and economics including transportation, storage, and disposal cost burdens.

7.5 Proposed SGEIS Revisions

Alpha understands that the NYSDEC currently is reviewing and revising the dSGEIS to reflect the current understanding of fracture fluid use.

8.0 COMMENTS ON CUMULATIVE IMPACTS RELATED TO SURFACE SPILLS

Section 4.5 and Appendix C of HS&LBG's report discusses impacts within the NYC's WOH watershed as related to acute and chronic spills. HS&LBG's estimate of the sensitivity of the NYC water supply to acute spills of fracturing chemicals is based on hypothetical release of a "load of fracturing chemicals" into Kenisco and Rondout Reservoirs. It is also asserted that chronic small-scale spills at or near well pads, even if most spills are mitigated with minimal impact, will compromise public confidence in the quality of NYC's water supply

8.1 Accuracy and Completeness

HS&LBG's estimates for the number of fracture job equivalents to exceed maximum contaminant levels in the NYC's reservoirs is not relevant because the NYSDEC has excluded the NYC WOH and the Skaneateles Watersheds from the SGEIS on the basis that that there are distinct and unique issues presented in these areas which are unrelated to the environmental safety of high volume hydrofracturing. A permit applicant will be required to prepare an individual, site-specific, environmental analysis for any gas well proposed in those two FAD-designated areas. Their comments are not entirely accurate. HS&LBG do not correctly interpret the spills database information, they assume that "loads of fracturing chemicals" will be spilled, and they do not incorporate the many existing and proposed provisions and mitigation measures to protect surface water and shallow ground water. HS&LBG appear to be concerned about the perception that chemical use and spills will not be regulated, monitored or detected, but acknowledge there would be "minimal impact" from most spills.

8.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential development within the NYC Water Supply System. The evaluation of the impacts to surface water quality resulting from acute spills to the Rondout and Kenisco Reservoirs are specific to the WOH watershed and are not relevant in light of the NYSDEC's decision to exclude WOH and Skaneateles watersheds from the dSGEIS; however, the impacts to water quality resulting from acute and chronic spills and releases are a concern statewide.

8.3 Supporting Information

HS&LBG assert that "releases associated with natural gas well drilling and fracturing activities have resulted in hundreds of documented ground water and surface water contamination incidents across the country." HS&LBG's Rapid Impact Assessment report, which is outside of Alpha's work scope, is cited the source of this data.

Millions of gallons of hazardous chemicals (including gasoline) are routinely transported over NYS's roads every year. The NYSDEC reviewed 270 spill incidents that occurred since 1979 were reportedly attributed to natural gas drilling activities in New York (Grannis, 2009). Of the 270 spills, 10 were associated with gas drilling and 44 were associated with gas well production sites. The remaining spills occurred at oil well production sites (106), abandoned well sites (40), natural gas storage facilities (17), or were determined not to be related to oil or gas drilling or production (53). More than 10,000 regulated wells were installed during that same period. The NYSDEC spills database, which catalogs all reported releases, includes over 350,000 reported spills reported statewide. Based on these statistics, incidence rate of spills associated with oil and gas drilling and production is very low. The USDOT and NYSDOT regulate the transportation of hazardous chemicals over public roads. The dSGEIS Section 5.5 (Transport of Hydraulic Fracturing Additives) and Section 5.6 (On-site Storage and Handling of Hydraulic Fracturing Additives) describe the regulations and procedures for transporting, handling, and managing hazardous materials.

Chapter 7 of the dSGEIS contains many subjects and mitigation measures related to accidental spills and potential impacts, covering areas including: Stormwater, Surface Spills and Releases at the Well Pad, Ground Water Impacts Associated With Well Drilling and Construction, Hydraulic Fracturing Procedures, Waste Transport, Centralized Flowback Water Surface Impoundments, SPDES-Regulated Discharges, Solids Disposal, Protecting New York City's Subsurface Water Supply Infrastructure, Protecting the Quality of New York City's Drinking Water Supply, Setbacks, Protecting Floodplains, Protecting Freshwater Wetlands, and Protecting Ecosystems and Wildlife, among others. Section 2.0 of this document also identifies the importance of measures, both existing and proposed, that dictate proper well construction and cemented surface casings to protect surface and shallow ground water quality.

Item 33 of Appendix 10 in the dSGEIS, Proposed Supplementary Permit Conditions For High-Volume Hydraulic Fracturing, also allows 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 (see also 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.

The proposed horizontal setbacks are adapted from other regulating authorities; the setbacks distances are supported by practical application, experience, and historical analyses. The dSGEIS references SEQRA, NYSDOH, NYC Watershed Rules and Regulations, the Clean Water Protection Act, and public water protection rules from other states. 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.

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 (See also Section 7.1.3.3.). The dSGEIS 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 EAF Addendum requires information about the number, individual and total capacity, and well pad location of receiving tanks for flowback (Section 7.1.3.4). NYSDEC can then impose a permit condition limiting the number of tanks, if necessary

The dSGEIS discusses 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. Examples of such requirements are listed on page 7-35 of the dSGEIS.

8.4 Mitigation Measures

HS&LBG recommends two mitigation measures to address surface spills (Appendix D).

- Expanding the buffers around streams (from 150 feet to 1,000 feet) and reservoirs (300 feet to 2,000 feet) within the WOH watershed.
- Prohibiting the transport of fracturing fluid additives and waste products on roads adjacent to public water supply reservoirs and major inflow streams.

It is Alpha's understanding that this mitigation measure is not being considered in light of the NYSDEC's decision to exclude the NYC WOH and the Skaneateles watersheds from the SGEIS on the basis that that there are distinct and unique issues presented in these areas which are unrelated to the environmental safety of high volume hydrofracturing.

8.5 Proposed SGEIS Revisions

Alpha recommends no revisions to the SGEIS based on this comment.

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 certain activities; physical controls and catchments; detailed material requirements for impermeable liners; conditions for tank containment of fluids; closure requirements for pit/impoundments; and detailed spill prevention, response, and reporting requirements in accordance with the SWPPP.

The GEIS also provides in Chapter 17, 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.

Mitigation measures for stormwater are identified in dSGEIS Section 7.1.2; centralized flow back impoundments in Section 7.1.7; setbacks from surface water resources in Section 7.1.12.2; floodplains in Section 7.2; wetlands in Section 7.3; and ecosystems and wildlife in Section 7.4.

The dSGEIS Sections 5.2.2.1 (reserve pits), Section 5.5 (transport of fracturing fluids), 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. Some of the conditions include those projects where 1) any centralized flowback surface water impoundment is proposed, with additional requirements within specific distances of a reservoir, perennial or intermittent stream, wetland, lake, pond, storm drain, private or public supply spring; 2) any proposed well pad within specific distances of the same resources listed above, and other surface water resources. The NYSDEC may use the provisions 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.

9.0 COMMENTS ON CUMULATIVE IMPACTS RELATED TO SUBSURFACE MIGRATION

Section 4.6 of HS&LBG's report discusses cumulative impacts within the NYC's WOH watershed as related to the migration of hydraulic fracturing fluids or formation water into a shallow fresh water aquifer or the NYC water supply infrastructure. HS&LBG identify the following as issues of concern related to subsurface contaminant migration:

1. Subsurface migration pathways via faults, fractures, crushed zones, and abandoned wells;
2. Enhancement of natural migration pathways resulting from the hydraulic fracturing process;
3. Extension of induced hydraulic fractures above the target formation caused by hydrofracturing a large number of wells
4. Injection wells;
5. Pressure gradients (forced vertical migration of fluids) from deeper strata into the water supply tunnels;
6. Tunnel liner structural impacts due to external pressure greater than design thresholds
7. Infiltration to the water supply tunnels
8. Water supply operations, regarding the migration and accumulation of methane and hydrogen sulfide leading to health and safety risk and damage to critical infrastructure.

Comments (5 – 8) regarding the tunnel liner structural considerations and infiltration into the water supply tunnels are specific to the NYC Water Supply System WOH, which NYSDEC has excluded from the SGEIS on the basis that that there are distinct and unique issues presented in these areas which are unrelated to the environmental safety of high-volume hydrofracturing.

Many of the comments in this section previously were summarized in HS&LBG's Section 2 (Area Geology). The responses to these concerns are addressed and discussed in Section 2.0 of this document.

HS&LBG assert in their report Section 4.6 that "vertical migration of deep groundwater, methane and/or fracking chemicals is a foreseeable occurrence, given the existence of naturally occurring and laterally extensive vertical brittle geological structures, and the documentation of faults and seeps during tunnel construction." The report also interprets that brittle structures mapped in the Catskill/Delaware watershed reach up to 6,000 feet deep and seven miles laterally. They contend that these extensive features paired with the potential for failed casings "could result in significant surface and subsurface contamination of fresh water aquifers…." HS&LBG state that "[i]t is estimated that location and condition records are lacking for over 50 percent of the previously constructed oil and gas wells in New York State." These wells may not be properly plugged and abandoned, making them conduits for contaminated fluid to the fresh water aquifer.

HS&LBG reference New York State's Brittle Structure Map (Isachsen & McKendree, 1977). The brittle structure map includes known faults and fractures, as well as linear features interpreted from topographic maps and aerial and satellite imagery. The topographic and "tonal" linear features may be indicative of brittle deformation features (Isachsen & McKendree, 1977). The maps are designated as "preliminary" in nature, for purposes that include the "aid in the selection of exploration targets for oil, natural gas, and economic mineral deposits" and to "identify major fracture conduits for ground water recharge and circulation." Dr. Terry Engelder, Pennsylvania State University (2010) points out that the

use of lineaments to map crustal faults is highly controversial. Dr. Engelder states that outside the Clarendon-Linden fault zone in western NY, vertical, curved ("listric") faults are extremely rare in outcrop. These lineaments cannot be assumed to represent vertical features that propagate from basement rocks through the Devonian section.

HS&LBG's report argues that hydrofracturing diminishes the isolating properties of the target shale which is a natural low-permeability barrier between surface aquifers and deeper low quality formational fluids. The report states that stimulation fracturing can create complex fracture zones of reopened existing fractures and intersecting induced fractures. The extensive complex fracture zone that HS&LBG expects and the up to one percent increase in volume of the hydrofractured rock that the dSGEIS acknowledges is possible may "alter rock stresses over an indeterminate distance…." This would cause the enhancement of subsurface fluid migration and depressurization of confined materials.

HS&LBG discusses underground injection in the context of the risk of the subsurface migration of fluids and the association of injection and "seismic events elsewhere."

9.1 Accuracy and Completeness

Section 2 and Appendix A of the HS&LGB report presents a summary of geologic and hydrogeologic conditions in the WOH watershed. HS&LBG contend there exists a "reasonably foreseeable risk to water supply operations from methane, fracking chemicals, and/or poor quality saline formation water migrating into ground water, watershed streams, reservoirs, tunnels, and other infrastructure." The assertion is based on:

- Observations made during the construction of the West Delaware Tunnel,
- The proximity of mapped brittle structures near the observed methane and saline ground water seeps, and
- A critique of ICF's evaluation of the potential for hydraulic fracturing fluids to migrate from the Marcellus to shallow fresh ground water aquifers.

The assertions are not supported by the data and sources presented, and do not represent reasonably foreseeable conditions as discussed in Section 2.0 of this document.

HS&LBG's comment that "it is estimated" that there are no location and condition records for more than 50 percent of the previously constructed oil and gas wells in New York State. Their report does not provide any supporting basis for this estimate.but appears to be based on the NYSDEC's estimate (http://www.dec.ny.gov/energy/205.html) of 75,000 wells drilled in the state since 1820s and approximately 40,000 wells in the DMR's database.

HS&LBG fails to acknowledge the existence of other tight, low-permeability shales between the Marcellus Shale and shallow aquifers when discussing the extensive, complex, interconnected fracture zone that they opine to be formed by hydraulic fracturing in NYS.

These shales that are known to exist between the Marcellus and shallow aquifers act as confining layers (dSGEIS, p. 4-8).

HS&LBG's discussion of the association of underground injection and "seismic events elsewhere" does not reference an information source or indicate locations that they refer to as "elsewhere". HS&LBG states that over 60 Class II UIC wells for flowback water disposal are permitted in New York State and cites a 2008 ALL Consulting presentation as a source; however, the 60 permits refer to a reported number of permits being drafted (Arthur et al, 2008). Only four disposal wells that can accept oil and gas brine are currently listed on the NYSDEC's website (http://www.dec.ny.gov/energy/29856.html).

Additional issues related to HS&LBG's supporting information are detailed in Section 9.3, below.

9.2 Applicability to Non-FAD Watersheds

The comments specifically discuss potential impacts to the NYC Water Supply System via migration into surface water bodies and into system tunnels; however, the concerns relating to impacts to a shallow ground water supply can be applied statewide.

9.3 Supporting Information

Much of the supporting information that HS&LBG references is addressed in Section 2.0 of this document. Some points are repeated here for convenience. The information presented by HS&LBG is indented.

> Statements about risk to water supply operations from methane, hydrofracturing chemicals, and/or poor quality saline formation water migrating into ground water, watershed streams, reservoirs, and tunnels are based on data from the construction of the NYC water supply tunnels that document the presence of fractures and joints that intersect the tunnel, observations of saline water inflow into the tunnel at some of the fractures and joints, and the presence of methane seeps.

The Marcellus is not the only source of methane and saline water in NYS. The presence of natural gas and/or saline ground water has been noted in water wells drilled through shallower gas-producing shales in the northeastern portion of New York (McPherson, 1993; Frimpter, 1972; Soren, 1963; Berden, 1954). Natural gas has been found in the younger Devonian shales of the Genesee, Sonyea, and West Falls Groups (dSGEIS Figure 4.2), through which the NYC's West Delaware Tunnel was constructed. The presence of saline water and/or methane cannot be used as conclusive evidence of a direct hydraulic connection via brittle structures between the Marcellus Shale and shallow ground water.

> HS&LBG reference New York's Preliminary Brittle Structure Map (Isachsen & McKendree, 1977). The brittle structure map includes known faults and fractures, as well as linear features interpreted from topographic maps and aerial and satellite imagery. The topographic and "tonal" linear features may be indicative of brittle deformation features (Isachsen & McKendree, 1977).

The maps are "preliminary." The intended purposes of the maps include to "aid in the selection of exploration targets for oil, natural gas, and economic mineral deposits" and to "identify major fracture conduits for ground water recharge and circulation." Producers have an economic incentive to contain induced fractures within the target formation (DOE, 2009) to avoid large interconnected faults and fractures that cross multiple formations. Engelder (2010) characterizes the use of lineaments to map crustal faults as highly controversial, and contends that lineaments cannot be assumed to represent vertical features propagating from basement rocks through the Devonian section.

> HS&LBG's critique of ICF's evaluation of the potential for hydraulic fracturing fluids to migrate from the Marcellus to shallow fresh ground water aquifers centers on the selection of bulk hydrogeologic parameters and the Preliminary Brittle Structure Map. HS&LBG state that the net hydraulic conductivity of a formation includes the effects of faults and fractures in addition to the bulk properties of the rock matrix. The report presents values for the hydraulic conductivities of Devonian shales range from 10^{-8} to 10^{0} feet per day (p. A-7), or $4x10^{-7}$ to $4x10^{-4}$ centimeters per second.

These conductivities are consistent with the values used by ICF (10^{-8} cm/s to 10^{-4} cm/s) in their analysis (dSGEIS Appendix 11). ICF does consider flow through fractures, faults, or unplugged boreholes and concludes that such a pathway is theoretically possible, but extremely unlikely to occur (ICF 2009). Regardless of the parameters, the hypothetical debate is not supported by several decades of hydrofracturing data and experience in the U.S. The assertion that hydraulic fracturing will connect deep, paleo-features to overlying fresh water resources and provide a pathway for upward contaminant migration is not supported by the existing data and basic hydrogeologic principles. Engelder (2010) identifies several issues with HS&LBG's arguments based on their report Figure 4-1; these issues are enumerated in Section 2.3 of this document. Engelder also points out that the properties of the shales overlying the Marcellus are ductile enough to adsorb an expansion of 1% volume, the estimated net volume that may be produced by development of the Marcellus shale through hydrofracturing.

As discussed in this report in Section 2.3, the primary evidence that the 1,000 feet plus overlying rock layers 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 permeable beds to the surface (Selley, 1998).

HS&LBG's report references a case in Garfield County, Colorado, in 2004 and an incident reported in 2009 in Dimock, Pennsylvania (p. 45). Natural gas was observed bubbling in a stream bed in Garfield County. Ground and surface water analyses yielded benzene concentrations of 200 and 90 micrograms per liter, respectively. The formation fluids believed to have caused the contamination allegedly migrated nearly 4,000 feet vertically and over 2,000 feet laterally. The contamination was attributed to inadequate casings or grouting in gas wells and the existence of a network of faults and fractures.

HS&LBG's report states that groundwater contamination was caused by drilling in the Marcellus Shale, in Dimock, PA, in early 2009. "[M]ethane migrated thousands of feet from the production formation, contaminating the fresh-water aquifer and resulting in at least one explosion at the surface." Methane gas has affected more than a dozen water supply wells in a nine-square-mile area. HS&LBG's report acknowledges, however, that the cause is still under investigation and the subsurface pathway has not been determined.

Neither case study has demonstrated that the contamination was caused by hydrofracturing. Grouting and casing issues, and over-pressuring of the annular space are the likely causes for the problems cited in other states. The Cornell University Cooperative Extension (2010) acknowledges that based on its review of documents pertaining to "water well contamination resulting from natural gas development" that "All instances of contamination that have been found thus far have not been caused by hydro-fracturing chemicals, but have been instead caused by improper well casings that have resulted in methane migration into aquifers or the turbidity that results from methane migration or ground vibrations." NYS's existing casing and cementing program requirements and additional proposed protections are designed to prevent such failures. The NYSEDC reports that methane migration associated with gas well drilling has been very rare since current casing and cementing practices were implemented.

The Pennsylvania DEP continued to investigate the source of gas in water wells in the Dimock, PA and determined that the gas was derived from the upper Devonian Mahantango formation and not from the Marcellus Shale that was the target formation for drilling in the area. (PADEP, 2010, personal communication). The depth to the Mahantango formation is approximately 1,500 to 1,800 feet below ground whereas the depth to the Marcellus Shale is approximately 7,000 feet. Confirmation by isotopic analysis (PADEP, 2010) of the source of the gas from the shallower Mahantango formation confirms that inadequate casing and cementing practices, not hydraulic fracturing of the Marcellus Shale, are the cause of the gas in the water supply wells in Dimock, PA.

Regarding injection wells, some induced seismicity has been reviewed and acknowledged in Texas from disposing brine. Injection wells are described in dSGEIS Section 5.13.3.1, and Section 4.5.1 of the dSGEIS discusses induced seismicity. Per Chapter 15 of the GEIS, injection wells for brine disposal associated with oil and gas operations are designated as Class IID in EPA's UIC program and require federal permits. These wells are categorized

and regulated as industrial discharges under the NYSDEC SPDES program. The 1992 GEIS Findings Statement notes the permitting process "require[s] an extensive surface and subsurface evaluation which is in effect asupplemental EIS addressing technical issues. An additional site-specific environmentalassessment and SEQR determination are required." Because the 1992 Findings require a site-specific SEQRA review for injections wells, the mitigation measures discussed in Chapter 7 are presented for informational purposes only and are not proposed or incorporated on a generic basis.

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.

9.4 Mitigation Measures

Two of the mitigation measures proposed by HS&LBG (Appendix D) are relevant to this comment.

- *HS&LBG proposes that the buffer zone surrounding NYCDEP infrastructure be expanded from 1,000 feet to seven miles, based on a statistical evaluation of the length of brittle structures within the watershed. HS&LBG proposes that the setback should apply to the lateral extent of the gas well and not just to the well head location.*

It is Alpha's understanding that this mitigation measure is not being considered in light of the NYSDEC's decision to exclude the NYC WOH and the Skaneateles watersheds from the SGEIS on the basis that that there are distinct and unique issues presented in these areas which are unrelated to the environmental safety of high volume hydrofracturing.

From a technical stand point, the proposed mitigation measure is not reasonable based on the available data. The Preliminary Brittle Structure Map should not be used as a basis for precluding or permitting drilling considering its stated preliminary basis, scale, and intended use and interpretation (Isachsen & McKendree, 1977; and Engelder, 2010).

- *HS&LBG's supports provisions requiring complete chemical composition and usage data for all drilling and fracturing additives used in the watershed and for the use of additives that are non-toxic or which toxicity is well understood (p. D-2).*

It is Alpha's understanding that others are addressing legal issues that arise with this measure with respect to trade secrets. Alpha also understands that screening criteria for evaluating alternative additives are being considered.

The SGEIS does address the issue of alternative additives that could be used (dSGEIS Section 9.3.1). In summary, some alternative additives are available and approved for use in

European countries; however, a reliable process for evaluating the environmental safety of such chemicals is not currently in place in the US. Industry is aware of the issues regarding chemical usage, and "greener" chemicals as well as alternative fracturing methods continue to be developed and assessed as technology progresses.

In addition to disclosing the chemicals used as part of the permitting process, Item 32 in Appendix 10 of the dSGEIS provides that "Fracturing products other than those identified in the well permit application materials may not be used without specific approval… [and] will require submission and review …and may require a site-specific environmental assessment and SEQRA determination prior to approving commencement of hydraulic fracturing operations…"

9.5 Proposed SGEIS Revisions

Alpha proposes no revisions to the SGEIS based on HS&LBG's comments.

Section 2.3 of this document outlines the many provisions to protect surface and shallow ground water, some of which are repeated here for convenience. The potential for fluids and gas to migrate and impact ground water resources as a result of natural gas drilling activities is discussed in the GEIS in chapters 9, 10, and 16 (pages 9-10 through 9-18, 9-23 through 9-24, 10-3 through 10-6, and 16-18). The potential for impacts related to high-volume hydrofracturing is discussed in the dSGEIS in Section 6.1.4, and mitigation measures are discussed in 7.1.4.

In addition, the existing GEIS and dSGEIS discuss the importance and mitigation factors to maintain well casing integrity. The requirements for conductor, surface, intermediate, and production casing and cementing are addressed in the GEIS in Section 9 and in the dSGEIS in Appendix 8. Proposed permit conditions specific to high-volume hydrofracturing are included in the dSGEIS (Appendix 10), including cement bond logging requirements for intermediate casing (if installed based on specific conditions) and production casing. NYS's current casing and cementing practices (NYSDEC, July 8, 2010) are attached as permit conditions to every permit issued (NYSDEC, personal communication, June 10, 2010). NYSDEC's current well permit application form requires the submission of a casing and cementing plan with every well permit application (NYSDEC, June 10, 2010), and is subject to NYSDEC review and approval.

The GEIS also specifies the requirements, conditions, and specifications for casing installation inspection, monitoring, and documentation prior to the continuation of drilling operations (Chapter 17). Chapter 17 of the GEIS and Section 7.1.4.2 of the dSGEIS describe the provisions and requirements for ensuring wellbore integrity, including lost circulation.

The potential for loss of circulation also is a concern that is relevant during the drilling phase. Supplemental permit conditions are included in the dSGEIS in Appendix 9 for all wells drilled in principal and primary aquifers to provide additional protections for those areas. Air

or fresh water-based drilling mud is required when drilling through freshwater aquifers (GEIS, Chapter 9). Surface casing is cemented in place below the base of the fresh water zone to seal fresh water zones and prevent the introduction of drilling fluids and deep formation water into fresh water zones.

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 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 ground water protections and mitigation, or to deny the project, per the required site-specific environmental assessment and determination.

10.0 COMMENTS ON IMPACTS RELATED TO WASTEWATER TREATMENT AND DISPOSAL

Section 4.7 of the HS&LBG report discusses concerns related to impacts within the NYC WOH watershed resulting from the treatment and disposal of wastewater. They discuss that fracturing fluids returning to the surface as flowback and produced water generally have elevated total dissolved solids and chlorides, and may contain fracturing fluid additives and naturally-occurring hydrocarbons, radionuclides, and heavy metals. The wastewater must be treated to prevent the release of these contaminants to the environment. Additional risks, including fluid migration and seismic events, associated with disposal of fluids in injection wells were discussed in Section 4.6 of HS&LBG's report.

HS&LBG assert that the development of natural gas will lead to a waste disposal problem for which there is no environmentally and economically viable solution. The report states that the lack of an economically viable disposal option will lead to irresponsible and illegal waste handling and disposal.

HS&LBG's report contains several comments regarding various treatment and disposal methods and discusses each method's limitations. The following is a list of the methods discussed and their limitations according to HS&LBG:

1. Injection Wells: "Injection well failures resulting in surface and ground water contamination have been reported elsewhere." The report cites a reference that addresses the Gulf Coast Aquifer of Southeast Texas, so it is assumed the well failures occurred there. The report continues on to repeat a comment from Section 4.6, which is that injection wells have been associated with induced seismicity which HS&LBG alleges could cause increased subsurface migration of fluids from hydrofractured strata and other deep formations.
2. Wastewater Treatment Plants and discharge to surface water: The Pennsylvania Department of Environmental Protection (PADEP) has proposed a regulatory

revision, to take effect on January 1, 2011, which includes adding effluent standards for oil and gas wastewaters of 500 mg/L for TDS, 250 mg/L for sulfates, and 250 mg/L for chlorides as daily maxima (PADEP, April 11, 2009). HS&LBG's report asserts that "[t]here are currently no facilities in the state that can treat flowback fluids to this level."

3. Evaporation/Crystallization: This is the only established technology that can meet the new proposed limits presented under #2, above. It produces either a highly concentrated brine solution or a large volume of salt cake, however, that must be disposed. Disposal would be expensive, and evaporation/crystallization plants are energy intensive and have a potential for significant air quality impacts.
4. Recycling Flowback: This method is limited because of the high concentration of scale-forming constituents.
5. Dilution: Dilution is unlikely to provide a viable solution based on the estimated flow rates that would be needed to dilute the expected waste stream.

10.1 Accuracy and Completeness

HS&LBG's report Section 4.7 is a discussion of waste fluid treatment and disposal methods and their shortcomings, especially as Pennsylvania regulations apply; however, HS&LBG does not address NYS and NYC regulations regarding treatment and disposal. HS&LBG contend that "the development of natural gas resources will present a significant waste disposal challenge for which there is no clear or viable solution evident at this date."

Their comments were intended to specifically discuss shale gas waste fluid treatment and disposal within the WOH watershed area. There was little information presented specific to the NYC WOH or New York State.

HS&LBG's discussion of the association of underground injection and "seismic events elsewhere" references an article that addresses the Gulf Coast Aquifer of Southeast Texas, so it is assumed that is the location cited. The discussion presents no comparison of operations and geology in Texas and those in NYS.

The HS&LBG report does not provide information about how wastewater from gas well development is currently being handled in NYS, the waste stream currently being treated and disposed, or the expected future waste stream.

HS&LBG's supporting information is based on assumptions and regulatory issues encountered in other states that are not applicable in NYS. Further issues with HS&LBG's assertions are presented in below Section 10.3.

10.2 Applicability to Non-FAD Watersheds

The comment specifically discusses potential development within the NYC Water Supply System; however, the treatment and disposal of waste fluids from gas development is relevant statewide.

10.3 Supporting Information

HS&LBG offer information from a few sources, including articles from professional journals, a paper from a professional meeting, and the dSGEIS itself. Much of the information, while useful, is not specific to NYS.

Disposal of industrial wastewater (drilling fluids, flowback water, and production water) and the potential environmental impacts are discussed in dSGEIS Sections 5.13, 6.1, 7.1.8, and 7.1.8.1. Section 8.2.2 (other DEC permits and approval) summarizes the NYS interagency departments and roles in evaluating the potential impacts of proposed POTW discharges.

The dSGEIS summarizes the requirements and regulatory authority for POTWs, including types of pretreatment programs and standards, and addresses both direct and indirect discharges to those facilities. Both the NYSDEC Division of Water and the USEPA have regulatory authority for discharges to the environment from POTWs (and privately-owned facilities in New York).

Discharge permits issued through the State Pollution Discharge Elimination System (SPDES) program are subject to regulatory notifications, modifications, and routine monitoring and reporting including reviewing new discharges or changes in discharge volume or characteristics. The mitigation measures acknowledge the potential high volumes, total dissolved solids, and diverse chemicals in the wastewater and identify operational program components to evaluate and mitigate potential impacts.

Existing data for concentrations of NORM is presented in the dSGEIS for Marcellus shale cuttings (Section 5.2.4.2) and flowback water (5.11.3.3). The database of cutting analyses demonstrates levels of radiation essentially are background values and do not present an exposure concern for workers or the general public. The dSGEIS Section 5.13 (waste disposal) states that except cuttings generated by air drilling, drill cutting from oil-based or polymer-based mud must be removed by a permitted hauler. The wastes must be disposed off-site at a permitted facility based on composition.

10.4 Mitigation Measures

HS&LBG propose that waste treatment and management provisions be established before issuing permits for high-volume hydrofracturing and that well permits be limited to the treatment & disposal capacity in place at the time of approval (HS&LBG Appendix D).

HS&LBG's proposed mitigation measure is not needed. Disposal of industrial wastewater (drilling fluids, flowback water, and production water), the potential environmental impacts, the requirements and regulatory authority for POTWs and their discharges, and the SPDES program are discussed in the dSGEIS as stated in Section 10.3. Specific characteristics and required testing information includes chemical composition, aquatic toxicity, general chemistry, and radiological scans. The mitigation measures acknowledge the evaluation of a proposed discharge that may be prohibitory to biological treatment processes.

Although the summary of disposal options indicated by HS&LBG is generally accurate for many gas-producing states, NYSDEC requires that a plan for fluids disposal be submitted prior to issuing permits and that the waste stream(s) is/are tracked and documented (Appendix 10, items 39, 40, 41, 47, 48). Further, it is not the mission of regulatory agencies to dictate the pace of energy development or the technologies to address waste streams; the development of shale-gas in NYS will be limited by ability and response of industry, commerce, and the open market to manage, transport, treat, recycle, dispose, and/or reuse wastes, including fluids. The private sector is responsible to innovate and demonstrate to the satisfaction of the regulatory agency, the ability to provide appropriate means to address waste streams, as provided in the dSGEIS.

10.5 Proposed SGEIS Revisions

Alpha recommends no revisions to the SGEIS based on these comments.

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