New York State Department of Environmental Conservation

Revised Draft

Supplemental Generic Environmental Impact Statement

On The Oil, Gas and Solution Mining

Regulatory Program

Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs

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New York State

DEC

Executive Summary

Revised Draft
Supplemental Generic Environmental Impact Statement

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EXECUTIVE SUMMARY

High-volume hydraulic fracturing is a well stimulation technique that has greatly increased the ability to extract natural gas from very tight rock. High-volume hydraulic fracturing, which is often used in conjunction with horizontal drilling and multi-well pad development, is an approach to extracting natural gas in New York that raises new, potentially significant, adverse impacts not studied in 1992 in the Department of Environmental Conservation's (Department or DEC) previous Generic Environmental Impact Statement (1992 GEIS) on the Oil, Gas and Solution Mining Regulatory Program.[1] Increased production of domestic natural gas resources from deep underground shale deposits in other parts of the country has dramatically altered future energy supply projections and has the promise of lowering costs for users and purchasers of this energy commodity.

High-volume hydraulic fracturing is distinct from other types of well completion that have been allowed in the State under the 1992 GEIS and Department permits due to the much larger volumes of water and additives used to conduct hydraulic fracturing operations. The use of high-volume hydraulic fracturing with horizontal well drilling technology provides for a number of wells to be drilled from a single well pad (multi-pad wells). Although horizontal drilling results in fewer well pads than traditional vertical well drilling, the pads are larger and the industrial activity taking place on the pads is more intense. Also, hydraulic fracturing requires chemical additives, some of which may pose hazards when highly concentrated. The extra water associated with such drilling may also result in significant adverse impacts relating to water supplies, wastewater treatment and disposal and truck traffic. Horizontal wells also generate greater volumes of drilling waste (cuttings). The industry projections of the level of drilling, as

[1] The Generic Environmental Impact Statement (1992 GEIS) on the Oil, Gas and Solution Mining Regulatory Program is posted on the Department's website at http://www.dec.ny.gov/energy/45912.html. The 1992 GEIS includes an analysis of impacts from vertical gas drilling as well as hydraulic fracturing. Since 1992 the Department has used the 1992 GEIS as the basis of its State Environmental Quality Review Act (SEQRA) review for permit applications for gas drilling in New York State.

reflected in the intense development activity in neighboring Pennsylvania, has raised additional concerns relating to community character and socioeconomics.

General Background

In New York, the primary target for shale-gas development is currently the Marcellus Shale, with the deeper Utica Shale also identified as a potential resource. Additional low-permeability reservoirs may be considered by project sponsors for development by high-volume hydraulic fracturing. The Department has received applications for permits to drill horizontal wells to evaluate and develop the Marcellus Shale for natural gas production by high-volume hydraulic fracturing.

The Department has prepared this revised draft Supplemental Generic Environmental Impact Statement (draft SGEIS, dSGEIS, or draft Supplement) to satisfy the requirements of the State Environmental Quality Review Act (SEQRA) by studying the new technique and identifying potential new significant adverse impacts for these anticipated operations. Additionally, the Department prepared this draft SGEIS to satisfy the requirements of the SEQRA for the future enactment of revisions or additions to the Department's regulations associated with high-volume hydraulic fracturing. In reviewing and processing permit applications for high-volume hydraulic fracturing in these deep, low-permeability formations, the Department would apply the requirements contained within regulations, along with the final SGEIS and the findings drawn from it, including criteria and conditions for future approvals, in conjunction with the 1992 GEIS.

The final SGEIS will apply statewide, except in areas that the Department proposes should be off-limits to surface drilling for natural gas using high-volume hydraulic fracturing technology. As explained below, these areas include the watersheds associated with unfiltered water supplied to the New York City and Syracuse areas pursuant to Filtration Avoidance Determinations issued by the U.S. Environmental Protection Agency (EPA), reforestation areas, wildlife management areas, and "primary" aquifers as defined by State regulations, and additional setback and buffer areas. Forest Preserve land in the Adirondacks and Catskills is already off-limits to natural gas development pursuant to the New York State Constitution.

SEQRA Procedure to Date

The public process to develop the dSGEIS began with public scoping sessions in the autumn of 2008. Since then, engineers, geologists and other scientists and specialists in all of the Department's natural resources and environmental quality programs have collaborated to comprehensively analyze a vast amount of information about the proposed operations and the potential significant adverse impacts of these operations on the environment, identify mitigation measures that would prevent or minimize any significant adverse impacts, and identify criteria and conditions for future permit approvals and other regulatory action.

In September 2009, the Department issued a dSGEIS (2009 dSGEIS) for public review and comment. The extensive public comments revealed a significant concern with potential contamination of groundwater and surface drinking water supplies that could result from this new technology. Concerns raised included comments that the 2009 dSGEIS did not fully study the potential for gas migration from this new stimulation technique, or adequately consider impacts from disposal of solid and liquid wastes. Additionally, commenters stated the 2009 dSGEIS did not contain sufficient consideration of visual, noise, traffic, community character or socioeconomic impacts. Accordingly, in 2010 Governor Paterson ordered the Department to issue a revised dSGEIS on or about June 1, 2011. The Executive Order also provided that no permits authorizing high-volume hydraulic fracturing would be issued until the SGEIS was finalized.

Since the issuance of the 2009 draft SGEIS, the Department has gained a more detailed understanding of the potential impacts associated with horizontal drilling from: (i) the extensive public comments from environmental organizations, municipalities, industry groups and other members of the public; (ii) its review of reports and studies of proposed operations prepared by industry groups; (iii) extensive consultations with scientists in several bureaus within the New York State Department of Health (NYSDOH); (iv) the use of outside consulting firms to prepare analyses relating to socioeconomic impacts, as well as impacts on community character, visual, noise and traffic impacts; and, (v) its review of information and data from the Pennsylvania Department of Environmental Protection (PADEP) and the Susquehanna River Basin Commission (SRBC) about events, regulations, enforcement and other matters associated with

ongoing Marcellus Shale development in Pennsylvania. In June 2011, moreover, Commissioner Joseph Martens and Department staff visited a well pad in LeRoy, Pennsylvania, where contaminants had discharged from the well pad into an adjacent stream, and had further conversations with industry representatives and public officials about that event and high-volume hydraulic fracturing operations in Pennsylvania generally.

The Draft SGEIS

The draft SGEIS contains revised and additional analyses relating to high-volume hydraulic fracturing operations compared to the 2009 dSGEIS and the preliminary draft released earlier this year. The draft SGEIS, which is summarized below, supersedes those earlier versions and the expectation is that public comment will focus on the revisions made since the 2009 dSGEIS. For ease of comparison by the public, this document underscores revised or additional discussion from the 2009 draft, and indicates where text from the 2009 draft has been omitted.

Chapter 1 – Introduction

This Chapter contains an introduction to the dSGEIS. The Chapter summarizes the changes in high-volume hydraulic fracturing operations seen since the 2009 SGEIS, describes the methodology of this environmental review, and highlights enhanced mitigation and new precautionary measures incorporated into the document.

Chapter 2 – Description of Proposed Action

This Chapter includes a discussion of the purpose, public need and benefit of proposed high-volume hydraulic fracturing operations, as well as the potential locations, projected activity levels and environmental setting for such operations. Information on the environmental setting focuses on topics determined during scoping to require attention in the SGEIS. The Department has determined, based on industry projections, that it may receive applications to drill approximately 1,700 - 2,500 horizontal and vertical wells for development of the Marcellus Shale by high-volume hydraulic fracturing during a “peak development” year. An average year may see 1,600 or more applications. Development of the Marcellus Shale in New York may occur over a 30-year period. Those peak and average levels of development are the assumptions

upon which the analyses contained in this dSGEIS are based. A consultant to the Department has completed a draft estimate of the potential economic and public benefits of proposed high-volume hydraulic fracturing development, including an analysis based on an average development scenario as well as a more conservative low potential development scenario. That analysis calculates for each scenario the total economic value to the proposed operations, potential state and local tax revenue, and projected total job creation.

Chapter 3 – Proposed SEQRA Review Process

This Chapter describes how the Department intends to use the 1992 GEIS and the final SGEIS in reviewing applications to conduct high-volume hydraulic fracturing operations in New York State. It describes the proposed Environmental Assessment Form (EAF) addendum requirements that would be used in connection with high-volume hydraulic fracturing applications, and also identifies those potential activities that would require site-specific SEQRA determinations of significance after the SGEIS is completed. Specifically, Chapter 3 states that site-specific environmental assessments and SEQRA determinations of significance would be required for the following types of high-volume hydraulic fracturing applications, regardless of the target formation, the number of wells drilled on the pad and whether the wells are vertical or horizontal:

1) Any proposed high-volume hydraulic fracturing where the top of the target fracture zone is shallower than 2,000 feet along a part of the proposed length of the wellbore;

2) Any proposed high-volume hydraulic fracturing where the top of the target fracture zone at any point along the entire proposed length of the wellbore is less than 1,000 feet below the base of a known fresh water supply;

3) Any proposed well pad within the boundaries of a principal aquifer, or outside but within 500 feet of the boundaries of a principal aquifer;

4) Any proposed well pad within 150 feet of a perennial or intermittent stream, storm drain, lake or pond;

5) A proposed surface water withdrawal that is found not to be consistent with the Department's preferred passby flow methodology as described in Chapter 7; and

6) Any proposed well location determined by the New York City Department of Environmental Protection (NYCDEP) to be within 1,000 feet of its subsurface water supply infrastructure.

In all of the aforementioned circumstances a site-specific SEQRA assessment is required because such application is either beyond the scope of the analyses contained in this draft SGEIS or the Department has determined that proposed activities in these areas raise environmental issues that necessitate a site-specific review.

Chapter 3 also identifies the Department's oil and gas well regulations, located at 6 NYCRR Part 550, and it discusses the existence of other regulations and mitigation measures described in this draft SGEIS related to high-volume hydraulic fracturing. For a number of these measures, the Department will propose revisions or additions to its regulations. This chapter discusses how proposed revisions and additions to regulations are part of the environmental review of this draft SGEIS and how the State Administrative Procedure Act process for rulemaking will consider additional impacts of these regulatory actions. These two processes will ensure full review of the proposed environmental controls for high-volume hydraulic fracturing.

Chapter 4 - Geology

Chapter 4 supplements the geology discussion in the 1992 GEIS (Chapter 5) with additional details about the Marcellus and Utica Shales, seismicity in New York State, naturally occurring radioactive materials (NORM) in the Marcellus Shale and naturally occurring methane in New York State. Chapter 4 does not contain significant revisions or additions from the 2009 dSGEIS.

Chapter 5 - Natural Gas Development Activities & High-Volume Hydraulic Fracturing

This Chapter comprehensively describes the activities associated with high-volume hydraulic fracturing and multi-well pad drilling, including the composition of hydraulic fracturing additives and flowback water characteristics. It is based on the most recent up-to-date description of proposed activities provided by industry and informed by high-volume hydraulic fracturing operations currently ongoing in Pennsylvania and elsewhere. In this Chapter, the average disturbance associated with a multi-well pad, access road and proportionate infrastructure during the drilling and fracturing stage is estimated at 7.4 acres, compared to the

average disturbance associated with a well pad for a single vertical well during the drilling and fracturing stage, which is estimated at 4.8 acres. As a result of required partial reclamation, the average well pad would generally be reduced to averages of about 5.5 acres and 4.5 acres, respectively, during the production phase.

This Chapter describes the process for constructing access roads, and observes that because most shale gas development would consist of several wells on a multi-well pad, more than one well would be serviced by a single access road instead of one well per access road as was typically the case when the 1992 GEIS was prepared. Therefore, in areas developed by horizontal drilling using multi-well pads, it is expected that fewer access roads as a function of the number of wells would be constructed. Industry estimates that 90% of the wells used to develop the Marcellus Shale would be horizontal wells located on multi-well pads. This method provides the most flexibility to avoid environmentally sensitive locations within the acreage to be developed.

With respect to overall land disturbance from a horizontal drilling, there would be a larger surface area used for an individual multi-well pad. This would be more than offset, however, by the fewer total number of well pads required within a given area and the need for only a single access road and gas gathering system to service multiple wells on a single pad. Overall, there clearly is a smaller total area of land disturbance associated with horizontal wells for shale gas development than that for vertical wells. For example, a spacing of 40 acres per well for vertical shale gas wells would result in, on average, 70 – 80 acres of disturbance for the well pads, access roads and utility corridors (4.8 acres per well) to develop an area of 640 acres. A single well pad with 6 to 8 horizontal shale gas wells could access all 640 acres with only 7 to 8 acres of total land disturbance.

Chapter 5 describes the constituents of drilling mud and the containment of drilling cuttings, through either a lined on-site reserve pit or in a closed-loop tank system. This Chapter also calculates the projected volume of cuttings and the potential for such cuttings to contain NORM.

This Chapter also discusses the hydraulic fracturing process, the composition of fracturing fluid, on-site storage and handling and transport of fracturing additives. The high-volume hydraulic fracturing process involves the controlled use of water and chemical additives, pumped under

pressure into the cased and cemented wellbore. To protect fresh water zones and isolate the target hydrocarbon-bearing zone, hydraulic fracturing does not occur until after the well is cased and cemented, and typically after the drilling rig and its associated equipment are removed from the well pad. Chapter 5 explains that the Department would generally require at least three strings of cemented casing in the well during fracturing operations. The outer string (i.e., surface casing) would extend below fresh ground water and would have been cemented to the surface before the well was drilled deeper. The intermediate casing string, also called protective string, is installed between the surface and production strings. The innermost casing string (i.e., production casing) typically extends from the ground surface to the toe of the horizontal well.

The fluid used for high-volume hydraulic fracturing is typically comprised of more than 98% fresh water and sand, with chemical additives comprising 2% or less of the fluid. The Department has collected compositional information on many of the additives proposed for use in fracturing shale formations in New York directly from chemical suppliers and service companies and those additives are identified and discussed in detail in Chapter 5. It is estimated that 2.4 million to 7.8 million gallons of water may be used for a multi-stage hydraulic fracturing procedure in a typical 4,000-foot lateral wellbore. Water may be delivered by truck or pipeline directly from the source to the well pad, or may be delivered by trucks or pipeline from centralized water storage or staging facilities consisting of tanks or engineered impoundments.

After the hydraulic fracturing procedure is completed and pressure is released, the direction of fluid flow reverses. The well is “cleaned up” by allowing water and excess proppant (typically sand) to flow up through the wellbore to the surface. Both the process and the returned water are commonly referred to as “flowback.” Chapter 5 discusses the volume, characteristics, recycling and disposal of flowback water. The dSGEIS estimates flowback water volume to range from 216,000 gallons to 2.7 million gallons per well, based on a pumped fluid estimate of 2.4 million to 7.8 million gallons.

Finally, Chapter 5 provides estimates of potential gas production from high-volume hydraulic fracturing operations and also discusses waste disposal associated with high-volume hydraulic fracturing operations, including disposal of cuttings, flowback and production brine

Chapter 6 – Potential Environmental Impacts

This chapter identifies and evaluates the potential significant adverse impacts associated with high-volume hydraulic fracturing operations and, like other chapters, should be read as a supplement to the 1992 GEIS.

Water Resources Impacts

Potential significant adverse impacts on water resources exist with regard to water withdrawals for hydraulic fracturing; stormwater runoff; surface spills, leaks and pit or surface impoundment failures; groundwater impacts associated with well drilling and construction; waste disposal and New York City's subsurface water supply infrastructure. During the public scoping process, additional concerns were raised relating to the potential degradation of New York City's surface drinking water supply and potential groundwater contamination from the hydraulic fracturing procedure itself.

Water for hydraulic fracturing may be obtained by withdrawing it from surface water bodies away from the well site or through new or existing water-supply wells drilled into aquifers. Chapter 6 concludes that, without proper controls on the rate, timing and location of such water withdrawals, the cumulative impacts of such withdrawals could cause modifications to groundwater levels, surface water levels, and stream flow that could result in significant adverse impacts, including but not limited to impacts to the aquatic ecosystem, downstream river channel and riparian resources, wetlands, and aquifer supplies.

Using an industry estimate of a yearly peak activity in New York of 2,462 wells, the dSGEIS estimates that high-volume hydraulic fracturing would result in a calculated peak *annual* fresh water usage of 9 billion gallons. Total *daily* fresh water withdrawal in New York has been estimated at about 10.3 billion gallons. This equates to an annual total of about 3.8 trillion gallons. Based on this calculation, at peak activity high-volume hydraulic fracturing would result in increased demand for fresh water in New York of 0.24%. Thus, water usage for high-volume hydraulic fracturing represents a very small percentage of water usage throughout the state. Nevertheless, as noted, the cumulative impact of water withdrawals, if such withdrawals

were temporally proximate and from the same water resource, could potentially be significant. The mitigation measures to ensure that such impacts are prevented are described in Chapter 7, summarized below.

Chapter 6 also describes the potential impacts on water resources from stormwater flow associated with the construction and operation of high-volume hydraulic fracturing well pads. All phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed. Proposed mitigation measures to prevent significant adverse impacts from stormwater runoff are described in Chapter 7.

The dSGEIS concludes that spills or releases in connection with high-volume hydraulic fracturing could have significant adverse impacts on water resources. The dSGEIS identifies a significant number of contaminants contained in fracturing additives, or otherwise associated with high-volume hydraulic fracturing operations. Spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, or improper operations. Spilled, leaked or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers. Proposed mitigation measures to prevent significant adverse impacts from spills and releases are described in Chapter 7.

Chapter 6 also assesses the potential significant adverse impacts on groundwater resources from well drilling and construction associated with high-volume hydraulic fracturing. Those potential impacts include impacts from turbidity, fluids pumped into or flowing from rock formations penetrated by the well, and contamination from natural gas present in the rock formations penetrated by the well. The dSGEIS concludes that these potential impacts are not unique to horizontal wells or high-volume hydraulic fracturing and are described and fully assessed in the 1992 GEIS. Nevertheless, because of the concentrated nature of the activity on multi-well pads and the larger fluid volumes and pressures associated with high-volume hydraulic fracturing, enhanced procedures and mitigation measures are proposed and described in Chapter 7.

A supporting study for this dSGEIS concludes that it is highly unlikely that groundwater contamination would occur by fluids escaping from the wellbore for hydraulic fracturing. The 2009 dSGEIS further observes that regulatory officials from 15 states recently testified that groundwater contamination as a result of the hydraulic fracturing process in the tight formation itself has not occurred.

The dSGEIS explains that the potential migration of natural gas to a water well, which presents a safety hazard because of its combustible and asphyxiant nature, especially if the natural gas builds up in an enclosed space such as a well shed, house or garage, was fully addressed in the 1992 GEIS. Well construction associated with high-volume hydraulic fracturing presents no new significant adverse impacts with regard to potential gas migration. Gas migration is a result of poor well construction (i.e., casing and cement problems). As with all gas drilling, well construction practices mandated in New York are designed to prevent gas migration. Those practices would also minimize the risk of migration of other formation fluids such as oil or brine.

The dSGEIS acknowledges that migration of naturally-occurring methane from wetlands, landfills and shallow bedrock can also contaminate water supplies independently or in the absence of any nearby oil and gas activities. Section 4.7 of this dSGEIS explains how the natural occurrence of shallow methane in New York can affect water wells unrelated to natural gas development.

Chapters 5 and 6 contain analyses that demonstrate that no significant adverse impact to water resources is likely to occur due to underground vertical migration of fracturing fluids through the shale formations. The developable shale formations are vertically separated from potential freshwater aquifers by at least 1,000 feet of sandstones and shales of moderate to low permeability. In fact, most of the bedrock formations above the Marcellus Shale are other shales. That shales must be hydraulically fractured to produce fluids is evidence that these types of rock formations do not readily transmit fluids. The high salinity of native water in the Marcellus and other Devonian shales is evidence that fluid has been trapped in the pore spaces for hundreds of millions of years, implying that there is no mechanism for discharge of fluids to other formations.

Hydraulic fracturing is engineered to target the prospective hydrocarbon-producing zone. The induced fractures create a pathway to the intended wellbore, but do not create a discharge mechanism or pathway beyond the fractured zone where none existed before. The pressure differential that pushes fracturing fluid into the formation is diminished once the rock has fractured, and is reversed toward the wellbore during the flowback and production phases. Accordingly, there is no likelihood of significant adverse impacts from the underground migration of fracturing fluids.

No significant adverse impacts are identified with regard to the disposal of liquid wastes. Drilling and fracturing fluids, mud-drilled cuttings, pit liners, flowback water and produced brine, although classified as non-hazardous industrial waste, must be hauled under a New York State Part 364 waste transporter permit issued by the Department. Furthermore, as discussed in Chapter 7, any environmental risk posed by the improper discharge of liquid wastes would be addressed through the institution of a waste tracking procedure similar to that which is required for medical waste, even though the hazards are not equivalent. Another concern relates to potential spills as a result of trucking accidents. Information about traffic management related to high-volume hydraulic fracturing is discussed in Chapter 7.

The disposal of flowback water could cause a significant adverse impact if the wastewater was not properly treated prior to disposal. Residual fracturing chemicals and naturally-occurring constituents from the rock formation could be present in flowback water and could result in treatment, sludge disposal, and receiving-water impacts. Salts and dissolved solids may not be sufficiently treated by municipal biological treatment and/or other treatment technologies which are not designed to remove pollutants of this nature. Mitigation measures have been identified that would eliminate any potential significant adverse impact from flowback water or treatment of other liquid wastes associated with high-volume hydraulic fracturing.

The Department is not proposing to alter its 1992 GEIS Finding that proposed disposal wells require individual site-specific review under SEQRA. Therefore, the potential for significant adverse environmental impacts from any proposal to inject flowback water from high-volume hydraulic fracturing into a disposal well would be reviewed on a site-specific basis with

consideration to local geology (including faults and seismicity), hydrogeology, nearby wellbores or other potential conduits for fluid migration and other pertinent site-specific factors.

The 1992 GEIS summarized the potential impacts of flood damage relative to mud or reserve pits, brine and oil tanks, other fluid tanks, brush debris, erosion and topsoil, bulk supplies (including additives) and accidents. Those potential impacts are equally applicable to high-volume hydraulic fracturing operations. Severe flooding is described as one of the few ways that bulk supplies such as additives "might accidentally enter the environment in large quantities." Mitigation measures to ensure that significant adverse impacts from floods do not occur in connection with high-volume hydraulic fracturing operations are identified and recommended in Chapter 7.

Gamma ray logs from deep wells drilled in New York over the past several decades show the Marcellus Shale to be higher in radioactivity than other bedrock formations including other potential reservoirs that could be developed by high-volume hydraulic fracturing. However, based on the analytical results from field-screening and gamma ray spectroscopy performed on samples of Marcellus Shale NORM levels in cuttings are not significant because the levels are similar to those naturally encountered in the surrounding environment. As explained in Chapter 5, the total volume of drill cuttings produced from drilling a horizontal well may be about 40% greater than that for a conventional, vertical well. For multi-well pads, cuttings volume would be multiplied by the number of wells on the pad. The potential water resources impact associated with the greater volume of drill cuttings from multiple horizontal well drilling operations would arise from the retention of cuttings during drilling, necessitating a larger reserve pit that may be present for a longer period of time, unless the cuttings are directed into tanks as part of a closed-loop tank system.

Impacts on Ecosystems and Wildlife

The dSGEIS has been revised to expand the analysis of the potential significant adverse impacts on ecosystems and wildlife from high-volume hydraulic fracturing operations. Four areas of concern related to high-volume hydraulic fracturing are: (1) fragmentation of habitat; (2)

potential transfer of invasive species; (3) impacts to endangered and threatened species; and (4) use of state-owned lands.

The dSGEIS concludes that high-volume hydraulic fracturing operations would have a significant impact on the environment because such operations have the potential to draw substantial development into New York, which would result in unavoidable impacts to habitats (fragmentation, loss of connectivity, degradation, etc.), species distributions and populations, and overall natural resource biodiversity. Habitat loss, conversion, and fragmentation (both short-term and long-term) would result from land grading and clearing, and the construction of well pads, roads, pipelines, and other infrastructure associated with gas drilling. Partial mitigation of such impacts is identified in Chapter 7.

The number of vehicle trips associated with high-volume hydraulic fracturing, particularly at multi-well sites, has been identified as an activity which presents the opportunity to transfer invasive terrestrial species. Surface water withdrawals also have the potential to transfer invasive aquatic species. The introduction of terrestrial and aquatic invasive species would have a significant adverse impact on the environment.

State-owned lands play a unique role in New York's landscape because they are managed under public ownership to allow for sustainable use of natural resources, provide recreational opportunities for all New Yorkers, and provide important wildlife habitat and open space. Given the level of development expected for multi-pad horizontal drilling, the dSGEIS anticipates that there would be additional pressure for surface disturbance on State lands. Surface disturbance associated with gas extraction could have an impact on habitats on State lands, and recreational use of those lands, especially large contiguous forest patches that are valuable because they sustain wide-ranging forest species, and provide more habitat for forest interior species.

The area underlain by the Marcellus Shale includes both terrestrial and aquatic habitat for 18 animal species listed as endangered or threatened in New York State that are protected under the State Endangered Species Law (ECL 11-0535) and associated regulations (6 NYCRR Part 182). Endangered and threatened wildlife may be adversely impacted through project actions such as clearing, grading and road building that occur within the habitats that they occupy. Certain

species are unable to avoid direct impact due to their inherent poor mobility (e.g., Blanding's turtle, club shell mussel). Certain actions, such as clearing of vegetation or alteration of stream beds, can also result in the loss of nesting and spawning areas.

Mitigation for potentially significant adverse impacts from potential transfer of invasive species or from use of State lands, and mitigation for potential impacts to endangered and threatened species is identified in Chapter 7.

Impacts on Air Resources

Chapter 6 of the dSGEIS provides a comprehensive list of federal and New York State regulations that apply to potential air emissions and air quality impacts associated with the drilling, completion (hydraulic fracturing and flowback) and production phases (processing, transmission and storage). The revised Chapter includes a regulatory assessment of the various air pollution sources and the air permitting process, as well as a supplemental analysis of impacts not addressed in the 2009 dSGEIS. The review of potential air impacts and expanded analyses accounts for information acquired subsequent to the initial review.

As part of the Department's effort to address the potential air quality impacts of horizontal drilling and hydraulic fracturing activities in the Marcellus Shale and other low-permeability gas reservoirs, an air quality modeling analysis was undertaken by DEC's Division of Air Resources (DAR). The analysis identifies the emission sources involved in well drilling, completion and production, and the analysis of source operations for purposes of assessing compliance with applicable air quality standards.

Since September 2009 industry has provided information that: (1) simultaneous drilling and completion operations at a single pad would not occur; (2) the maximum number of wells to be drilled at a pad in a year would be four in a 12-month period; and (3) centralized flowback impoundments, which are large volume, lined ponds that function as fluid collection points for multiple wells, are not contemplated. Based on these operational restrictions, the Department revised the limited modeling of 24 hour PM2.5 impacts and conducted supplemental air quality modeling to assess standards compliance and air quality impacts. In addition, the Department conducted supplemental modeling to account for the promulgation of new 1 hour SO_2 and NO_2

National Ambient Air Quality Standards (NAAQS) after September 2009. The results of this supplemental modeling indicate the need for the imposition of certain control measures to achieve the NO_2 and PM2.5 NAAQS. These measures, along with all other restrictions reflecting industry's proposed operational restrictions and recommended mitigation measures based on the modeling results, are detailed in Section 7.5.3 of the dSGEIS as proposed operation conditions to be included in well permits. The Department also developed an air monitoring program to fully address potential for adverse air quality impacts beyond those analyzed in the dSGEIS, which are either not fully known at this time or not verifiable by the assessments to date. The air monitoring plan would help determine and distinguish both the background and drilling related concentrations of pertinent pollutants in the ambient air.

Air quality impact mitigation measures are further discussed in Chapter 7 of the dSGEIS, including a detailed discussion of pollution control techniques, various operational scenarios and equipment that can be used to achieve regulatory compliance, and mitigation measures for well pad operations. In addition, measures to reduce benzene emissions from glycol dehydrators and formaldehyde emissions from off-site compressor stations are provided.

Greenhouse Gas Emission Impacts

All operational phases of proposed well pad activities were considered, and resulting greenhouse gas (GHG) emissions determined in the dSGEIS. Emission estimates of carbon dioxide (CO_2) and methane (CH_4) are included as both short tons and as carbon dioxide equivalents (CO_2e) expressed in short tons for expected exploration and development of the Marcellus Shale and other low-permeability gas reservoirs using high-volume hydraulic fracturing. The Department not only quantified potential GHG emissions from activities, but also identified and characterized major sources of CO_2 and CH_4 during anticipated operations so that key contributors of GHGs with the most significant Global Warming Potential (GWP) could be addressed and mitigated, with particular emphasis placed on mitigating CH_4, with its greater GWP.

Socioeconomic Impacts

To assess the potential socioeconomic impacts of high-volume hydraulic fracturing, including the potential impacts on population, employment and housing, three representative regions were selected. The three regions were selected to evaluate how high-volume hydraulic fracturing might impact areas with different production potential, different land use patterns, and different levels of experience with natural gas well development. Region A consists of Broome, Chemung and Tioga County. Region B consists of Delaware, Otsego and Sullivan County, and Region C consists of Cattaraugus and Chautauqua County. Using a low and average rate of development based on industry estimates, high-volume hydraulic fracturing will have a significant positive economic effect where the activity takes place. At the maximum rate of well construction, total direct construction employment is predicted to range from 4,408 construction jobs under the low development scenario to 17,634 jobs under the average scenario. An additional 29,174 jobs are predicted to result indirectly from the introduction of high-volume hydraulic fracturing statewide.

There will also be positive impacts on income levels in the state as a result of high-volume hydraulic fracturing. When well construction reaches its maximum levels, total annual construction earnings are projected to range from $298.4 million under the low development scenario to nearly $1.2 billion under the average development scenario. Employee earnings from operational employment are expected to range from $121.2 million under the low development scenario to $484.8 million under the average development scenario in Year 30. Indirect employee earnings are anticipated to range from $202.3 million under the low development scenario to $809.2 million under the average development scenario in Year 30. The total direct and indirect impacts on employee earnings are projected to range from $621.9 million to $2.5 billion per year at peak production and construction levels in Year 30. Chapter 6 details how the potential job creation and employee earnings might be distributed across the three representative regions.

Chapter 6 also assesses the potential temporary and permanent population impacts on each of the three selected regions, finding that Region A will experience an estimated 1.4% increase in the

region's total population the first decade after high-volume hydraulic fracturing in introduced. Region C is projected to be more modestly impacted by high-volume hydraulic fracturing.

While providing positive impacts in the areas of employment and income, high-volume hydraulic fracturing could cause adverse impacts on the availability of housing, especially temporary housing such as hotels and motels. In Region A, where the use of high-volume hydraulic fracturing is expected to be initially concentrated, there could be shortages of rental housing. High-volume hydraulic fracturing would also bring both positive and negative impacts on state and local government spending. Increased activity will result in large increases in local tax revenues and increases in the receipt of production royalties but would also result in an increased demand for local services, including emergency response services.

Visual, Noise and Community Character Impacts

The construction of well pads and wells associated with high-volume hydraulic fracturing will result in temporary, but adverse impacts relating to noise. In certain areas the construction activity would also result in temporary visual impacts. Mitigation measures to address such impacts are summarized in Chapter 7.

The cumulative impact of well construction activity and related truck traffic would cause impacts on the character of the rural communities where much of this activity would take place. Methods to control simultaneous development within a specific area are discussed in Chapter 7.

Transportation Impacts

The introduction of high-volume hydraulic fracturing has the potential to generate significant truck traffic during the construction and development phases of the well. These impacts would be temporary, but the cumulative impact of this truck traffic has the potential to result in significant adverse impacts on local roads and, to a lesser extent, state roads where truck traffic from this activity is concentrated. It is not feasible to conduct a detailed traffic assessment given that the precise location of well pads is unknown at this time. However, such traffic has the potential to damage roads. Chapter 7 discusses the potential mitigation measures to address such impacts, including the requirement that the applicant develop a Transportation Plan that sets

forth proposed truck routes, surveys road conditions along those routes and requires local road use agreements to address any impacts on local roads.

Additional NORM Concerns

Based upon currently available information it is anticipated that flowback water would not contain levels of NORM of significance, whereas production brine could contain elevated NORM levels. Although the highest concentrations of NORM are in produced waters, it does not present a risk to workers because the external radiation levels are very low. However, the build-up of NORM in pipes and equipment (pipe scale and sludge) has the potential to cause a significant adverse impact because it could expose workers handling (cleaning or maintenance) the pipe to increased radiation levels. Also, wastes from the treatment of production waters may contain concentrated NORM and, if so, controls would be required to limit radiation exposure to workers handling this material as well as to ensure that this material is disposed of in accordance with applicable regulatory requirements.

Seismicity

There is a reasonable base of knowledge and experience related to seismicity induced by hydraulic fracturing. Information reviewed indicates that there is essentially no increased risk to the public, infrastructure, or natural resources from induced seismicity related to hydraulic fracturing. The microseisms created by hydraulic fracturing are too small to be felt, or to cause damage at the ground surface or to nearby wells. Accordingly, no significant adverse impacts from induced seismicity are expected to result from high-volume hydraulic fracturing operations.

Chapter 7 – Mitigation Measures

This Chapter describes the measures the Department has identified that, if implemented, would eliminate or mitigate potentially significant adverse impacts from high-volume hydraulic fracturing operations. A number of significant, new mitigation measures not contained in the 2009 dSGEIS have been identified as follows.

No High-Volume Hydraulic Fracturing Operations in the New York City and Syracuse Watersheds

In April 2010 the Department concluded that due to the unique issues presented by high-volume hydraulic fracturing operations within the drinking watersheds for the City of New York and Syracuse, the SGEIS would not apply to activities in those watersheds. Those areas present unique issues that primarily stem from the fact that they are unfiltered water supplies that depend on strict land use and development controls to ensure that water quality is protected.

The revised analysis of high-volume hydraulic fracturing operations in the revised dSGEIS concludes that the proposed high-volume hydraulic fracturing activity is not consistent with the preservation of these watersheds as an unfiltered drinking water supply. Even with all of the criteria and conditions identified in this dSGEIS, a risk remains that significant high-volume hydraulic fracturing activities in these areas could result in a degradation of drinking water supplies from accidents, surface spills, etc. Moreover, such large scale industrial activity in these areas, even without spills, could imperil EPA's Filtration Avoidance Determinations and result in the affected municipalities incurring substantial costs to filter their drinking water supply. Accordingly, this dSGEIS supports a finding that site disturbance relating to high-volume hydraulic fracturing operations not be permitted in the Syracuse and New York City watersheds or in a protective 4,000 foot buffer area around those watersheds.

No High-Volume Hydraulic Fracturing Operations on Primary Aquifers

Although not subject to Filtration Avoidance Determinations, 18 other aquifers in the State of New York have been identified by the New York State Department of Health as highly productive aquifers presently utilized as sources of water supply by major municipal water supply systems and are designated as "primary aquifers." Because these aquifers are the primary source of drinking water for many public drinking water supplies, the Department recommends in this dSGEIS that site disturbance relating to high-volume hydraulic fracturing operations should not be permitted there either or in a protective 500-foot buffer area around them. Horizontal extraction of gas resources underneath primary aquifers from well pads located outside this area would not significantly impact this valuable water resource.

No High-Volume Hydraulic Fracturing Operations on Certain State Lands

This dSGEIS supports a finding that site disturbance relating to high-volume hydraulic fracturing operations should not be permitted on certain State lands because it is inconsistent with the purposes for which those lands have been acquired. In addition, precluding site disturbance on certain State lands would partially mitigate the significant adverse impacts from habitat fragmentation on forest lands due to high-volume hydraulic fracturing activity. It would preclude the loss of such habitat in the protected State land areas which represent some of the largest contiguous forest patches where high-volume hydraulic fracturing activity could occur. Horizontal extraction of gas resources underneath State lands from well pads located outside this area would not significantly impact this valuable habitat on forested State lands.

No High-Volume Hydraulic Fracturing Operations on Principal Aquifers Without Site-Specific Environmental Review

Principal Aquifers are aquifers known to be highly productive or whose geology suggests abundant potential water supply, but which are not intensively used as sources of water supply by major municipal systems at the present time. In order to mitigate the risk of significant adverse impacts on these important water resources from the risk of surface discharges from high-volume hydraulic fracturing well pads, the dSGEIS proposes that for at least two years from issuance of the final SGEIS, applications for high-volume hydraulic fracturing operations at any surface location within the boundaries of principal aquifers, or outside but within 500 feet of the boundaries of principal aquifers, would require (1) site-specific SEQRA determinations of significance and (2) individual SPDES permits for storm water discharges. The dSGEIS proposes the Department re-evaluate the necessity of this restriction after two years of experience issuing permits in areas outside of the 500-foot boundary.

No High-Volume Hydraulic Fracturing Operations within 2,000 feet of Public Drinking Water Supplies

The dSGEIS seeks to mitigate the risk of significant adverse impacts on water resources from the risk of surface discharges from high-volume hydraulic fracturing well pads by proposing that high-volume hydraulic fracturing operations at any surface location within 2,000 feet of public water supply wells, river or stream intakes and reservoirs should not be permitted. The dSGEIS

proposes that the Department re-evaluate the necessity of this approach after three years of experience issuing permits in areas outside of this setback.

No High-Volume Hydraulic Fracturing Operations in Floodplains or Within 500 Feet of Private Water Wells

In order to address potential significant adverse impacts due to flooding, the dSGEIS supports a finding that the Department not issue permits for high-volume hydraulic fracturing operations at any well pad that is wholly or partially within a 100-year floodplain. In order to ensure that there are no impacts on drinking water supplies from high-volume hydraulic fracturing operations, the dSGEIS also supports a finding that no permits be issued for any well pad located within 500 feet of a private water well or domestic use spring, unless waived by the landowner.

Mandatory Disclosure of Hydraulic Fracturing Additives and Alternatives Analysis

The dSGEIS identifies by chemical name and Chemical Abstract Services (CAS) number, 322 chemicals proposed for use for high-volume hydraulic fracturing in New York. Chemical usage was reviewed by NYSDOH, which provided health hazard information that is presented in the document. In response to public concerns relating to the use of hydraulic fracturing additives and their potential impact on water resources, this dSGEIS adds a new requirement that operators evaluate the use of alternative hydraulic fracturing additive products that pose less potential risk to water resources. In addition, in the EAF addendum a project sponsor must disclose all additive products it proposes to use, and provide Material Safety Data Sheets for those products, so that the appropriate remedial measures can be imposed if a spill occurs. The Department will publicly disclose the identities of hydraulic fracturing fluid additive products and their Material Safety Data Sheets, provided that information which meets the confidential business information exception to the Department's records access program will not be subject to public disclosure.

Enhanced Well Casing

In order to mitigate the risk of significant adverse impacts to water resources from the migration of gas or pollutants in connection with high-volume hydraulic fracturing operations, the dSGEIS adds a requirement for a third cemented "string" of well casing around the gas production wells

in most situations. This enhanced casing specification is designed to specifically address concerns over migration of gas into aquifers.

Required Secondary Containment and Stormwater Controls

In order to mitigate the risk of a significant adverse impact to water resources from spills of chemical additives, hydraulic fracturing fluid or liquid wastes associated with high-volume hydraulic fracturing, secondary containment, spill prevention and storm water pollution prevention are comprehensively addressed for all stages of well pad development. The dSGEIS supports the Department's proposal for a new stormwater general permit for gas drilling operations that would address potential stormwater impacts associated with high-volume hydraulic fracturing operations.

Conditions Related to Disposal of Wastewater and Solid Waste

As provided in the 2009 dSGEIS, to ensure that wastewater from high-volume hydraulic fracturing operation is properly disposed, the Department proposes to require that before any permit is issued the operator have Department-approved plans in place for disposing of flowback water and production brine. In addition, the Department proposes to require a tracking system, similar to what is in place for medical waste, for all liquid and solid wastes generated in connection with high-volume hydraulic fracturing operations.

The dSGEIS also proposes to expand its proposed requirement for closed-loop drilling in order to ensure that no significant adverse impacts related to the disposal of pyrite-rich Marcellus Shale cuttings on-site.

Air Quality Control Measures and Mitigation for Greenhouse Gas Emissions

The dSGEIS identifies additional mitigation measures designed to ensure that emissions associated with high-volume hydraulic fracturing operations do not result in the exceedance of any NAAQS. In addition, the Department has committed to implement local and regional level air quality monitoring at well pads and surrounding areas.

The dSGEIS also identifies mitigation measures that can be required through permit conditions and possibly new regulations to ensure that high-volume hydraulic fracturing do not result in significant adverse impacts relating to climate change. The dSGEIS proposes to require a greenhouse gas emission impacts mitigation plan (the Plan). The Plan must include: a list of best management practices for GHG emission sources for implementation at the permitted well site; a leak detection and repair program; use of EPA's Natural Gas Star best management practices for any pertinent equipment; use of reduced emission completions that provide for the recovery of methane instead of flaring whenever a gas sales line and interconnecting gathering line are available; and a statement that the operator would provide the Department with a copy of the report filed with EPA to meet the GHG Reporting Rule.

Mitigation for Loss of Habitat and Impacts on Wildlife

In order to further mitigate significant adverse impacts on wildlife habitat caused by fragmentation of forest and grasslands on private land, the Department proposes to require that surface disturbance in contiguous forest patches of 150 acres or more and contiguous grassland patches of 30 acres or more within specified Forest and Grassland Focus areas, respectively, be contingent upon site-specific ecological assessments conducted by the permit applicant and implementation of best management practices identified through such assessments.

Other Control Measures

Other important existing and anticipated regulatory requirements and/or permit conditions that would be imposed to ensure that high-volume hydraulic fracturing operations do not cause significant impacts on the environment in New York include:

- Before a permit is issued, Department staff would review the proposed layout of the well site based on analysis of application materials and a site visit. Risky site plans would either not be approved or would be subject to enhanced site-specific construction requirements.

- The Department's staff reviews the proposed casing and cementing plan for each well prior to permit issuance. Permits are not issued for improperly designed wells, and in

the case of high-volume hydraulic fracturing, the as-built wellbore construction would be verified before the operation is allowed to proceed.

- The current dSGEIS proposes to require in most cases fully cemented intermediate casing, with the setting depths of both surface and intermediate casing determined by site-specific conditions.

- Fracturing equipment components would be pressure tested with fresh water, mud or brine prior to the introduction of chemical additives.

- The current dSGEIS requires pressure testing of blowout prevention equipment, the use of at least two mechanical barriers that can be tested, the use of specialized equipment designed for entering the wellbore when pressure is anticipated, and the on-site presence of a certified well control specialist.

- Flowback water stored on-site must use covered watertight tanks within secondary containment and the fluid contained in the tanks must be removed from the site within certain time periods.

- The Department has a robust permitting and approval process in place to address any proposals to discharge flowback water or production brine to wastewater treatment plants. The Department would require that before any permit is issued the operator have Department-approved plans in place for disposing of flowback water and production brine. Permission to treat such wastewater at a treatment plant in New York State would not be granted without a demonstrable showing that such wastewater can be properly treated at the plant. Additionally, the Department anticipates that operators would favor reusing flowback water for subsequent fracturing operations as they are now doing in Pennsylvania, so that disposal of flowback would be minimized.

- The Department would require that a Transportation Plan be developed and included with any permit application. That plan would include proposed truck routes and an assessment of road conditions along such routes. Any local road use agreement(s)

would have to be disclosed and the applicant would have to demonstrate that the roads to be used are sufficient to accommodate the proposed truck traffic.

- The Department would consult with local governments and, where appropriate, place limits on the number of wells and/or well pads that can be constructed in a specific area at a single time in order to mitigate potential adverse impacts on community character, tourism and other potential socioeconomic impacts that could result from a concentration of well construction activity in a short period of time within a confined area.

- The Department would also impose measures designed to reduce adverse noise or visual impacts from well construction.

Chapter 8 – Permit Process and Regulatory Coordination

This Chapter explains inter- and intra-agency coordination relative to the well permit process, including the role of local governments and a revised approach to local government notification and consideration of potential impacts of high-volume hydraulic fracturing operations on local land use laws and policies. Unlike the 2009 dSGEIS, the current draft Supplement supports a condition that local governments be given notice in writing of all high-volume hydraulic fracturing applications in the locality. A continuously updated database of local government officials and an electronic notification system would be developed for this purpose.

In addition, the EAF Addendum would require the project sponsor to identify whether the proposed location of the well pad, or any other activity under the jurisdiction of the Department, conflicts with local land use laws or regulations, plans or policies. The project sponsor would also be required to identify whether the well pad is located in an area where the affected community has adopted a comprehensive plan or other local land use plan and whether the proposed action is inconsistent with such plan(s). Where the project sponsor indicates that the location of the well pad, or any other activity under the jurisdiction of the Department, is either consistent with local land use laws, regulations, plans or policies, or is not covered by such local land use laws, regulations, plans or policies, no further review of local land use laws and policies would be required.

In cases where a project sponsor indicates that all or part of their proposed application is inconsistent with local land use laws, regulations, plans or policies, or where the potentially impacted local government advises the Department that it believes the application is inconsistent with such laws, regulations, plans or policies, the Department intends to request additional information in the permit application process to determine whether this inconsistency raises significant adverse environmental impacts that have not been addressed in the SGEIS.

Chapter 9 – Alternative Actions

Chapter 9 discusses the alternatives to well permit issuance that were reviewed and considered by the Department. Chapter 21 of the 1992 GEIS and the 1992 Findings Statement discussed a range of alternatives concerning oil and gas resource development in New York State that included both its prohibition and the removal of oil and gas industry regulation. Regulation as described by the GEIS was found to be the best alternative.

The dSGEIS considers a range of alternatives to the proposed approach for regulating and authorizing high-volume hydraulic fracturing operations in New York. As required by SEQRA, the dSGEIS considers the no action alternative. The Department finds that the no action alternative would not result in any of the significant adverse impacts identified herein, but would also not result in the significant economic and other benefits identified with natural gas drilling by this method. The Department believes that this alternative is not preferable because significant adverse impacts from high-volume hydraulic fracturing operations can be fully or partially mitigated.

The alternatives analysis also considers the use of a phased-permitting approach to developing the Marcellus Shale and other low permeability gas reservoirs, including consideration of limiting and/or restricting resource development in designated areas. As discussed above, the Department proposes to partially adopt this alternative by restricting resource development in the New York City and Syracuse watersheds (plus buffer), public water supplies, primary aquifers and certain state lands. In addition, restrictions and setbacks relating to development in other areas near public water supplies, principal aquifers and other resources as outlined above are recommended. The Department does not believe that resource development should be further

limited by imposing an annual limit on permits issued for high-volume hydraulic fracturing operations. The Department believes any such annual limit would be arbitrary. Rather, the Department proposes to limit permit issuance to match the Department resources that are made available to review and approve permit applications, and to adequately inspect well pads and enforce permit conditions and regulations. Although it is not possible to predict the number of permit applications that will be submitted in any given area, and therefore proscribe the level of activity that any one operator may undertake in those areas, the Department has the ability to respond and adjust to conditions in the field. If it is demonstrated, for example, that the measures in place to mitigate noise impacts do not adequately address the impact of high-volume hydraulic fracturing on a host community, the department retains the option through the permitting process to impose additional conditions on operations, such as phasing of drilling operations on adjacent well pads, to prevent or mitigate cumulative or simultaneous operations from impacting nearby residents.

The dSGEIS also contains a review and analysis of the development and use of "green" or non-chemical fracturing alternatives. The Department finds that the use of environmentally-friendly or "green chemicals" would proceed based on the characteristics of the Marcellus Shale play and other shale plays across the United States, as well as the potential environmental impacts of the development. While more research and approval criteria would be necessary to establish benchmarks for "green chemicals," this dSGEIS adopts this alternative approach where feasible by requiring applicants to review and consider the use of alternative additive products that may pose less risk to the environment, including water resources, and to publicly disclose the chemicals that make up these additives. These requirements may be altered and/or expanded as the use of "green chemicals" begin to provide reasonable alternatives and the appropriate technology, criteria and processes are in place to evaluate and produce "green chemicals."

Chapter 10 – Review of Selected Non-Routine Incidents in Pennsylvania

Chapter 10 discusses a number of widely publicized incidents involving high-volume hydraulic fracturing operations in Pennsylvania that have caused public concern about the safety and potential adverse impacts associated with high-volume hydraulic fracturing operations. The case

studies describe the events and their likely causes, and explains how protective measures currently in place or identified as proposed mitigation measures in this dSGEIS would further minimize the risk of such events occurring should high-volume hydraulic fracturing operations be permitted in New York.

Chapter 11 – Summary of Potential Impacts and Mitigation Measures

Chapter 11 highlights the mitigation measures implemented through the 1992 GEIS and summarizes the impacts and mitigation that are discussed in Chapters 6 and 7.

Next Steps

Following the public comment period for the revised draft SGEIS and the draft regulations, the Department will produce a final SGEIS. The final SGEIS will include summaries of the substantive comments received on both the 2009 draft SGEIS and the revised dSGEIS, along with the Department's responses to such comments. The final SGEIS will also incorporate by reference all volumes of the 1992 GEIS.

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New York State

DEC

Chapter 1

Introduction

Revised Draft
Supplemental Generic Environmental Impact Statement

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Chapter 1 – Introduction

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Chapter 1 INTRODUCTION

The Department of Environmental Conservation (Department) has received applications for permits to drill horizontal wells to evaluate and develop the Marcellus and Utica Shales for natural gas production. To release the gas embedded in the shale formations, wells would undergo a stimulation process known as high-volume hydraulic fracturing. While the horizontal well applications received to date are for proposed locations in Broome, Cattaraugus, Chemung, Chenango, Delaware, and Tioga Counties, the Department expects to receive applications to drill in other areas, including counties where natural gas production has not previously occurred. There is also potential for development of the Utica Shale using horizontal drilling and high-volume hydraulic fracturing in Otsego and Schoharie Counties and elsewhere as shown in Chapter 4. Other shale and low-permeability formations in New York may also be targeted for future application of horizontal drilling and high-volume hydraulic fracturing. The Department has prepared this revised draft Supplemental Generic Environmental Impact Statement (SGEIS) to satisfy the requirements of the State Environmental Quality Review Act (SEQRA) for some of these anticipated operations. In reviewing and processing permit applications for horizontal drilling and hydraulic fracturing in these deep, low-permeability formations, the Department would apply the findings and requirements of the SGEIS, including criteria and conditions for future approvals, in conjunction with the existing Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, issued by the Department in 1992 (1992 GEIS).[1]

1.1 Hydraulic Fracturing and Multi-Well Pad Drilling

Hydraulic fracturing is a well stimulation technique which consists of pumping an engineered fluid system and a propping agent (proppant) such as sand down the wellbore under high pressure to create fractures in the hydrocarbon-bearing rock. The fractures serve as pathways for hydrocarbons to move to the wellbore for production. Further information on high-volume hydraulic fracturing, including the composition of the fluid system, is provided in Chapter 5.

[1] The 1992 GEIS is posted on the Department's website at http://www.dec.ny.gov/energy/45912.html.

For environmental review purposes pursuant to SEQRA, stimulation including hydraulic fracturing is considered part of the action of drilling a well. Wells where high-volume hydraulic fracturing is used may be drilled vertically, directionally or horizontally. Multiple wells may be drilled from a common location (multi-well pad or multi-well site).

1.1.1 Significant Changes in Proposed Operations Since 2009

The gas drilling industry has informed the Department of the following changes in its planned operations in New York, based, in part, on experience gained in actively developing the Marcellus Shale in Pennsylvania. These changes are reflected in the assumptions used in this revised draft SGEIS to identify and consider potential significant adverse impacts.

1.1.1.1 Use of Reserve Pits or Centralized Impoundments for Flowback Water

The Department was informed in September 2010 that operators would not routinely propose to store flowback water either in reserve pits on the wellpad or in centralized impoundments.[2] Therefore, these practices are not addressed in this revised draft SGEIS and such impoundments would not be approved without site-specific environmental review.

1.1.1.2 Flowback Water Recycling

The Department was also informed in September 2010 that operators plan to maximize reuse of flowback water for subsequent high-volume hydraulic fracturing operations, with some companies targeting goals of recycling 100% of flowback water.[3] The technologies for accomplishing this have evolved through ongoing Marcellus Shale development in Pennsylvania. The Susquehanna River Basin Commission (SRBC) has confirmed that operators are re-using flowback water.[4] This development has the potential to greatly reduce the volume of flowback water that requires treatment, hauling and disposal, and the related environmental concerns. Fresh water consumption and hauling are also somewhat reduced, but in current practice fresh water still comprises 80-90% of the water used at each well for high-volume hydraulic fracturing.

[2] ALL Consulting, 2010, pp. 18-19.

[3] ALL Consulting, 2010, pp. 73-76.

[4] Richenderfer, 2010, p. 30.

1.2 Regulatory Jurisdiction

The State of New York's official policy, enacted into law, is "to conserve, improve and protect its natural resources and environment . . . ,"[5] and it is the Department's responsibility to carry out this policy. As set forth in Environmental Conservation Law (ECL) §3-0301(1), the Department's broad authority includes, among many other things, the power to:

- manage natural resources to assure their protection and balanced utilization;
- prevent and abate water, land and air pollution; and
- regulate storage, handling and transport of solids, liquids and gases to prevent pollution.

The Department regulates the drilling, operation and plugging of oil and natural gas wells to ensure that activities related to these wells are conducted in accordance with statutory mandates found in the ECL. In addition to protecting the environment and public health and safety, the Department is also required by Article 23 of the ECL (ECL 23) to prevent waste of the State's oil and gas resources, to provide for greater ultimate recovery of the resources, and to protect correlative rights.[6]

1.3 State Environmental Quality Review Act

As explained in greater detail in Chapter 3, the Department's SEQRA regulations authorize the use of generic environmental impact statements to assess the environmental impacts of separate actions having generic or common impacts. Drilling and production of separate oil and gas wells, and other wells regulated under the Oil, Gas and Solution Mining Law (ECL 23) have common impacts. After a comprehensive review of all the potential environmental impacts of oil and gas drilling and production in New York, the Department finalized a Generic Environmental Impact Statement and issued SEQRA Findings on the regulatory program in 1992 (1992 GEIS). In 2008, the Department determined that some aspects of the current and anticipated application of high-volume hydraulic fracturing, which is often used in conjunction with horizontal drilling and multi-well pad development, warranted further review in the context

[5] Environmental Conservation Law (ECL) §1-0101(1).

[6] Correlative rights are the rights of mineral owners to receive or recover oil and gas, or the equivalent thereof, from their owned tracts without drilling unnecessary wells or incurring unnecessary expense.

of a SGEIS. This revised draft SGEIS discusses high-volume hydraulic fracturing in great detail and describes the potential significant impacts from this activity as well as measures that would fully or partially mitigate the identified impacts. Specific mitigation measures would be adopted as part of the Department's Findings Statement in the event high-volume hydraulic fracturing is authorized pursuant to the studies presented herein.

1.4 Project Chronology

1.4.1 February 2009 Final Scope

The Department released a draft Scope for public review in October 2008, and held public scoping sessions at six venues in the Southern Tier and Catskills in November and December, 2008. A total of 188 verbal comments were received at these sessions. In addition, over 3,770 written comments were received (via e-mail, mail, or written comment card). All of these comments were read and reviewed by Department staff and the Final Scope was completed in February 2009, outlining the detailed analysis required for a thorough understanding of the potentially significant environmental impacts of horizontal drilling and high-volume hydraulic fracturing in low-permeability shale.

1.4.2 2009 Draft SGEIS

The Department released the 2009 draft SGEIS for public review on September 30, 2009 and held public hearings at four venues in New York City (NYC), the Catskills and the Southern Tier in October and November, 2009. Comments were accepted at the hearings verbally and in writing, by postal mail, by e-mail and through a web-based application developed specifically for that purpose. More than 2,500 people attended the Department hearings, and more than 200 verbal comments were delivered by individuals, local government officials, representatives of environmental groups and other organizations and members of the oil and gas industry. The Department also received over 13,000 comments via e-mail, postal mail and the web-based comment system. In addition, transcripts from hearings held by the New York State Assembly, the City of Oneonta, and the Tompkins County Council of Governments on the 2009 draft SGEIS also provided the Department with numerous comments.

1.4.2.1 April 2010 Announcement Regarding Communities with Filtration Avoidance Determinations

On April 23, 2010, then-Commissioner Pete Grannis announced that due to the unique issues related to the protection of NYC and Syracuse drinking water supplies, these watersheds would be excluded from the generic environmental review process.

1.4.2.2 Subsequent Exclusion of Communities with Filtration Avoidance Determinations

The analysis of high-volume hydraulic fracturing conducted since the 2009 draft SGEIS supports a finding that high-volume hydraulic fracturing is not consistent with the preservation of these watersheds as an unfiltered drinking water supply.

1.4.3 Revised Draft SGEIS

On January 1, 2011, Governor Cuomo continued Executive Order No. 41 (EO 41), which had been issued by then-Governor Paterson on December 13, 2010. EO 41 directed the Department to publish a revised draft SGEIS on or about June 1, 2011 and to accept public comment on the revisions for a period of not less than 30 days.

1.4.4 Next Steps

Once the revised draft SGEIS is deemed complete, the public comment period will begin. The Department will address the comments and include summaries of the substantive comments received on both the 2009 draft SGEIS and the revised draft SGEIS, along with the Department's responses in the final SGEIS. The final SGEIS will incorporate all volumes of the 1992 GEIS.

At least 10 days after issuance of the final SGEIS, the Department will issue a written Findings Statement. Chapter 3 presents detailed information about a proposed future SEQRA compliance process.

1.5 Methodology

1.5.1 Information about the Proposed Operations

For the 2009 draft SGEIS, the Department primarily relied on two sources of information regarding the operations proposed for New York: (1) a number of permit applications filed with the Department; and (2) the Independent Oil & Gas Association of New York (IOGA-NY),

which provided the Department with information from operators actively developing the Marcellus Shale in Pennsylvania.

Preliminary review of comments on the 2009 draft SGEIS led Department staff to identify additional technical and operational details needed from industry in order to evaluate and address the comments. In April 2010, Department staff sent a "Notice of Information Needs" to IOGA-NY and to specific exploration/production and service companies that commented on the 2009 draft SGEIS. Again, IOGA-NY coordinated industry's response, which was received in September 2010 (ALL Consulting, 2010).

Department staff also communicated with and reviewed information and data made available from the Pennsylvania Department of Environmental Protection (PADEP) and the SRBC about events, regulations, enforcement and other matters associated with ongoing Marcellus Shale development in Pennsylvania.

1.5.2 Intra-/Inter-agency Coordination

Within the Department, preparation of both the 2009 draft SGEIS and the revised draft SGEIS involved all of the programs listed on the "Acknowledgements" page of each document.[7] Other State agencies also provided assistance. Department staff consulted extensively with New York State Department of Health (NYSDOH) staff, and staff in the Department of Public Service (Public Service Commission, or PSC) assisted with the text describing that Department's jurisdiction and regulation over gas gathering facilities.

1.5.3 Comment Review

Of the nearly 13,300 comments received on the 2009 draft SGEIS, at least 9,830 were identified as various campaigns likely generated by on-line form letters, eleven were unique petitions signed by 31,464 individuals and organizations collectively, and seven were the transcripts of the hearings described in Subsection 1.4.2. Each of the transcripts includes comments from a large number of speakers, some of whom also submitted written comments. These transcripts were treated as official public comments, and all comments received are being given equal

[7] As a result of organizational changes within the Department, the Division of Solid & Hazardous Materials is now the Division of Materials Management.

consideration regardless of the method by which they are received. Department staff read and categorized every transcript and every piece of correspondence received to ensure that all substantive comments would be evaluated.

Although the comment period officially closed on December 31, 2009, the Department accepted all comments submitted through January 8, 2010 to further ensure that all substantive comments would be considered.

Following the comment period for the revised draft SGEIS, Department staff will again review and categorize every comment. Comments on both draft documents will be consolidated, and all programs involved in preparing the revised draft SGEIS will also be involved with developing responses to the summarized comments.

1.6 Layout and Organization

The revised draft SGEIS supplements the existing 1992 GEIS, and does not exhaustively repeat narrative from the 1992 GEIS that remains applicable to well permit issuance for horizontal drilling and high-volume hydraulic fracturing.

1.6.1 Chapters

Chapter 1 is an introduction that explains the context, history and contents of the document, and highlights the enhanced procedures, regulations and mitigation measures incorporated into the document.

Chapter 2 is a description of the proposed action, and includes sections on purpose, public need and benefit, project location and environmental setting that are required by SEQRA. The environmental setting section focuses on topics that arose during the public scoping sessions. For a comprehensive understanding of the environmental setting where high-volume hydraulic fracturing might occur, it is necessary to also consult the 1992 GEIS.

Chapter 3 describes the use of a generic environmental impact statement and the resultant SEQRA review process, identifies those potential projects which would require site-specific SEQRA determinations of significance after the SGEIS is completed, and identifies restricted locations where high-volume hydraulic fracturing would be prohibited.

Chapter 4 supplements the geology discussion in Chapter 5 of the 1992 GEIS with additional details about the Marcellus and Utica Shales, seismicity in New York State, naturally-occurring radioactive materials (NORM) in the Marcellus Shale and naturally-occurring methane in New York State.

Chapter 5 comprehensively describes the activities associated with high-volume hydraulic fracturing and multi-well pad drilling, including the composition of hydraulic fracturing additives and flowback water characteristics.

Chapter 6 describes potential impacts associated with the proposed activity and, like other chapters, should be read as a supplement to the 1992 GEIS.

Chapter 7 describes the enhanced procedures, regulations and proposed mitigation measures that have been identified to fully and/or partially mitigate potential significant adverse impacts from high-volume hydraulic fracturing activities to be covered by the SGEIS and 1992 GEIS for SEQRA purposes.

Chapter 8 explains intra- and interagency coordination involved in the well permitting process, including the role of local governments and an expanded approach to local government notification. Descriptions of other regulatory programs that govern some aspects of the potential activities that were previously distributed among several chapters in the document are also now included in Chapter 8.

Chapter 9 discusses the alternatives to well permit issuance that were reviewed and considered.

Chapter 10 is new in the revised draft SGEIS and provides information on certain non-routine incidents in Pennsylvania where development of the Marcellus Shale by high-volume hydraulic fracturing is currently ongoing.

Chapter 11 is new in the revised draft SGEIS and summarizes the impacts and mitigation discussed in Chapters 6 and 7.

1.6.2 Revisions

Except for the Executive Summary which is entirely new, revisions to the 2009 draft SGEIS text are generally marked by vertical lines in the page margins, and new text is underlined. Revised or new Tables, Figures and Appendices are identified as such in their captions or on their cover pages.

1.6.3 Glossary, Bibliographies and Appendices

The Chapters described above are augmented by 27 Appendices and a lengthy glossary that includes acronyms and technical or scientific terms that appear in the document. References cited throughout the document are listed in a bibliography, and separate bibliographies are included that list the various consultants' sources.

1.7 Enhanced Impact Analyses and Mitigation Measures

The Department has identified numerous enhanced procedures and proposed mitigation measures that are available to address the potential significant environmental impacts associated with well permit issuance for horizontal drilling and high-volume hydraulic fracturing. Only the most significant are listed below. Chapter 7 of this document and the 1992 GEIS in its entirety would need to be consulted for the full range of available and required mitigation practices.

The list presented below does not include analyses and mitigation measures proposed in September 2009 that are superseded by the revised draft SGEIS, or that are no longer relevant because of changes in proposed operations.

1.7.1 Hydraulic Fracturing Chemical Disclosure

The Department's hydraulic fracturing chemical disclosure requirements and public disclosure approach set forth in Chapter 8, combined with the chemical disclosures required from industry for the SGEIS analysis, make the Department's disclosure regime among the most stringent in the country. The Department's regime exceeds the requirements of 22 of the 27 oil and gas producing states reviewed and is on par with the five states currently leading the country on chemical disclosure. Additionally, the enhanced disclosure requirements are equivalent to the proposed requirements of the federal Fracturing Awareness and Responsibility (FRAC) Act of 2011.

1.7.2 Water Well Testing

Prior to drilling, operators would be required to test private wells within 1,000 feet of the drill site to provide baseline information and allow for ongoing monitoring. If there are no wells within 1,000 feet, the survey area would extend to 2,000 feet. Chapter 7 reflects updated recommendations from the NYSDOH regarding what analyses should be conducted.

1.7.3 Water Withdrawal and Consumption

1.7.3.1 2009 Draft SGEIS

Applicants would not only have to follow SRBC and Delaware River Basin Commission (DRBC) protocols for water withdrawal where applicable, but would also be required to adhere to a more stringent and protective passby flow requirement in regards to water withdrawal plans - whether inside or outside of the Susquehanna or Delaware river basins. The intended results of these requirements would be to protect aquatic organisms and their habitats in surface waters.

1.7.3.2 Revised Draft SGEIS

The discussion of passby flow and the required streamflow analysis have been updated based on research and studies conducted after the release of the 2009 draft SGEIS. Additionally, details have been added regarding the Department's methodology for evaluating and determining approvable groundwater withdrawal rates.

1.7.4 Well Control and Emergency Response Planning

Although current practices and requirements have proven effective at countless wells throughout New York State, the Department has responded to the public's heightened concerns regarding well control and emergency response issues by including three significant revisions in the revised draft SGEIS:

- Submission, for review in the permit application, of the operator's proposed blowout preventer use and test plan for drilling and completion;
- Description of the required elements of an emergency response plan (ERP); and
- Submission and on-site availability of an ERP consistent with the SGEIS, including a list of emergency contact numbers for the community surrounding the well pad.

1.7.5 Local Planning Documents

The Department proposes that applicants be required to compare the proposed well pad location to local land use laws, regulations, plans and policies to determine whether the proposed activity is consistent with such local land use laws, regulations, plans and policies. If the applicant or the potentially impacted local government informs the Department that it believes a conflict exists, the Department would request additional information with regard to this issue so it can consider whether significant adverse impacts relating to land use and zoning would result from permit issuance.

1.7.6 Secondary Containment, Spill Prevention and Stormwater Pollution Prevention

The Department proposes to require, via permit condition and/or new regulation, that operators provide secondary containment around all additive staging areas and fueling tanks, manned fluid/fuel transfers and visible piping and appropriate use of troughs, drip pads or drip pans. In addition, drilling and hydraulic fracturing operations would be subject to an activity-specific general stormwater permit that would address industrial activities as well as the construction activities that are traditionally the focus of stormwater permitting for oil and gas well sites. The comprehensive Stormwater Pollution Prevention Plan (SWPPP) would incorporate by reference a Spill Prevention, Control and Countermeasures Plan.

1.7.7 Well Construction

Existing requirements are designed to ensure that surface casing be set deeply enough to not only isolate fresh water zones but also to serve as an adequate foundation for well control while drilling deeper. It is also necessary under existing requirements, to the extent possible, to avoid extending the surface casing into shallow gas-bearing zones. Existing casing and cementing requirements that are incorporated into permit conditions establish the required surface casing setting depth based on the best available site-specific information. Each subsequent installation of casing and cement serves to further protect the surface casing and hence, the surrounding fresh water zones.

1.7.7.1 2009 Draft SGEIS

Proposed well construction enhancements for high-volume hydraulic fracturing included:

- Requirement for fully cemented production casing or intermediate casing (if used), with the cement bond evaluated by use of a cement bond logging tool; and

- Required certification prior to hydraulic fracturing of the sufficiency of as-built wellbore construction.

1.7.7.2 Revised Draft SGEIS

Additional well construction enhancements for high-volume hydraulic fracturing that the Department proposes to require pursuant to permit condition and/or regulation are listed below:

- Specific American Petroleum Institute (API) standards, specifications and practices would be incorporated into permit conditions related to well construction. Among these would be requirements to adhere to specifications for centralizer type and for casing and cement quality;

- Fully cemented intermediate casing would be required unless supporting site-specific documentation to waive the requirement is presented. This directly addresses gas migration concerns by providing additional barriers (i.e., steel casing, cement) between aquifers and shallow gas-bearing zones;

- Additional measures to ensure cement strength and sufficiency would be incorporated into permit conditions, also directly addressing gas migration concerns. Compliance would continue to be tracked through site inspections and required well completion reports, and any other documentation the Department deems necessary for the operator to submit or make available for review; and

- Minimum compressive strength requirements.

    - Minimum waiting times during which no activity is allowed which might disturb the cement while it sets;

    - Enhanced requirements for use of centralizers which serve to ensure the uniformity and strength of the cement around the well casing; and

    - Required use of more advanced cement evaluation tools.

1.7.8 Flowback Water Handling On-Site

The Department proposes to require that operators storing flowback water on-site would be required to use watertight tanks located within secondary containment, and remove the fluid from the wellpad within specified time frames.

1.7.9 Flowback Water Disposal

Under existing regulations, before a permit is issued, the operator must disclose plans for disposal of flowback water and production brine. Further, in the SGEIS the Department proposes to use a new "Drilling and Production Waste Tracking" process, similar to the process applicable to medical waste, to monitor disposal. Under existing regulations, full analysis and approvals under state water laws and regulations are required before a water treatment facility can accept flowback from high-volume hydraulic fracturing operations. Appendix 22 includes a description and flow chart of the required approval process for discharge of flowback water or production brine from high-volume hydraulic fracturing to a Publicly-Owned Treatment Works (POTW). An applicant proposing discharge to a POTW would be required to submit a treatment capacity analysis for the receiving POTW, and, in the event that the POTW is the primary fluid disposal plan, a contingency plan. Additionally, limits would be established for NORM in POTW influent.

1.7.10 Management of Drill Cuttings

The Department has determined that drill cuttings are solid wastes, specifically construction and demolition debris, under the State's regulatory system. Therefore, the Department would allow disposal of cuttings from drilling processes which utilize only air and/or water on-site, at construction and demolition (C&D) debris landfills, or at municipal solid waste (MSW) landfills, while cuttings from processes which utilize any oil-based or polymer-based products could only be disposed of at MSW landfills. The revised draft SGEIS proposes to require, pursuant to permit conditions and/or regulation, that a closed-loop tank system be used instead of a reserve pit to manage drilling fluids and cuttings for:

- Horizontal drilling in the Marcellus Shale without an acceptable acid rock drainage (ARD) mitigation plan for on-site cuttings burial; and
- Cuttings that, because of the drilling fluid composition used must be disposed off-site, including at a landfill.

Only ARD mitigation plans that do not require long-term monitoring would be acceptable. Examples are provided in Chapter 7.

1.7.11 Emissions and Air Quality

The need to re-evaluate air quality impacts and the applicability of various regulations was raised during the scoping process, with emphasis on the duration of activities at a multi-well pad and the number of internal combustion engines used for high-volume hydraulic fracturing.

1.7.11.1 2009 Draft SGEIS

The following conclusions and requirements were set forth:

- Per United States Environmental Protection Agency (EPA) NESHAPS subpart ZZZZ, the compressor station would have an oxidation catalyst for formaldehyde. This also reduces carbon monoxide (CO) by 90% and Volatile Organic Compounds (VOCs) by 70%;

- Per EPA subpart HH, the glycol dehydrator would have a condenser to achieve a benzene emission of <1 ton per year (Tpy) (if "wet" gas is detected);

- Use of Ultra Low Sulfur Fuel (ULSF) of 15 parts per million (ppm) in all engines would be required;

- Small stack height increases on compressor, vent and dehydrator would be required (if "sour" and "wet" gas encountered for the latter two, respectively);

- All annual and short-term ambient standards (National Ambient Air Quality Standards, or NAAQS) and the Department's toxics thresholds (Annual and Short-Term Guideline Concentrations, or AGCs and SGCs) would be met, except 24-hour PM10/PM2.5 NAAQS due to drilling and hydraulic fracturing engines; and

- Impacts from a nearby pad modeled and indicated no overlap in the calculated "cumulative" impacts on local scale.

The facility definition for permitting was based on Clean Air Act (CAA) 112(n)(4) per EPA guidance at the time, which limits it to "surface area" (i.e., per pad). Annual emissions from all sources were calculated assuming ten wells per pad and resulted in a classification of the emissions as "minor" sources. No final determination was made as to whether non-road engines would be part of "stationary" facility since it was unclear before September 2009 if these would be at the pad more than 12 months.

1.7.11.2 Revised Draft SGEIS

The Department performed substantive additional emissions and air quality analyses, which identified the following mitigation measures that the Department proposes to require through enhanced procedures, permit conditions and/or regulations:

- The diesel fuel used in drilling and completion equipment engines would be limited to ULSF with a maximum sulfur content of 15 ppm;
- There would not be any simultaneous operations of the drilling and completion equipment engines at the single well pad;
- The maximum number of wells to be drilled and completed annually or during any consecutive 12-month period at a single pad would be limited to four;
- The emissions of benzene at any glycol dehydrator to be used at the well pad would be limited to 1 Tpy as determined by calculations with the Gas Research Institute's (GRI) GlyCalc program. If wet gas is encountered, then the dehydrator would have a minimum stack height of 30 feet (9.1 meters) and would be equipped with a control device to limit the benzene emissions to 1 Tpy;
- Condensate tanks used at the well pad would be equipped with vapor recovery systems to minimize fugitive VOC emissions;
- During the flowback phase, the venting of gas from each well pad would be limited to a maximum of 5 million standard cubic feet (MMscf) during any consecutive 12 month period. If "sour" gas is encountered with detected hydrogen sulfide (H_2S) emissions, the height at which the gas would be vented would be a minimum of 30 feet (9.1 meters);
- During the flowback phase, flaring of gas at each well pad would be limited to a maximum of 120 MMscf during any consecutive 12-month period;
- Wellhead compressors would be equipped with Non-Selective Catalytic Reduction (NSCR) controls;
- No uncertified (i.e., EPA Tier 0) drilling or completion equipment engines would be used for any activity at the well sites;
- The drilling engines and drilling air compressors would be limited to EPA Tier 2 or newer equipment. If Tier 1 drilling equipment is to be used, these would be equipped with both particulate traps (Continuously Regenerating Diesel Particulate Filters, or CRDPF) and Selective Catalytic Reduction (SCR) controls. During operations, this equipment would be positioned as close to the center of the well pad as practicable. If industry deviates from the control requirements or proposes alternate mitigation

and/or control measures to demonstrate ambient standard compliance, site-specific information would be provided to the Department for review and concurrence; and

- The completion equipment engines would be limited to EPA Tier 2 or newer equipment. CRDPFs would be required for all Tier 2 engines. SCR control would be required on all completion equipment engines regardless of the emission Tier. During operations, this equipment would be positioned as close to the center of the well pad as practicable. If industry deviates from this requirement or proposes mitigation and/or alternate control measures to demonstrate ambient standard compliance, site specific information would be provided to the Department for review and concurrence.

In addition, the revised draft SGEIS discusses the effect of region-wide emissions on State Implementation Plan (SIP) for Ozone NAAQS and implementation of local and regional level air quality monitoring at well pads and surrounding areas.

1.7.12 Greenhouse Gas Mitigation

All operational phases of well pad activities, and all greenhouse gas (GHG) emission sources are evaluated in both the 2009 draft SGEIS and the current draft. Based on this analysis, the Department proposes in the current draft to require the following controls and mitigation measures, pursuant to permit conditions and/or regulation:

- Implementation by the operator of a Leak Detection and Repair Program;
- Upon request, the operator would be required to provide a copy of data required under federal (EPA) GHG reporting rule;
- Reduced Emissions Completion (REC) would be required whenever a gathering line is already constructed. In addition, two years after issuance of the first permit for high-volume hydraulic fracturing, the Department would evaluate whether the number of wells that can be drilled on a pad without REC should be limited; and
- Implementation of other control technologies when applicable, as described in Chapter 7.

1.7.13 Habitat Fragmentation

The current draft includes a substantially augmented analysis of potential impacts from high-volume hydraulic fracturing on wildlife and habitat. Based on that analysis, two measures that were not included in the 2009 draft SGEIS are proposed as mitigation in the revised draft SGEIS:

- *Grassland Focus Areas on private land* – Surface disturbance in grassland patches comprised of 30 acres or more of contiguous grassland within Grassland Focus Areas would be contingent on the findings of a a site-specific ecological assessment conducted by the permit applicant and implementation of mitigation measures identified as part of such ecological assessment; and

- *Forest Focus Areas on private land* – Surface disturbance in forest patches comprised of 150 acres or more of undisturbed, contiguous forest within Forest Focus Areas would be contingent on a site-specific ecological assessment conducted by the permit applicant and implementation of mitigation measures identified as part of such ecological assessment.

1.7.14 State Forests, State Wildlife Management Areas and State Parks

Surface disturbance associated with high-volume hydraulic fracturing would not be allowed on State-owned lands administered by the Department, including but not limited to State Forests and State Wildlife Management Areas, because it is inconsistent with the suite of purposes for which those lands have been acquired. Current Office of Parks, Recreation and Historic Preservation (OPRHP) policy would impose a similar restriction on State Parks.

1.7.15 Community and Socioeconomic Impacts

Chapter 6 of this revised draft SGEIS includes a significantly expanded discussion of community and socioeconomic impacts, traffic impacts, and noise and visual impacts, with measures that will be implemented by the Department to mitigate these impacts described in Chapter 7.

1.8 Additional Precautionary Measures

In order to safeguard the environment from risks associated with spills or other events that could release contaminants into environmentally sensitive areas, the revised draft SGEIS includes the following prohibitions and mitigation measures for high-volume hydraulic fracturing:

- Well pads for high-volume hydraulic fracturing would be prohibited in the NYC and Syracuse watersheds, and within a 4,000-foot buffer around those watersheds;

- Well pads for high-volume hydraulic fracturing would be prohibited within 500 feet of primary aquifers (subject to reconsideration 2 years after issuance of the first permit for high-volume hydraulic fracturing);

- Well pads for high-volume hydraulic fracturing would be prohibited within 2,000 feet of public water supply wells, river or stream intakes and reservoirs (subject to reconsideration 3 years after issuance of the first permit for high-volume hydraulic fracturing);

- For at least two years from issuance of the first permit for high-volume hydraulic fracturing, proposals for high-volume hydraulic fracturing at any well pad within within 500 feet of principal aquifers, would require (1) site-specific SEQRA determinations of significance and (2) individual State Pollutant Discharge Elimination System (SPDES) permits for stormwater discharges. The Department would re-evaluate the necessity of this approach after two years of experience issuing permits in areas outside of the 500-foot boundary;

- The Department would not issue permits for proposed high-volume hydraulic fracturing at any well pad in 100-year floodplains; and

- The Department would not issue permits for proposed high-volume hydraulic fracturing at any proposed well pad within 500 feet of a private water well or domestic use spring, unless waived by the owner.

New York State

DEC

Chapter 2

Description of Proposed Action

Revised Draft
Supplemental Generic Environmental Impact Statement

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Chapter 2 – Description of Proposed Action

FIGURES

TABLES

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Chapter 2 DESCRIPTION OF PROPOSED ACTION

The proposed action is the Department's issuance of permits to drill, deepen, plug back or convert wells for horizontal drilling and high-volume hydraulic fracturing in the Marcellus Shale and other low-permeability natural gas reservoirs. Wells where high-volume hydraulic fracturing is used may be drilled vertically, directionally or horizontally. The proposed action, however, does not include horizontal drilling where high-volume hydraulic fracturing is not employed. Such drilling is covered under the GEIS.

Hydraulic fracturing is a well stimulation technique which consists of pumping an engineered fluid system and a proppant such as sand down the wellbore under high pressure to create fractures in the hydrocarbon-bearing rock. The fractures serve as pathways for hydrocarbons to move to the wellbore for production. High-volume hydraulic fracturing, using 300,000 gallons of water or more per well, is also referred to as "slick water fracturing." An individual well treatment may consist of multiple stages (multi-stage frac). Further information on high-volume hydraulic fracturing, including the composition of the fluid system, is provided in Chapter 5.

Multiple wells may be drilled from a common location (multi-well pad, or multi-well site). The Department may receive applications to drill approximately 1,700 – 2,500 horizontal and vertical wells for development of the Marcellus Shale by high-volume hydraulic fracturing during a "peak development" year. An average year may see 1,600 or more applications. Development of the Marcellus Shale in New York may occur over a 30-year period.[1] More information about these activity estimates and the factors which could affect them is presented in Chapter 5.

This SGEIS is focused on topics not addressed by the 1992 GEIS, with emphasis on potential impacts associated with the large volumes of water required to hydraulically fracture horizontal shale wells using the slick water fracturing technique and the disturbance associated with multi-well sites. An additional aspect of this SGEIS is to consider measures that will be incorporated into revisions or additions to the Department's regulations concerning high-volume hydraulic fracturing.

[1] ALL Consulting, 2010, pp. 7 - 9.

2.1 Purpose

As stated in the 1992 GEIS, a generic environmental impact statement is used to evaluate the environmental effects of a program having wide application and is required for direct programmatic actions undertaken by a state agency. The SGEIS will address new activities or new potential impacts not addressed by the 1992 GEIS and will set forth practices and mitigation designed to reduce environmental impacts to the maximum extent practicable. The SGEIS and its findings will be used to satisfy SEQR for the issuance of permits to drill, deepen, plug back or convert wells for horizontal drilling and high-volume hydraulic fracturing. The SGEIS will also be used to satisfy SEQR for the enactment of revisions or additions to the Department's regulations relating to high-volume hydraulic fracturing.

2.2 Public Need and Benefit

The exploration and development of natural gas resources serves the public's need for energy while providing substantial economic and environmental benefits. Natural gas consumption comprises about 23 percent of the total energy consumption in the United States. Natural gas is used for many purposes: home space and water heating; cooking; commercial and industrial space heating; commercial and industrial processes; as a raw material for the manufacture of fertilizer, plastics, and petrochemicals; as vehicle fuel; and for electric generation. Over 50 percent of the homes in the United States use natural gas as the primary heating fuel. In 2008 U.S. natural gas consumption totaled about 23.2 trillion cubic feet (Tcf), nearly matching the peak consumption of 23.3 Tcf reached in 2000.[2]

New York is the fourth largest natural gas consuming state in the nation using about 1,200 billion cubic feet (Bcf) of natural gas per year and accounting for about five percent of U.S. demand.[3]

In 2008 New York's 4.3 million residential customers used about 393 Bcf of natural gas or 33 percent of total statewide gas use. The State's 394,000 commercial customers used about 292 Bcf or 25 percent of total natural gas use. Natural gas consumption in the residential and commercial sectors in New York represents a larger proportion of the total consumption than

[2] New York State Energy Planning Board, December 2009, p. 7.

[3] New York State Energy Planning Board, December 2009, p. 8.

U.S. consumption for those sectors which is 21 and 13 percent, respectively. The primary use of natural gas in New York for residential and small commercial customers is for space heating and is highly weather sensitive. The State's natural gas market is winter- peaking with over 70 percent of residential and 60 percent of commercial natural gas consumption occurring in the five winter months (November through March).[4]

Since natural gas is a national market, developments nationwide regarding gas supply are critical to the State. U.S. natural gas dry production totaled 20.5 Tcf in 2008, which was 6 percent higher than in 2007. About 98 percent of the natural gas produced in the United States comes from production areas in the lower 48 states. The overall U.S. dry natural gas production has been relatively flat over much of the last ten years. However, in the past few years, there has been a significant shift in gas supplies from conventional or traditional supply areas and sources to unconventional or new supply areas and sources. U.S. natural gas production from traditional, more mature and accessible natural gas supply basins has steadily declined. However, this has been offset by increased drilling and production from new unconventional gas supply areas. In 2008 natural gas production from new supply resources totaled about 10.4 Tcf (28.5 Bcf per day) or about 51 percent of the total U.S. dry natural gas production.[5]

The increased production from unconventional resources is primarily from tight sands, coal-bed methane, and shale formations. The Rocky Mountain Region is the fastest-growing region for tight sands natural gas production and the predominant region for coal-bed methane natural gas production in the United States. There are at least 21 shale gas basins located in over 20 states in the United States. Currently, the most prolific-shale producing areas in the country are in the southern US and include the Barnett Shale area in Texas, the Haynesville Shale in Texas and Louisiana, the Woodford Shale in Oklahoma, and the Fayetteville Shale in Arkansas. In the Appalachian region, which extends into New York, the Marcellus Shale is expected to develop into a major natural gas production area. Proven natural gas reserves for the United States totaled over 237 Tcf at the end of 2007, an increase of about 12 percent over 2006 levels. The

[4] New York State Energy Planning Board, December 2009, p. 8.

[5] New York State Energy Planning Board, December 2009, p. 10.

increase in reserves was the ninth year in a row that U.S. natural gas proven reserves have increased.[6]

Over 95 percent of the natural gas supply required to meet the demands of New York natural gas customers is from other states, principally the Gulf Coast region, and Canada. The gas supply is brought to the New York market by interstate pipelines that move the gas from producing and storage areas for customers, such as local distribution companies (LDCs) and electric generators, who purchase the gas supplies from gas producers and marketers.

New York natural gas production supplies about 5 percent of the State's natural gas requirements. Currently, there are about 6,700 active natural gas wells in the State. For the 2010 calendar year, total reported State natural gas production was 35.7 Bcf, down 35 percent from the 2006 record total of 55.2 Bcf. These figures represent an increase of over 100 percent since 1998 (16.7 Bcf).[7]

The Marcellus Shale formation has attracted great attention as a significant new source of natural gas production. The Marcellus Shale extends from Ohio through West Virginia and into Pennsylvania and New York. In New York, the Marcellus Shale is located in much of the Southern Tier stretching from Chautauqua and Erie Counties in the west to the counties of Sullivan, Ulster, Greene and Albany in the east. According to researchers at Penn State University, the Marcellus Shale is the largest known shale deposit of gas in the world.[8] Engelder and Lash (2008) first estimated gas-in-place to be between 168 and 500 Tcf with a recoverable estimate of 50 Tcf.[9] While it is early in the productive life of Marcellus Shale wells, the most recent estimates by Engelder using well production decline rates indicate a 50 percent probability that recoverable reserves could be as high as 489 Tcf.[10]

In Pennsylvania, where Marcellus Shale development is underway, researchers at Penn State University estimated that the natural gas industry generated $2.3 billion in total value, added

[6] New York State Energy Planning Board, December 2009, p. 12.

[7] New York State Energy Planning Board, August 2009, p.14.

[8] Considine et al., 2009, p.2.

[9] Engelder and Lash, 2008, p.87.

[10] Engelder, 2009, p.5.

more than 29,000 jobs, and $240 million in state and local taxes in 2008. With a substantially higher pace of development projected by these researchers subsequently, they anticipated substantially higher economic output, state and local tax revenues, and job creation.[11]

The Draft 2009 New York State Energy Plan recognizes the potential benefit to New York by development of the Marcellus Shale natural gas resource:

Production and use of in-state energy resources – renewable resources and natural gas – can increase the reliability and security of our energy systems, reduce energy costs, and contribute to meeting climate change, public health and environmental objectives. Additionally, by focusing energy investments on in-state opportunities, New York can reduce the amount of dollars "exported" out of the State to pay for energy resources.[12]

The New York State Energy Plan further includes a recommendation to encourage development of the Marcellus Shale natural gas formation with environmental safeguards that are protective of water supplies and natural resources.[13]

The New York State Commission on State Asset Maximization recommends that "Taking into account the significant environmental considerations, the State should study the potential for new private investment in extracting natural gas in the Marcellus Shale on State-owned lands, in addition to development on private lands." Depending on the geology, a typical horizontal well in the Marcellus Shale (covering approximately 80 acres) may produce 1.0 to 1.5 Bcf of gas cumulatively over the first five years in service. At a natural gas price of $6 per thousand cubic feet (Mcf), a 12.5 percent royalty could result in royalty income to a landowner of $750,000 to over $1 million over a five-year period.[14]

The Final report concludes that an increase in natural gas supplies would place downward pressure on natural gas prices, improve system reliability and result in lower energy costs for New Yorkers. In addition, natural gas extraction would create jobs and increase wealth to

[11] Considine et al., 2009, p. 30.

[12] New York State Energy Planning Board, December 2009, p. xiv.

[13] New York State Energy Planning Board, December 2009, p.xv.

[14] New York State Commission on State Asset Maximization, June 2009, p. 62.

upstate landowners, and increase State revenue from taxes and landowner leases and royalties. The report also concludes that development of State-owned lands not protected by Article XIV of the State Constitution could provide revenue relief to the State and spur economic development and job creation in economically depressed regions of the State.[15]

Broome County, New York commissioned a study entitled *Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York,* which was released in July 2009. The report details significant potential economic impacts on the Greater Binghamton Region:

Table 2.1 - Economic and Fiscal Impacts of Gas Well Drilling Activities in Broome County, NY Over 10 Years[16]

Description	Impact 2,000 Wells	Impact 4,000 Wells
Total Spending	$ 7,000,000,000	$ 14,000,000,000
Total Economic Activity	$ 7,648,652,000	$ 15,297,304,000
Total Wages, Salaries, Benefits (labor income)	$ 396,436,000	$ 792,872,000
Total Employment (person years)	8,136	16,272
Total Property Income*	$ 605,676,000	$ 1,211,352,000
State Taxes‡	$ 22,240,000	$ 44,480,000
Local Taxes†	$ 20,528,000	$ 41,056,000

**Includes royalties, rents, dividends, and corporate profits. † Includes sales, excise, property taxes, fees, and licenses.*

The local economic impacts are already being realized in some cases as exploration companies continue to lease prospective acreage in the Southern Tier and as oil and gas service companies seek to locate in the heart of the activity to better serve their customers. News reports on June 20, 2009, detailed the terms of a lease agreement between Hess Corporation and a coalition of landowners in the Towns of Binghamton and Conklin. The coalition represents some 800 residents who control more than 19,000 acres. The lease provides bonus payments of $3,500 per acre and a royalty of 20 percent. On August 26, 2009, it was reported that in Horseheads, New York, Schlumberger Technology Corporation planned to build a $30 million facility to house

[15] New York State Commission on State Asset Maximization, June 2009, p. 62.

[16] Broome County, 2009, p. 10.

$120 million worth of equipment and technology to service oil and gas exploration companies in the Southern Tier and Northern Pennsylvania. As of June 2011, construction of the Schlumberger CT (coiled tubing) facility was ongoing but the facility was offering some services. Once completed, the facility will comprehensively service horizontal multistage completion needs in the Marcellus Shale. The facility is ideally located to respond to immediate callout and minimize mobilization time and costs. This operations base will be designed to combine CT, cementing, stimulation, and other completion expertise.[17]

According to researchers at Penn State University, natural gas will play a pivotal role in the transformation of our economy to achieve lower levels of GHG emissions. Natural gas has lower carbon emissions than both coal and oil, so that any displacement of these fuels by natural gas to supply power plants and other end-users will produce a reduction in GHG.[18]

In Chapter 6 the potential negative environmental impacts of the proposed action will be systematically identified and discussed. What is clear is that there are significant positive economic consequences along with significant potential impacts on the environment that need to be carefully considered.

2.3 Project Location

The 1992 GEIS is applicable to onshore oil and gas well drilling statewide. Sedimentary rock formations which may someday be developed by horizontal drilling and hydraulic fracturing exist from the Vermont/Massachusetts border up to the St. Lawrence/Lake Champlain region, west along Lake Ontario to Lake Erie and across the Southern Tier and Finger Lakes regions. Drilling will not occur on State-owned lands in the Adirondack and Catskill Forest Preserves because of the State Constitution's requirement that Forest Preserve lands be kept forever wild and not be leased or sold. Drilling will not occur on State reforestation areas and wildlife management areas that are located in the Forest Preserve because the State Constitution prohibits those areas from being leased or sold. Surface disturbance associated with high-volume hydraulic fracturing would not be allowed on State-owned lands administered by DEC outside of the Forest Preserve, including but not limited to State Forests and State Wildlife Management

[17] http://www.slb.com/~/media/Files/coiled_tubing/brochures/usland_ct_br.ashx.

[18] Considine et al., 2009, p. 2.

Areas, because high-volume hydraulic fracturing would be inconsistent with the purposes for which those lands were acquired. Current OPRHP policy would impose a similar restriction on State Parks. In addition, the subsurface geology of the Adirondacks, NYC and Long Island and other factors render drilling for hydrocarbons in those areas unlikely.

The prospective region for the extraction of natural gas from Marcellus and Utica Shales has been roughly described as an area extending from Chautauqua County eastward to Greene, Ulster and Sullivan Counties, and from the Pennsylvania border north to the approximate location of the east-west portion of the New York State Thruway between Schenectady and Auburn. The maps in Chapter 4 depict the prospective area.

2.4 Environmental Setting

Environmental resources discussed in the 1992 GEIS with respect to potential impacts from oil and gas development include: waterways/water bodies; drinking water supplies; public lands; coastal areas; wetlands; floodplains; soils; agricultural lands; intensive timber production areas; significant habitats; areas of historical, architectural, archeological and cultural significance; clean air and visual resources.[19] Further information is provided below regarding specific aspects of the environmental setting for Marcellus and Utica Shale development and high-volume hydraulic fracturing that were determined during Scoping to require attention in the SGEIS.

2.4.1 Water Use Classifications[20]

Water use classifications are assigned to surface waters and groundwaters throughout New York. Surface water and groundwater sources are classified by the best use that is or could be made of the source. The preservation of these uses is a regulatory requirement in New York. Classifications of surface waters and groundwaters in New York are identified and assigned in 6 NYCRR Part 701.

[19] NYSDEC, 1992, GEIS Chapter 6 provides a broad background of these environmental resources, including the then-existing legislative protections, other than SEQRA, guarding these resources from potential impacts. Chapters 8, 9, 10, 11, 12, 13, 14 and 15 of the GEIS contain more detailed analyses of the specific environmental impacts of development on these resources, as well as the mitigation measures required to prevent these impacts.

[20] URS, 2009, p. 4-2.

In general, the discharge of sewage, industrial waste, or other wastes must not cause impairment of the best usages of the receiving water as specified by the water classifications at the location of discharge and at other locations that may be affected by such discharge. In addition, for higher quality waters, the Department may impose discharge restrictions (described below) in order to protect public health, or the quality of distinguished value or sensitive waters.

A table of water use classifications, usages and restrictions follows.

Table 2.2 - New York Water Use Classifications

Water Use Class	Water Type	Best Usages and Suitability	Notes
N	Fresh Surface	1, 2	
AA-Special	Fresh Surface	3, 4, 5, 6	Note a
A-Special	Fresh Surface	3, 4, 5, 6	Note b
AA	Fresh Surface	3, 4, 5, 6	Note c
A	Fresh Surface	3, 4, 5, 6	Note d
B	Fresh Surface	4, 5, 6	
C	Fresh Surface	5, 6, 7	
D	Fresh Surface	5, 7, 8	
SA	Saline Surface	4, 5, 6, 9	
SB	Saline Surface	4, 5, 6,	
SC	Saline Surface	5, 6, 7	
I	Saline Surface	5, 6, 10	
SD	Saline Surface	5, 8	
GA	Fresh Groundwater	11	
GSA	Saline Groundwater	12	Note e
GSB	Saline Groundwater	13	Note f
Other – T/TS	Fresh Surface	Trout/Trout Spawning	
Other – Discharge Restriction Category	All Types	N/A	See descriptions below

Best Usage/Suitability Categories [Column 3 of Table 2.2 above]

1. Best usage for enjoyment of water in its natural condition and, where compatible, as a source of water for drinking or culinary purposes, bathing, fishing, fish propagation, and recreation;

2. Suitable for shellfish and wildlife propagation and survival, and fish survival;

3. Best usage as source of water supply for drinking, culinary or food processing purposes;

4. Best usage for primary and secondary contact recreation;

5. Best usage for fishing;

6. Suitable for fish, shellfish, and wildlife propagation and survival;

7. Suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes;

8. Suitable for fish, shellfish, and wildlife survival (not propagation);

9. Best usage for shellfishing for market purposes;

10. Best usage for secondary, but not primary, contact recreation;

11. Best usage for potable water supply;

12. Best usage for source of potable mineral waters, or conversion to fresh potable waters, or as raw material for the manufacture of sodium chloride or its derivatives or similar products; and

13. Best usage is as receiving water for disposal of wastes (may not be assigned to any groundwaters of the State, unless the Commissioner finds that adjacent and tributary groundwaters and the best usages thereof will not be impaired by such classification).

Notes [Column 4 of Table 2.2 above]

a. These waters shall contain no floating solids, settleable solids, oil, sludge deposits, toxic wastes, deleterious substances, colored or other wastes or heated liquids attributable to sewage, industrial wastes or other wastes; there shall be no discharge or disposal of sewage, industrial wastes or other wastes into these waters; these waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages; there shall be no alteration to flow that will impair the waters for their best usages; there shall be no increase in turbidity that will cause a substantial visible contrast to natural conditions;

b. This classification may be given to those international boundary waters that, if subjected to approved treatment, equal to coagulation, sedimentation, filtration and disinfection with additional treatment, if necessary, to reduce naturally present impurities, meet or will meet NYSDOH drinking water standards and are or will be considered safe and satisfactory for drinking water purposes;

c. This classification may be given to those waters that if subjected to pre-approved disinfection treatment, with additional treatment if necessary to remove naturally present impurities, meet or will meet NYSDOH drinking water standards and are or will be considered safe and satisfactory for drinking water purposes;

d. This classification may be given to those waters that, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to reduce naturally present impurities, meet or will meet NYSDOH drinking water standards and are or will be considered safe and satisfactory for drinking water purposes;

e. Class GSA waters are saline groundwaters. The best usages of these waters are as a source of potable mineral waters, or conversion to fresh potable waters, or as raw material for the manufacture of sodium chloride or its derivatives or similar products; and

f. Class GSB waters are saline groundwaters that have a chloride concentration in excess of 1,000 milligrams per liter (mg/L) or a total dissolved solids (TDS) concentration in excess of 2,000 mg/L; this classification shall not be assigned to any groundwaters of the State, unless the Department finds that adjacent and tributary groundwaters and the best usages thereof will not be impaired by such classification.

Discharge Restriction Categories [Last Row of Table 2.2 above]

Based on a number of relevant factors and local conditions, per 6 NYCRR §701.20, discharge restriction categories may be assigned to: (1) waters of particular public health concern; (2) significant recreational or ecological waters where the quality of the water is critical to maintaining the value for which the waters are distinguished; and (3) other sensitive waters

where the Department has determined that existing standards are not adequate to maintain water quality.

1. Per 6 NYCRR §701.22, new discharges may be permitted for waters where discharge restriction categories are assigned when such discharges result from environmental remediation projects, from projects correcting environmental or public health emergencies, or when such discharges result in a reduction of pollutants for the designated waters. In all cases, best usages and standards will be maintained;

2. Per 6 NYCRR §701.23, except for storm water discharges, no new discharges shall be permitted and no increase in any existing discharges shall be permitted; and

3. Per 6 NYCRR §701.24, specified substances shall not be permitted in new discharges, and no increase in the release of specified substances shall be permitted for any existing discharges. Storm water discharges are an exception to these restrictions. The substance will be specified at the time the waters are designated.

2.4.2 Water Quality Standards

Generally speaking, groundwater and surface water classifications and quality standards in New York are established by the United States Environmental Protection Agency (USEPA) and the Department. The NYC Department of Environmental Protection (NYCDEP) defers to the New York State Department of Health (NYSDOH) for water classifications and quality standards. The most recent NYC Drinking Water Quality Report can be found at http://www.nyc.gov/html/dep/pdf/wsstate10.pdf. The Susquehanna River Basin Commission (SRBC) has not established independent classifications and quality standards. However, one of SRBC's roles is to recommend modifications to state water quality standards to improve consistency among the states. The Delaware River Basin Commission (DRBC) has established independent classifications and water quality standards throughout the Delaware River Basin, including those portions within New York. The relevant and applicable water quality standards and classifications include the following:

- 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations;[21]
- USEPA Drinking Water Contaminants;[22]
- 18 CFR Part 410, DRBC Administrative Manual Part III Water Quality Regulations;[23]
- 10 NYCRR Part 5, Subpart 5-1 Public Water Systems; [24] and
- NYCDEP Drinking Water Supply and Quality Report.[25]

2.4.3 Drinking Water[26]

The protection of drinking water sources and supplies is extremely important for the maintenance of public health, and the protection of this water use type is paramount. Chemical or biological substances that are inadvertently released into surface water or groundwater sources that are designated for drinking water use can adversely impact or disqualify such usage if there are constituents that conflict with applicable standards for drinking water. These standards are discussed below.

2.4.3.1 Federal

The Safe Drinking Water Act (SDWA), passed in 1974 and amended in 1986 and 1996, gives USEPA the authority to set drinking water standards. There are two categories of drinking water standards: primary and secondary. Primary standards are legally enforceable and apply to public water supply systems. The secondary standards are non-enforceable guidelines that are recommended as standards for drinking water. Public water supply systems are not required to comply with secondary standards unless a state chooses to adopt them as enforceable standards. New York has elected to enforce both as Maximum Contaminant Levels (MCLs) and does not make the distinction.

[21] http://www.dec.ny.gov/regs/4590.html.

[22] http://www.epa.gov/safewater/contaminants/index.html.

[23] http://www.state.nj.us/drbc/regs/WQRegs_071608.pdf.

[24] http://www.health.state.ny.us/environmental/water/drinking/part5/subpart5.htm

[25] http://www.nyc.gov/html/dep/html/drinking_water/wsstate.shtml.

[26] URS, 2009, pp. 4-5:4-16.

The primary standards are designed to protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in drinking water. The determinations of which contaminants to regulate are based on peer-reviewed science research and an evaluation of the following factors:

- Occurrence in the environment and in public water supply systems at levels of concern;
- Human exposure and risks of adverse health effects in the general population and sensitive subpopulations;
- Analytical methods of detection;
- Technical feasibility; and
- Impacts of regulation on water systems, the economy and public health.

After reviewing health effects studies and considering the risk to sensitive subpopulations, EPA sets a non-enforceable Maximum Contaminant Level Goal (MCLG) for each contaminant as a public health goal. This is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. MCLGs only consider public health and may not be achievable given the limits of detection and best available treatment technologies. The SDWA prescribes limits in terms of MCLs or Treatment Techniques (TTs), which are achievable at a reasonable cost, to serve as the primary drinking water standards. A contaminant generally is classified as microbial in nature or as a carcinogenic/non-carcinogenic chemical.

Secondary contaminants may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. The numerical secondary standards are designed to control these effects to a level desirable to consumers.

Table 2.3 and Table 2.4 list contaminants regulated by federal primary and secondary drinking water standards.

Table 2.3 - Primary Drinking Water Standards

Microorganisms

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Cryptosporidium	0	TT
Giardia Lamblia	0	TT
Heterotrophic plate count	n/a	TT
Legionella	0	TT
Total Coliform (including fecal coliform and E. coli)	0	5%
Turbidity	n/a	TT
Viruses (enteric)	0	TT

MCLG: Maximum contaminant level goal
MCL: Maximum contaminant level
TT: Treatment technology

Disinfection Byproducts

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Bromate	0	0.01
Chlorite	0.8	1
Haloacetic acids (HAA5)	n/a	0.06
Total Trihalomethanes (TTHMs)	n/a	0.08

Disinfectants

Contaminant	MRDLG (mg/L)	MRDL (mg/L)
Chloramines (as Cl_2)	4.0	4.0
Chlorine (as Cl_2)	4.0	4.0
Chlorine dioxide (as ClO_2)	0.8	0.8

MRDL: Maximum Residual Disinfectant Level
MRDLG: Maximum Residual Disinfectant Level Goal

Inorganic Chemicals

Contaminant	CAS number	MCLG (mg/L)	MCL or TT (mg/L)
Antimony	07440-36-0	0.006	0.006
Arsenic	07440-38-2	0	0.01 as of 01/23/06
Asbestos (fiber >10 micrometers)	01332-21-5	7 million fibers per liter	7 MFL
Barium	07440-39-3	2	2
Beryllium	07440-41-7	0.004	0.004
Cadmium	07440-43-9	0.005	0.005
Chromium (total)	07440-47-3	0.1	0.1
Copper	07440-50-8	1.3	TT; Action Level=1.3
Cyanide (as free cyanide)	00057-12-5	0.2	0.2
Fluoride	16984-48-8	4	4

Inorganic Chemicals

Contaminant	CAS number	MCLG (mg/L)	MCL or TT (mg/L)
Lead	07439-92-1	0	TT; Action Level=0.015
Mercury (inorganic)	07439-97-6	0.002	0.002
Nitrate (measured as Nitrogen)		10	10
Nitrite (measured as Nitrogen)		1	1
Selenium	07782-49-2	0.05	0.05
Thallium	07440-28-0	0.0005	0.002

Organic Chemicals

Contaminant	CAS number	MCLG (mg/L)	MCL or TT (mg/L)
Acrylamide	00079-06-1	0	TT
Alachlor	15972-60-8	0	0.002
Atrazine	01912-24-9	0.003	0.003
Benzene	00071-43-2	0	0.005
Benzo(a)pyrene (PAHs)	00050-32-8	0	0.0002
Carbofuran	01563-66-2	0.04	0.04
Carbon tetrachloride	00056-23-5	0	0.005
Chlordane	00057-74-9	0	0.002
Chlorobenzene	00108-907	0.1	0.1
2,4-Dichloro-phenoxyacetic acid (2,4-D)	00094-75-7	0.07	0.07
Dalapon	00075-99-0	0.2	0.2
1,2-Dibromo-3-chloropropane (DBCP)	00096-12-8	0	0.0002
o-Dichlorobenzene	00095-50-1	0.6	0.6
p-Dichlorobenzene	00106-46-7	0.075	0.075
1,2-Dichloroethane	00107-06-2	0	0.005
1,1-Dichloroethylene	00075-35-4	0.007	0.007
cis-1,2-Dichloroethylene	00156-59-2	0.07	0.07
trans-1,2-Dichloroethylene	00156-60-5	0.1	0.1
Dichloromethane	00074-87-3	0	0.005
1,2-Dichloropropane	00078-87-5	0	0.005
Di(2-ethylhexyl) adipate	00103-23-1	0.4	0.4
Di(2-ethylhexyl) phthalate	00117-81-7	0	0.006
Dinoseb	00088-85-7	0.007	0.007
Dioxin (2,3,7,8-TCDD)	01746-01-6	0	0.00000003
Diquat		0.02	0.02
Endothall	00145-73-3	0.1	0.1
Endrin	00072-20-8	0.002	0.002
Epichlorohydrin		0	TT
Ethylbenzene	00100-41-4	0.7	0.7
Ethylene dibromide	00106-93-4	0	0.00005
Glyphosate	01071-83-6	0.7	0.7
Heptachlor	00076-44-8	0	0.0004

Organic Chemicals

Contaminant	CAS number	MCLG (mg/L)	MCL or TT (mg/L)
Heptachlor epoxide	01024-57-3	0	0.0002
Hexachlorobenzene	00118-74-1	0	0.001
Hexachlorocyclopentadiene	00077-47-4	0.05	0.05
Lindane	00058-89-9	0.0002	0.0002
Methoxychlor	00072-43-5	0.04	0.04
Oxamyl (Vydate)	23135-22-0	0.2	0.2
Polychlorinated biphenyls (PCBs)		0	0.0005
Pentachlorophenol	00087-86-5	0	0.001
Picloram	01918-02-1	0.5	0.5
Simazine	00122-34-9	0.004	0.004
Styrene	00100-42-5	0.1	0.1
Tetrachloroethylene	00127-18-4	0	0.005
Toluene	00108-88-3	1	1
Toxaphene	08001-35-2	0	0.003
2,4,5-TP (Silvex)	00093-72-1	0.05	0.05
1,2,4-Trichlorobenzene	00120-82-1	0.07	0.07
1,1,1-Trichloroethane	00071-55-6	0.2	0.2
1,1,2-Trichloroethane	00079-00-5	0.003	0.005
Trichloroethylene	00079-01-6	0	0.005
Vinyl chloride	00075-01-4	0	0.002
Xylenes (total)		10	10

Radionuclides

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Alpha particles	none ---------- zero	15 picocuries per Liter (pCi/L)
Beta particles and photon emitters	none ---------- zero	4 millirems per year
Radium 226 and Radium 228 (combined)	none ---------- zero	5 pCi/L
Uranium	zero	30 ug/L

Table 2.4 - Secondary Drinking Water Standards

Contaminant	CAS number	Standard
Aluminum	07439-90-5	0.05 to 0.2 mg/L
Chloride		250 mg/L
Color		15 (color units)
Copper	07440-50-8	1.0 mg/L
Corrosivity		Non-corrosive
Fluoride	16984-48-8	2.0 mg/L
Foaming Agents (surfactants)		0.5 mg/L
Iron	07439-89-6	0.3 mg/L
Manganese	07439-96-5	0.05 mg/L
Odor		3 threshold odor number
pH		6.5-8.5
Silver	07440-22-4	0.10 mg/L
Sulfate	14808-79-8	250 mg/L
Total Dissolved Solids		500 mg/L
Zinc	07440-66-6	5 mg/L

New York State is a primacy state and has assumed responsibility for the implementation of the drinking water protection program.

2.4.3.2 New York State

Authorization to use water for a public drinking water system is subject to Article 15, Title 15 of the ECL administered by the Department, while the design and operation of a public drinking water system and quality of drinking water is regulated under the State Sanitary Code 10 NYCRR, Subpart 5-1 administered by NYSDOH.[27]

Anyone planning to operate or operating a public water supply system must obtain a Water Supply Permit from the Department before undertaking any of the regulated activities.

Contact with the Department and submission of a Water Supply Permit application will automatically involve NYSDOH, which has a regulatory role in water quality and other sanitary aspects of a project relating to human health. Through the State Sanitary Code (Chapter 1 of 10 NYCRR), NYSDOH oversees the suitability of water for human consumption. Section 5-1.30 of

[27] 6 NYCRR 601 – http://www.dec.ny.gov/regs/4445.html.

10 NYCRR[28] prescribes the required minimum treatment for public water systems, which depends on the source water type and quality. To assure the safety of drinking water in New York, NYSDOH, in cooperation with its partners, the county health departments, regulates the operation, design and quality of public water supplies; assures water sources are adequately protected, and sets standards for constructing individual water supplies.

NYSDOH standards, established in regulations found at Section 5-1.51 of 10 NYCRR and accompanying Tables in Section 1.52, meet or exceed national drinking water standards. These standards address national primary standards, secondary standards and other contaminants, including those not listed in federal standards such as principal organic contaminants with specific chemical compound classification and unspecified organic contaminants.

2.4.4 Public Water Systems

Public water systems in New York range in size from that of NYC, the largest engineered water system in the nation, serving more than nine million people, to those run by municipal governments or privately-owned water supply companies serving municipalities of varying size and type, schools with their own water supply, and small retail outlets in rural areas serving customers water from their own wells. Privately owned, residential wells supplying water to individual households do not require a water supply permit. In total, there are nearly 10,000 public water systems in New York State. A majority of the systems (approximately 8,460) rely on groundwater aquifers, although a majority of the State's population is served by surface water sources. Public water systems include community water systems (CWS) and non-community water systems (NCWS). NCWSs include non-transient non-community (NTNC) and transient non-community (TNC) water systems. NYSDOH regulations contain the definitions listed in Table 2.5.

[28] 10 NYCRR 5-1.30 – http://www.health.state.ny.us/nysdoh/phforum/nycrr10.htm.

Table 2.5 - Public Water System Definition[29]

Public water system means a community, non-community or non-transient non-community water system which provides water to the public for human consumption through pipes or other constructed conveyances, if such system has at least five service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. Such term includes:

a. collection, treatment, storage and distribution facilities under control of the supplier of water of such system and used with such system; and
b. collection or pretreatment storage facilities not under such control which are used with such system.

Community water system (CWS) means a public water system which serves at least five service connections used by year-round residents or regularly serves at least 25 year-round residents.

Noncommunity water system (NCWS) means a public water system that is not a community water system.

Non-transient noncommunity water system (NTNC) means a public water system that is not a community water system but is a subset of a noncommunity water system that regularly serves at least 25 of the same people, four hours or more per day, for four or more days per week, for 26 or more weeks per year.

Transient noncommunity water system (TNC) means a noncommunity water system that does not regularly serve at least 25 of the same people over six months per year.

2.4.4.1 Primary and Principal Aquifers

About one quarter of New Yorkers rely on groundwater as a source of potable water. In order to enhance regulatory protection in areas where groundwater resources are most productive and most vulnerable, the NYSDOH, in 1981, identified 18 Primary Water Supply Aquifers (also referred to simply as Primary Aquifers) across the State. These are defined in the Division of Water (DOW) Technical and Operational Guidance Series (TOGS) 2.1.3[30] as "highly productive aquifers presently utilized as sources of water supply by major municipal water supply systems."

Many Principal Aquifers have also been identified and are defined in the DOW TOGS as "highly productive, but which are not intensively used as sources of water supply by major municipal systems at the present time." Principal Aquifers are those known to be highly productive aquifers or where the geology suggests abundant potential supply, but are not presently being heavily used for public water supply. The 21 Primary and the many Principal Aquifers greater than one square mile in area within New York State (excluding Long Island) are shown on

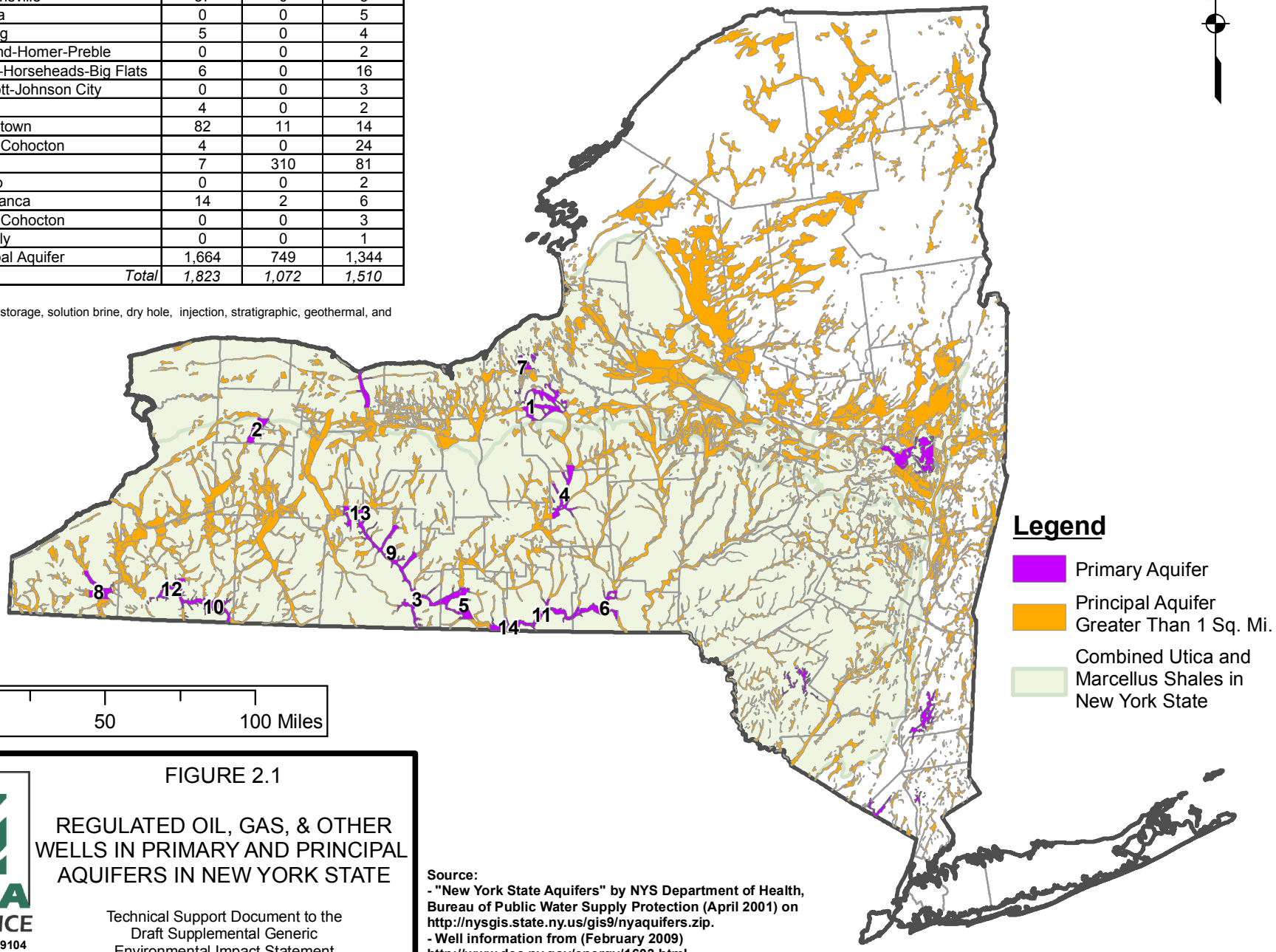
[29] 10 NYCRR, Part 5, Subpart 5-1 Public Water Systems (Current as of: October 1, 2007); SUBPART 5-1; PUBLIC WATER SYSTEMS; 5-1.1 Definitions. (Effective Date: May 26, 2004).

[30] http://www.dec.ny.gov/docs/water_pdf/togs213.pdf.

Map No.	Aquifer Name	Number of Wells Within Mapped Aquifer Boundary		
		Gas Wells	Oil Wells	Other Wells*
1	Baldwinsville	37	0	3
2	Batavia	0	0	5
3	Corning	5	0	4
4	Cortland-Homer-Preble	0	0	2
5	Elmira-Horseheads-Big Flats	6	0	16
6	Endicott-Johnson City	0	0	3
7	Fulton	4	0	2
8	Jamestown	82	11	14
9	Lower Cohocton	4	0	24
10	Olean	7	310	81
11	Owego	0	0	2
12	Salamanca	14	2	6
13	Upper Cohocton	0	0	3
14	Waverly	0	0	1
	Principal Aquifer	1,664	749	1,344
	Total	*1,823*	*1,072*	*1,510*

Notes:

* - Other wells include storage, solution brine, dry hole, injection, stratigraphic, geothermal, and not listed well types.



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Alpha Project No. 09104

FIGURE 2.1

REGULATED OIL, GAS, & OTHER WELLS IN PRIMARY AND PRINCIPAL AQUIFERS IN NEW YORK STATE

Technical Support Document to the Draft Supplemental Generic Environmental Impact Statement

Source:
- "New York State Aquifers" by NYS Department of Health, Bureau of Public Water Supply Protection (April 2001) on http://nysgis.state.ny.us/gis9/nyaquifers.zip.
- Well information from (February 2009) http://www.dec.ny.gov/energy/1603.html

Figure 2.1. The remaining portion of the State is underlain by smaller aquifers or low-yielding groundwater sources that typically are suitable only for small community and non-community public water systems or individual household supplies.[31]

2.4.4.2 Public Water Supply Wells

NYSDOH estimates that over two million New Yorkers outside of Long Island are served by public groundwater supplies.[32] Most public water systems with groundwater sources pump and treat groundwater from wells. Public groundwater supply wells are governed by Subpart 5-1 of the State Sanitary Code under 10 NYCRR.[33]

2.4.5 Private Water Wells and Domestic-Supply Springs

There are potentially tens to hundreds of thousands of private water supply wells in the State. To ensure that private water wells provide adequate quantities of water fit for consumption and intended uses, they need to be located and constructed to maintain long-term water yield and reduce the risk of contamination. Improperly constructed water wells can allow for easy transport of contaminants to the well and pose a significant health risk to users. New, replacement or renovated private wells are required to be in compliance with the New York State Residential Code, NYSDOH Appendix 5-B "Standards for Water Wells,"[34] installed by a certified Department-registered water well contractor and have groundwater as the water source. However, many private water wells installed before these requirements took effect are still in use. The 1992 GEIS describes how improperly constructed private water wells are susceptible to pollution from many sources, and proposes a 150-foot setback to protect vulnerable private wells.[35]

NYSDOH includes springs – along with well points, dug wells and shore wells – as susceptible sources that are vulnerable to contamination from pathogens, spills and the effects of drought.[36]

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[31] Alpha, 2009, p. 3-2.

[32] http://www.health.state.ny.us/environmental/water/drinking/facts_figures.htm.

[33] http://www.health.state.ny.us/environmental/water/drinking/part5/subpart5.htm.

[34] http://www.health.state.ny.us/environmental/water/drinking/part5/appendix5b.htm.

[35] NYSDEC, 1992, GEIS, p. 8-22.

[36] http://www.health.state.ny.us/environmental/water/drinking/part5/append5b/fs5_susceptible_water_sources.htm.

Use of these sources for drinking water is discouraged and should be considered only as a last resort with proper protective measures. With respect to springs, NYSDOH specifically states:

> Springs occur where an aquifer discharges naturally at or near the ground surface, and are broadly classified as either rock or earth springs. It is often difficult to determine the true source of a spring (that is, whether it truly has the natural protection against contamination that a groundwater aquifer typically has.) Even if the source is a good aquifer, it is difficult to develop a collection device (e.g., "spring box") that reliably protects against entry of contaminants under all weather conditions. (The term "spring box" varies, and, depending on its construction, would be equivalent to, and treated the same, as either a spring, well point or shore well.) Increased yield and turbidity during rain events are indications of the source being under the direct influence of surface water.[37]

Because of their vulnerability, and because in addition to their use as drinking water supplies they also supply water to wetlands, streams and ponds, the 1992 GEIS proposes a 150-foot setback.[38]

For oil and gas regulatory purposes, potable fresh water is defined as water containing less than 250 ppm of sodium chloride or 1,000 ppm TDS[39] and salt water is defined as containing more than 250 ppm sodium chloride or 1,000 ppm TDS.[40] Groundwater from sources below approximately 850 feet in New York typically is too saline for use as a potable water supply; however, there are isolated wells deeper than 850 feet that produce potable water and wells less than 850 feet that produce salt water. A depth of 850 feet to the base of potable water is commonly used as a practical generalization for the maximum depth of potable water; however, a variety of conditions affect water quality, and the maximum depth of potable water in an area should be determined based on the best available data.[41]

2.4.6 History of Drilling and Hydraulic Fracturing in Water Supply Areas

A tabulated summary of the regulated oil, gas, and other wells located within the boundaries of the Primary and Principal Aquifers in the State is provided on Figure 2.1. There are 482 oil and gas wells located within the boundaries of 14 Primary Aquifers and 2,413 oil and gas wells

[37] NYSDOH - http://www.health.ny.gov/environmental/water/drinking/part5/append5b/docs/fs5_susceptible_water_sources.pdf.

[38] NYSDEC, 1992, GEIS, p. 8-16.

[39] 6 NYCRR Part 550.3(ai).

[40] 6 NYCRR Part 550.3(at).

[41] Alpha, 2009, p. 3-3.

located within the boundaries of Principal Aquifers. Another 1,510 storage, solution brine, injection, stratigraphic, geothermal, and other deep wells are located within the boundaries of the mapped aquifers. The remaining regulated oil and gas wells likely penetrate a horizon of potable freshwater that can be used by residents or communities as a drinking water source. These freshwater horizons include unconsolidated deposits and bedrock units.[42]

Chapter 4, on Geology, includes a generalized cross-section (Figure 4.3) across the Southern Tier of New York State which illustrates the depth and thickness of rock formations including the prospective shale formations.

No documented instances of groundwater contamination from previous horizontal drilling or hydraulic fracturing projects in New York are recorded in the Department's well files or records of complaint investigations. No documented incidents of groundwater contamination in public water supply systems could be recalled by the NYSDOH central office and Rochester district office (NYSDOH, 2009a; NYSDOH, 2009b). References have been made to some reports of private well contamination in Chautauqua County in the 1980s that may be attributed to oil and gas drilling (Chautauqua County Department of Health, 2009; NYSDOH, 2009a; NYSDOH, 2009b; Sierra Club, undated). The reported Chautauqua County incidents, the majority of which occurred in the 1980s and which pre-date the current casing and cementing practices and fresh water aquifer supplementary permit conditions, could not be substantiated because pre-drilling water quality testing was not conducted, improper tests were run which yielded inconclusive results and/or the incidents of alleged well contamination were not officially confirmed.[43]

An operator caused turbidity (February 2007) in nearby water wells when it continued to pump compressed air for many hours through the drill string in an attempt to free a stuck drill bit at a well in the Town of Brookfield, Madison County. The compressed air migrated through natural fractures in the shallow bedrock because the well had not yet been drilled to the permitted surface casing seat depth. This non-routine incident was reported to the Department and staff were dispatched to investigate the problem. The Department shut down drilling operations and ordered the well plugged when it became apparent that continued drilling at the wellsite would cause

[42] Alpha, 2009, p. 3-3.

[43] Alpha, 2009, p. 3-3.

turbidity to increase above what had already been experienced. The operator immediately provided drinking water to the affected residents and subsequently installed water treatment systems in several residences. Over a period of several months the turbidity abated and water wells returned to normal. Operators that use standard drilling practices and employ good oversight in compliance with their permits would not typically cause the excessive turbidity event seen at the Brookfield wells. The Department has no records of similar turbidity caused by well drilling as occurred at this Madison County well. Geoffrey Snyder, Director Environmental Health Madison County Health Department, stated in a May 2009 email correspondence regarding the Brookfield well accident that, "Overall we find things have pretty much been resolved and the water quality back to normal if not better than pre-incident conditions."

2.4.7 Regulated Drainage Basins

New York State is divided into 17 watersheds, or drainage basins, which are the basis for various management, monitoring, and assessment activities.[44] A watershed is an area of land that drains into a body of water, such as a river, lake, reservoir, estuary, sea or ocean. The watershed includes the network of rivers, streams and lakes that convey the water and the land surfaces from which water runs off into those water bodies. Since all of New York State's land area is incorporated into watersheds, all oil and gas drilling that has occurred since 1821 has occurred within watersheds, specifically, in 13 of the State's 17 watersheds. Watersheds are separated from adjacent watersheds by high points, such as mountains, hills and ridges. Groundwater flow within watersheds may not be controlled by the same topographic features as surface water flow.

The river basins described below are subject to additional jurisdiction by existing regulatory bodies with respect to certain specific activities related to high-volume hydraulic fracturing.

The delineations of the Susquehanna and Delaware River Basins in New York are shown on Figure 2.2.

2.4.7.1 Delaware River Basin

Including Delaware Bay, the Delaware River Basin comprises 13,539 square miles in four states (New York, Pennsylvania, Delaware and New Jersey). Approximately 18.5 % of the surface area

[44] See map at http://www.dec.ny.gov/lands/26561.html.

of the basin, or 2,362 square miles, lies within portions of Broome, Chenango, Delaware, Schoharie, Greene, Ulster, Sullivan and Orange Counties in New York. This acreage overlaps with NYC's West of Hudson Watershed; the Basin supplies about half of NYC's drinking water and 100% of Philadelphia's supply.

The DRBC was established by a compact among the federal government, New York, New Jersey, Pennsylvania and Delaware to coordinate water resource management activities and the review of projects affecting water resources in the basin. New York is represented on the DRBC by a designee of New York State's Governor, and the Department has the opportunity to provide input on projects requiring DRBC action.

DRBC has identified its areas of concern with respect to natural gas drilling as reduction of flow in streams or aquifers, discharge or release of pollutants into ground water or surface water, and treatment and disposal of hydraulic fracturing fluid. DRBC staff will also review drill site characteristics, fracturing fluid composition and disposal strategy prior to recommending approval of shale gas development projects in the Delaware River Basin.[45]

2.4.7.2 Susquehanna River Basin

The Susquehanna River Basin comprises 27,510 square miles in three states (New York, Pennsylvania and Maryland) and drains into the Chesapeake Bay. Approximately 24 % of the basin, or 6,602 square miles, lies within portions of Allegany, Livingston, Steuben, Yates, Ontario, Schuyler, Chemung, Tompkins, Tioga, Cortland, Onondaga, Madison, Chenango, Broome, Delaware, Schoharie, Otsego, Herkimer and Oneida Counties in New York.

[45] http://www.state.nj.us/drbc/naturalgas.htm

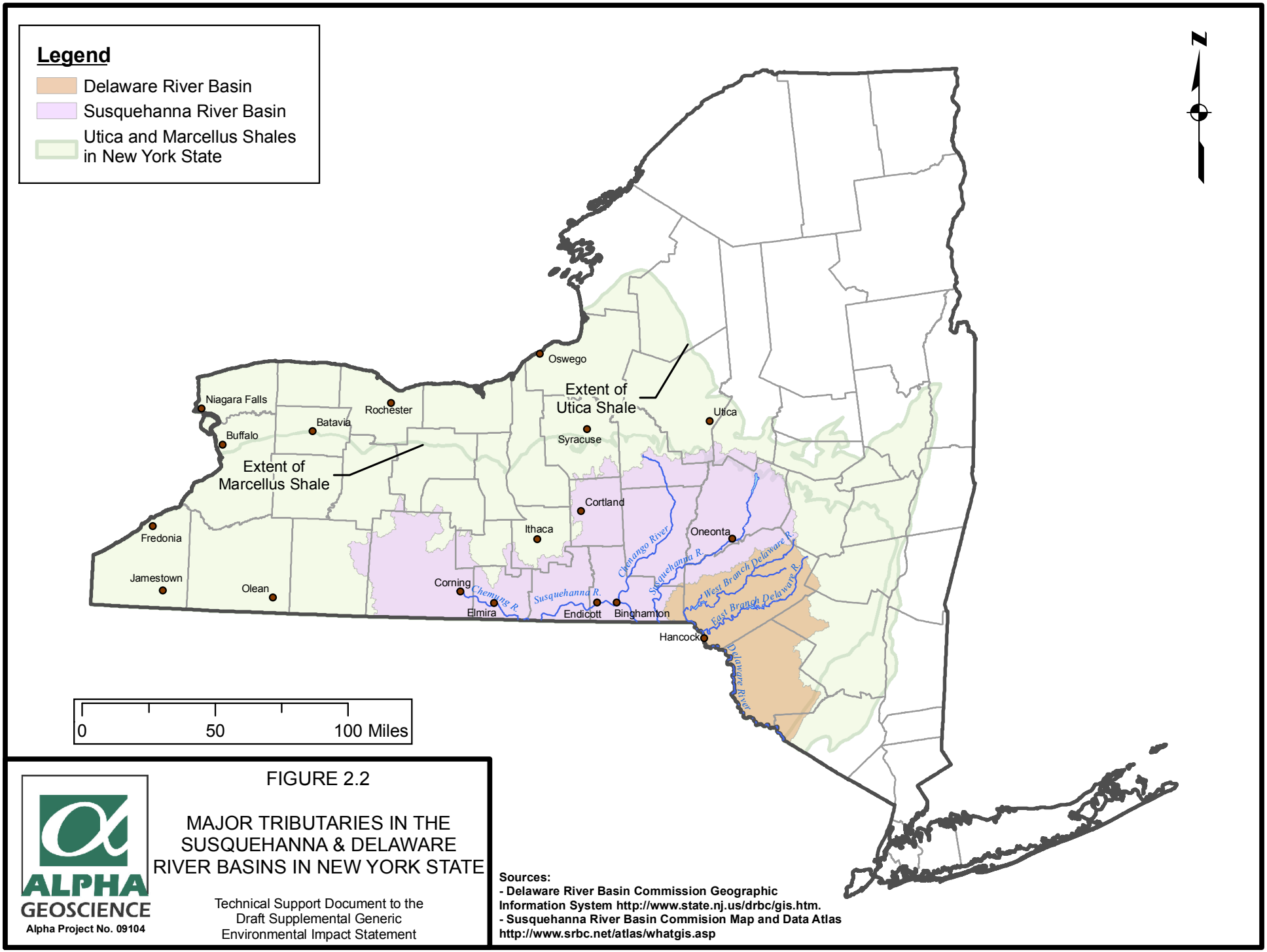


FIGURE 2.2

MAJOR TRIBUTARIES IN THE SUSQUEHANNA & DELAWARE RIVER BASINS IN NEW YORK STATE

Technical Support Document to the Draft Supplemental Generic Environmental Impact Statement

ALPHA GEOSCIENCE

Alpha Project No. 09104

Sources:
- Delaware River Basin Commission Geographic Information System http://www.state.nj.us/drbc/gis.htm.
- Susquehanna River Basin Commision Map and Data Atlas http://www.srbc.net/atlas/whatgis.asp

The SRBC was established by a compact among the federal government, New York, Pennsylvania and Maryland to coordinate water resource management activities and review of projects affecting water resources in the Basin. New York is represented on the SRBC by a designee of the Department's Commissioner, and the Department has the opportunity to provide input on projects requiring SRBC action.

The Susquehanna River is the largest tributary to the Chesapeake Bay, with average annual flow to the Bay of over 20 billion gallons per day (gpd). Based upon existing consumptive use approvals plus estimates of other uses below the regulatory threshold requiring approval, SRBC estimates current maximum use potential in the Basin to be 882.5 million gpd. Projected maximum consumptive use in the Basin for gas drilling, calculated by SRBC based on twice the drilling rate in the Barnett Shale play in Texas, is about 28 million gpd as an annual average.[46]

2.4.7.3 Great Lakes-St. Lawrence River Basin

In New York, the Great Lakes-St. Lawrence River Basin is the watershed of the Great Lakes and St. Lawrence River, upstream from Trois Rivieres, Quebec, and includes all or parts of 34 counties, including the Lake Champlain and Finger Lakes sub-watersheds. Approximately 80 percent of New York's fresh surface water, over 700 miles of shoreline, and almost 50% of New York's lands are contained in the drainage basins of Lake Ontario, Lake Erie, and the St. Lawrence River. Jurisdictional authorities in the Great Lakes-St. Lawrence River Basin, in addition to the Department, include the Great Lakes Commission, the Great Lakes Fishery Commission, the International Joint Commission, the Great Lakes-St. Lawrence River Water Resources Compact Council, and the Great Lakes-St. Lawrence Sustainable Water Resources Regional Body.

2.4.8 Water Resources Replenishment[47]

The ability of surface water and groundwater systems to support withdrawals for various purposes, including natural gas development, is based primarily on replenishment (recharge). The Northeast region typically receives ample precipitation that replenishes surface water (runoff and groundwater discharge) and groundwater (infiltration).

[46] http://www.srbc.net/programs/projreviewmarcellustier3.htm.

[47] Alpha, 2009, p. 3-26.

The amount of water available to replenish groundwater and surface water depends on several factors and varies seasonally. A "water balance" is a common, accepted method used to describe when the conditions allow groundwater and surface water replenishment and to evaluate the amount of withdrawal that can be sustained. The primary factors included in a water balance are precipitation, temperature, vegetation, evaporation, transpiration, soil type, and slope.

Groundwater recharge (replenishment) occurs when the amount of precipitation exceeds the losses due to evapotranspiration (evaporation and transpiration by plants) and water retained by soil moisture. Typically, losses due to evapotranspiration are large in the growing season and consequently, less groundwater recharge occurs during this time. Groundwater also is recharged by losses from streams, lakes, and rivers, either naturally (in influent stream conditions) or induced by pumping. The amount of groundwater available from a well and the associated aquifer is typically determined by performing a pumping test to determine the safe yield, which is the amount of groundwater that can be withdrawn for an extended period without depleting the aquifer. Non-continuous withdrawal provides opportunities for water resources to recover during periods of non-pumping.

Surface water replenishment occurs directly from precipitation, from surface runoff, and by groundwater discharge to surface water bodies. Surface runoff occurs when the amount of precipitation exceeds infiltration and evapotranspiration rates. Surface water runoff typically is greater during the non-growing season when there is little or no evapotranspiration, or where soil permeability is relatively low.

Short-term variations in precipitation may result in droughts and floods which affect the amount of water available for groundwater and surface water replenishment. Droughts of significant duration reduce the amount of surface water and groundwater available for withdrawal. Periods of drought may result in reduced stream flow, lowered lake levels, and reduced groundwater levels until normal precipitation patterns return.

Floods may occur from short or long periods of above-normal precipitation and rapid snow melt. Flooding results in increased flow in streams and rivers and may increase levels in lakes and reservoirs. Periods of above-normal precipitation that may cause flooding also may result in

increased groundwater levels and greater availability of groundwater. The duration of floods typically is relatively short compared to periods of drought.

The SRBC and DRBC have established evaluation processes and mitigation measures to ensure adequate replenishment of water resources. The evaluation processes for proposed withdrawals address recharge potential and low-flow conditions. Examples of the mitigation measures utilized by the SRBC include:

- Replacement – release of storage or use of a temporary source;
- Discontinue – specific to low-flow periods;
- Conservation releases;
- Payments; and
- Alternatives – proposed by applicant.

Operational conditions and mitigation requirements establish passby criteria and withdrawal limits during low-flow conditions. A passby flow is a prescribed quantity of flow that must be allowed to pass an intake when withdrawal is occurring. Passby requirements also specify low-flow conditions during which no water can be withdrawn.

2.4.9 Floodplains

Floodplains are low-lying lands next to rivers and streams. When left in a natural state, floodplain systems store and dissipate floods without adverse impacts on humans, buildings, roads or other infrastructure. Floodplains can be viewed as a type of natural infrastructure that can provide a safety zone between people and the damaging waters of a flood. Changes to the landscape outside of floodplain boundaries, like urbanization and other increases in the area of impervious surfaces in a watershed, may increase the size of floodplains. Floodplain information is found on Flood Insurance Rate Maps (FIRMs) produced by the Federal Emergency Management Agency (FEMA). These maps are organized on either a county, town, city or

village basis and are available through the FEMA Map Service Center.[48] They may also be viewed at local government facilities, the Department, and county and regional planning offices.

A floodplain development permit issued by a local government (town, city or village) must be obtained before commencing any floodplain development activity. This permit must comply with a local floodplain development law (often named Flood Damage Prevention Laws), designed to ensure that development will not incur flood damages or cause additional off-site flood damages. These local laws, which qualify communities for participation in the National Flood Insurance Program (NFIP), require that any development in mapped, flood hazard areas be built to certain standards, identified in the NFIP regulations (44 CFR 60.3) and the Building Code of New York State and the Residential Code of New York State. Floodplain development is defined to mean any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures (including gas and liquid storage tanks), mining, dredging, filling, paving, excavation or drilling operations, or storage of equipment or materials. Virtually all communities in New York with identified flood hazard areas participate in the NFIP.

The area that would be inundated by a 100-year flood (also thought of as an area that has a one percent or greater chance of experiencing a flood in any single year) is designated as a Special Flood Hazard Area. The 100-year flood is also known as the *base flood*, and the elevation that the base flood reaches is known as the base flood elevation (BFE). The BFE is the basic standard for floodplain development, used to determine the required elevation of the lowest floor of any new or substantially improved structure. For streams where detailed hydraulic studies have identified the BFE, the 100-year floodplain has been divided into two zones, the floodway and the floodway fringe. The floodway is that area that must be kept open to convey flood waters downstream. The floodway fringe is that area that can be developed in accordance with FEMA standards as adopted in local law. The floodway is shown either on the community's FIRM or on a separate "Flood Boundary and Floodway" map or maps published before about 1988. Flood Damage Prevention Laws differentiate between more hazardous floodways and other areas inundated by flood water. In particular for floodways, no encroachment can be permitted unless

[48] http://msc.fema.gov.

there is an engineering analysis that proves that the proposed development does not increase the BFE by any measurable amount at any location.

Each participating community in the State has a designated floodplain administrator. This is usually the building inspector or code enforcement official. If development is being considered for a flood hazard area, then the local floodplain administrator reviews the development to ensure that construction standards have been met before issuing a floodplain development permit.

2.4.9.1 Analysis of Recent Flood Events[49]

The Susquehanna and Delaware River Basins in New York are vulnerable to frequent, localized flash floods every year. These flash floods usually affect the small tributaries and can occur with little advance warning. Larger floods in some of the main stem reaches of these same river-basins also have been occurring more frequently. For example, the Delaware River in Delaware and Sullivan Counties experienced major flooding along the main stem and in its tributaries during more than one event from September 2004 through June 2006 (Schopp and Firda, 2008). Significant flooding also occurred along the Susquehanna River during this same time period.

The increased frequency and magnitude of flooding has raised a concern for unconventional gas drilling in the floodplains of these rivers and tributaries, and the recent flooding has identified concerns regarding the reliability of the existing FEMA FIRMs that depict areas that are prone to flooding with a defined probability or recurrence interval. The concern focused on the Susquehanna and Delaware Rivers and associated tributaries in Steuben, Chemung, Tioga, Broome, Chenango, Otsego, Delaware and Sullivan Counties, New York.

2.4.9.2 Flood Zone Mapping[50]

Flood zones are geographic areas that FEMA has defined according to varying levels of flood risk. These zones are depicted on a community's FIRM. Each zone reflects the severity or type of flooding in the area and the level of detailed analysis used to evaluate the flood zone.

[49] Alpha, 2009, p. 3-30.

[50] Alpha, 2009, p. 3-30.

Appendix 1 Alpha's Table 3.4 – FIRM Maps summarizes the availability of FIRMs for New York State as of July 23, 2009 (FEMA, 2009a). FIRMs are available for all communities in Broome, Delaware, and Sullivan Counties. The effective date of each FIRM is included in Appendix 1**.** As shown, many of the communities in New York use FIRMs with effective dates prior to the recent flood events. Natural and anthropogenic changes in stream morphology (e.g., channelization) and land use/land cover (e.g., deforestation due to fires or development) can affect the frequency and extent of flooding. For these reasons, FIRMs are updated periodically to reflect current information. Updating FIRMs and incorporation of recent flood data can take two to three years (FEMA, 2009b).

While the FIRMs are legal documents that depict flood-prone areas, the most up-to-date information on extent of recent flooding is most likely found at local or county-wide planning or emergency response departments (DRBC, 2009). Many of the areas within the Delaware and Susquehanna River Basins that were affected by the recent flooding of 2004 and 2006 lie outside the flood zones noted on the FIRMs (SRBC, 2009; DRBC, 2009; Delaware County 2009). Flood damage that occurs outside the flood zones often is related to inadequate maintenance or sizing of storm drain systems and is unrelated to streams. Mapping the areas affected by recent flooding in the Susquehanna River Basin currently is underway and is scheduled to be published in late 2012 (SRBC, 2011). Updated FIRMs are being prepared for communities in Delaware County affected by recent flooding and are expected to be released in late 2012 (Delaware County, 2011).

According to the DOW, preliminary county-wide FIRMs have been completed and adopted by Sullivan County. County-wide FIRMs for Broome and Delaware Counties are scheduled to be completed in late 2012.

2.4.9.3 Seasonal Analysis[51]

The historic and recent flooding events do not show a seasonal trend. Flooding in Delaware County, which resulted in Presidential declarations of disaster and emergency between 1996 and 2006, occurred during the following months: January 1996, November 1996, July 1998, August 2003, October 2004, August 2004 and April 2005 (Tetra Tech, 2005). The Delaware River and many of its tributaries in Delaware and Sullivan Counties experienced major flooding that caused

[51] Alpha, 2009, p. 3-31.

extensive damage from September 2004 to June 2006 (Schopp and Firda, 2008). These data show that flooding is not limited to any particular season and may occur at any time during the year.

2.4.10 Freshwater Wetlands

Freshwater wetlands are lands and submerged lands, commonly called marshes, swamps, sloughs, bogs, and flats, supporting aquatic or semi-aquatic vegetation. These ecological areas are valuable resources, necessary for flood control, surface and groundwater protection, wildlife habitat, open space, and water resources. Freshwater wetlands also provide opportunities for recreation, education and research, and aesthetic appreciation. Adjacent areas may share some of these values and, in addition, provide a valuable buffer for the wetlands.

The Department has classified regulated freshwater wetlands according to their respective functions, values and benefits. Wetlands may be Class I, II, III or IV. Class I wetlands are the most valuable and are subject to the most stringent standards.

The Freshwater Wetlands Act (FWA), Article 24 of the ECL, provides the Department and the Adirondack Park Agency (APA) with the authority to regulate freshwater wetlands in the State. The NYS Legislature passed the Freshwater Wetlands Act in 1975 in response to uncontrolled losses of wetlands and problems resulting from those losses, such as increased flooding. The FWA protects wetlands larger than 12.4 acres (5 hectares) in size, and certain smaller wetlands of unusual local importance. In the Adirondack Park, the APA regulates wetlands, including wetlands above one acre in size, or smaller wetlands if they have free interchange of flow with any surface water. The law requires the Department and APA to map those wetlands that are protected by the FWA. In addition, the law requires the Department and APA to classify wetlands. Inside the Adirondack Park, wetlands are classified according to their vegetation cover type. Outside the Park, the Department classifies wetlands according to 6 NYCRR Part 664, Wetlands Mapping and Classification.[52] Around every regulated wetland is a regulated adjacent area of 100 feet, which serves as a buffer area for the wetland.

FWA's main provisions seek to regulate those uses that would have an adverse impact on wetlands, such as filling or draining. Other activities are specifically exempt from regulation,

[52] 6 NYCRR 664 - http://www.dec.ny.gov/regs/4612.html.

such as cutting firewood, continuing ongoing activities, certain agricultural activities, and most recreational activities like hunting and fishing. In order to obtain an FWA permit, a project must meet the permit standards in 6 NYCRR Part 663, Freshwater Wetlands Permit Requirement Regulations.[53] Intended to prevent despoliation and destruction of freshwater wetlands, these regulations were designed to:

- preserve, protect, and enhance the present and potential values of wetlands;
- protect the public health and welfare; and
- be consistent with the reasonable economic and social development of the State.

2.4.11 Socioeconomic Conditions[54]

The Marcellus and Utica Shales are the most prominent shale formations in New York State. The prospective region for the extraction of natural gas from these formations generally extends from Chautauqua County eastward to Greene, Ulster, and Sullivan Counties, and from the Pennsylvania border north to the approximate location of the east-west portion of the New York State Thruway, between Schenectady and Auburn (Figure 2.3). This region covers all or parts of 30 counties. Fourteen counties are entirely within the area underlain by the Marcellus and Utica Shales, and 16 counties are partially within the area.

Due to the broad extent of the prospective region for the extraction of natural gas from the Marcellus and Utica Shales, the socioeconomic analysis in the SGEIS focuses on representative regional and local areas of New York State where natural gas extraction may occur, and also provides a statewide analysis. The three regions were selected to evaluate differences between areas with a high, moderate and low production potential; areas that have experienced gas development in the past and areas that have not experienced gas development in the past; and differences in land use patterns. The three representative regions and the respective counties within the region are:

[53] 6 NYCRR 663 - http://www.dec.ny.gov/regs/4613.html.

[54] Subsection 2.4.11, in its entirety, was provided by Ecology and Environment Engineering, P.C., August 2011 and was adapted by the Department.

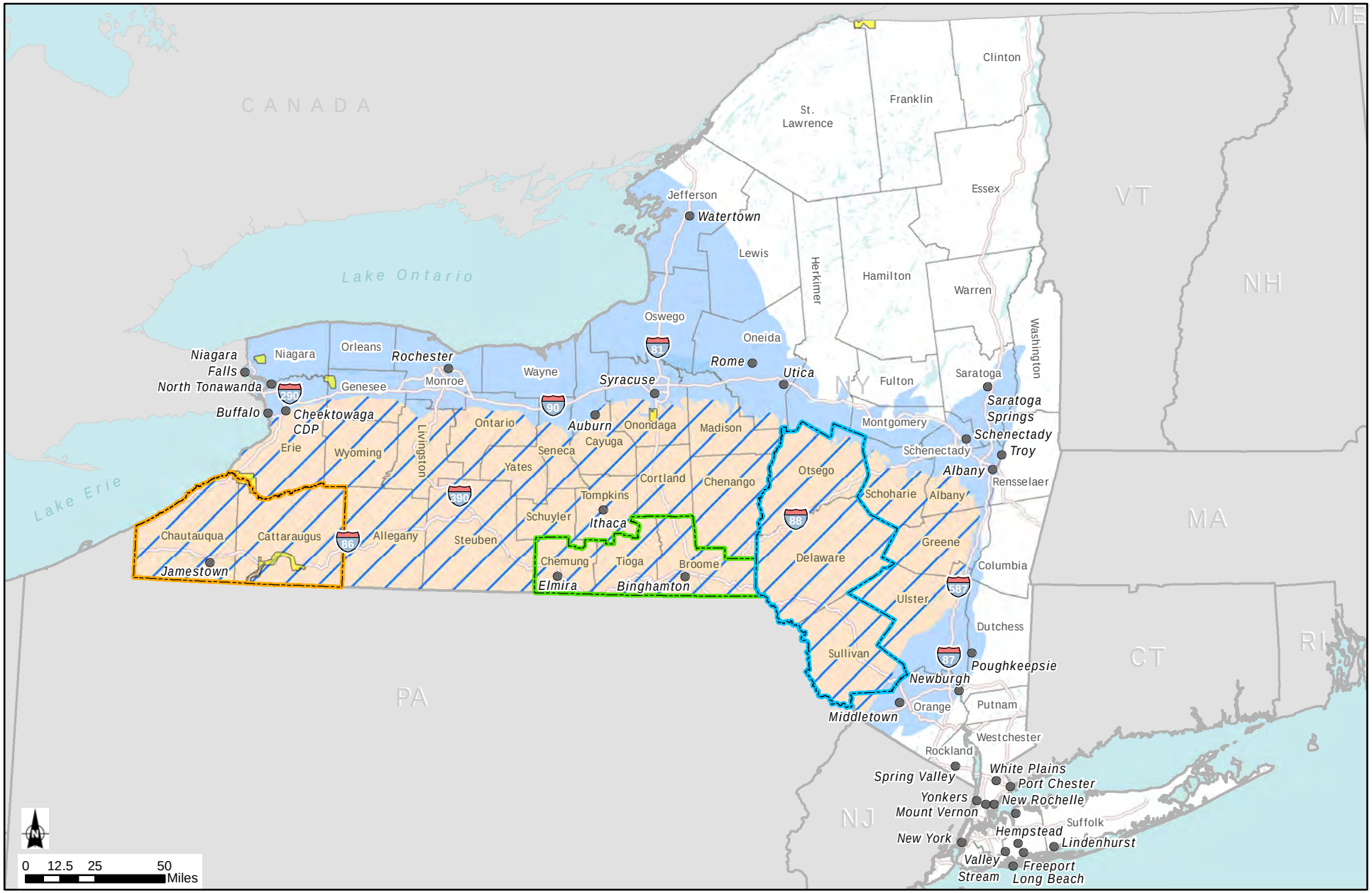


Figure 2.**3**: Representative Regions within the Marcellus Shale Extent in New York

Source: ESRI, 2010; USGS, 2002

- Region A: Broome County, Chemung County, and Tioga County (Figure 2.4a);
- Region B: Delaware County, Otsego County, and Sullivan County (Figure 2.4b); and
- Region C: Cattaraugus County and Chautauqua County (Figure 2.4c);

Region A is defined as a high-potential production area. Wells in Broome, Chemung, and Tioga Counties are expected to yield some of the highest production of shale gas, based on the geology, thermal maturity of the organic matter, and other geochemical factors of the Marcellus and Utica Shale formations. Due to the proximity to active gas drilling in these counties, and neighboring counties in Pennsylvania, the associated infrastructure (pipelines) has already been developed. With the associated infrastructure in place, developers are expected to begin development of wells in this area if development in New York State is approved. Region A encompasses urban/suburban land uses associated with the larger cities of Binghamton and Elmira, as well as rural settings. In addition, conventional natural gas development has occurred in this area.

Region B is defined as an average-potential production area. High-volume hydraulic-fracturing is expected to occur in portions of Delaware, Otsego, and Sullivan Counties, but the production of shale gas is not anticipated to reach the levels expected in Region A. Region B is largely rural and encompasses part of the Catskill Mountains. Development in this region would be limited by the exclusion of drilling from the New York City watershed and state-owned lands (e.g., the Forest Preserve) in the Catskill Mountains. To date, only exploratory natural gas well development has occurred in this region.

Region C is defined as a low-potential production area. Although Chautauqua and Cattaraugus Counties are within the footprints of both the Utica and Marcellus Shales, they are outside of the fairways for both shales; thus, horizontal wells in this region would not be expected to yield enough gas to be economically feasible. However, thousands of vertical gas wells exist in conventional formations, and additional vertical wells would likely be constructed. If the price of gas increases or drilling technology advances, gas production in the Utica or other formations in this region may become more feasible. Region C is largely rural, and conventional natural gas development has been occurring in this area for many years.

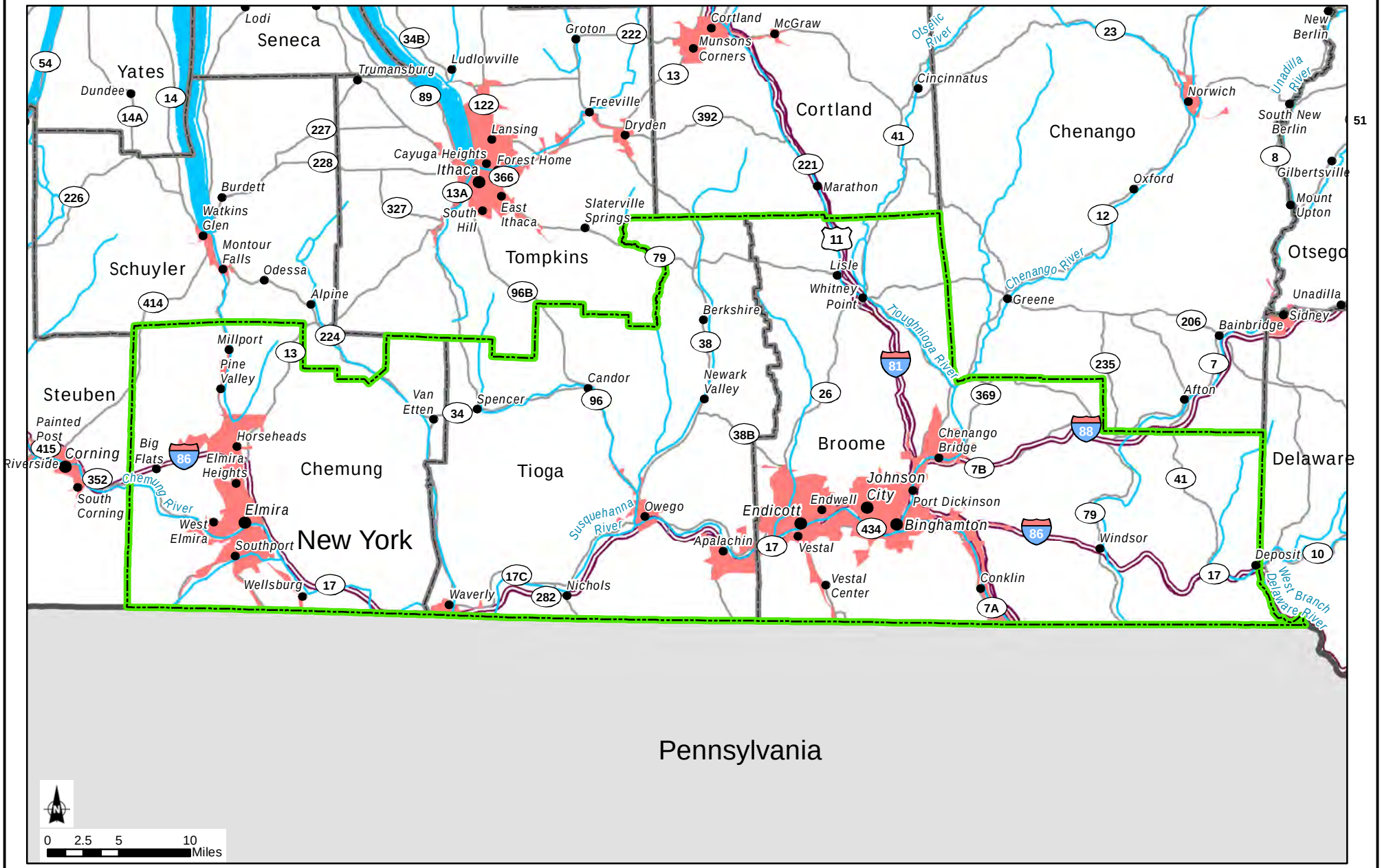


Figure 2.**4**a: Representative Region A

Source: ESRI, 2010; USGS, 2002

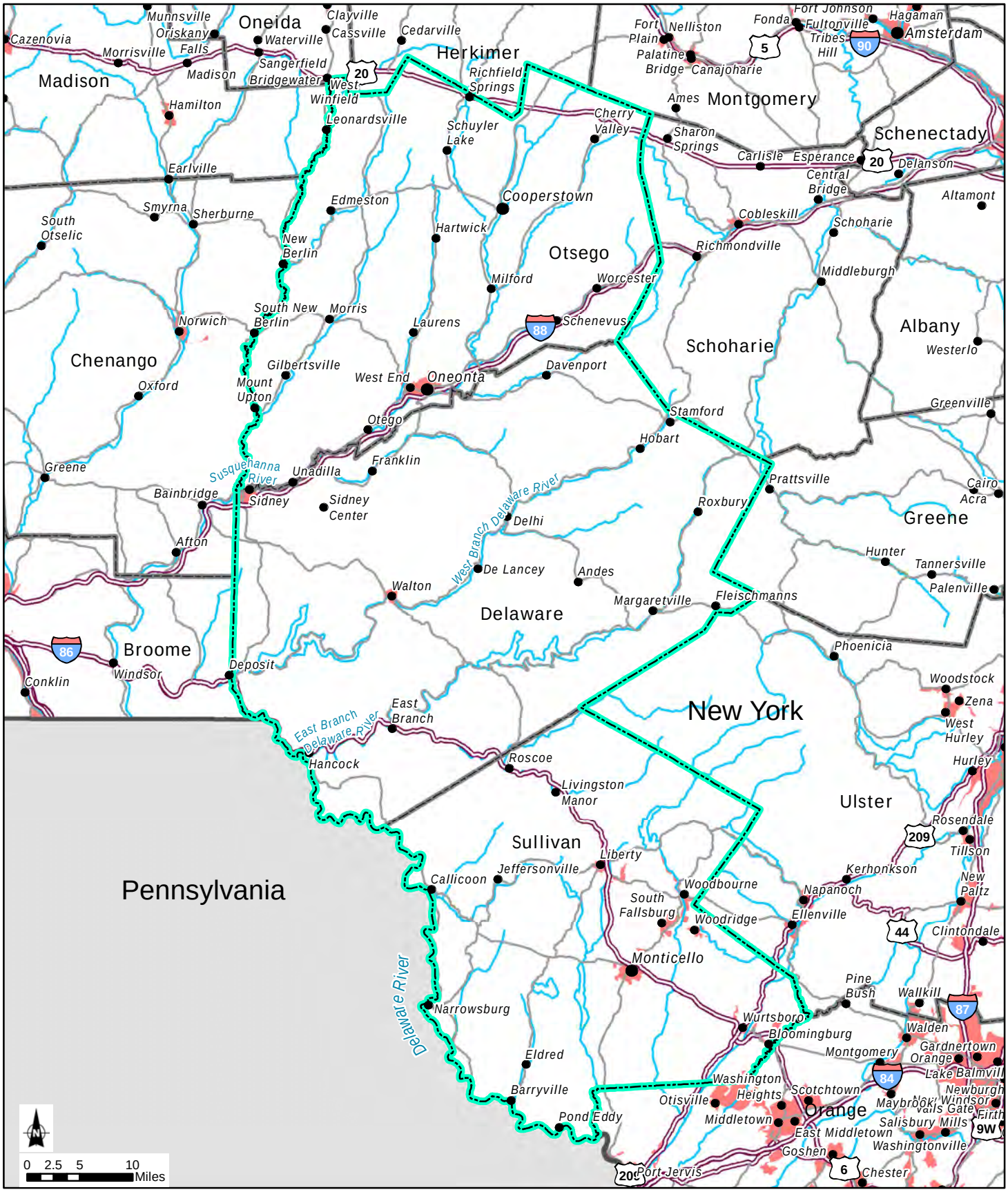


Figure 2.4b: Representative Region B

Source: NESRI, 2010; USGS, 2002

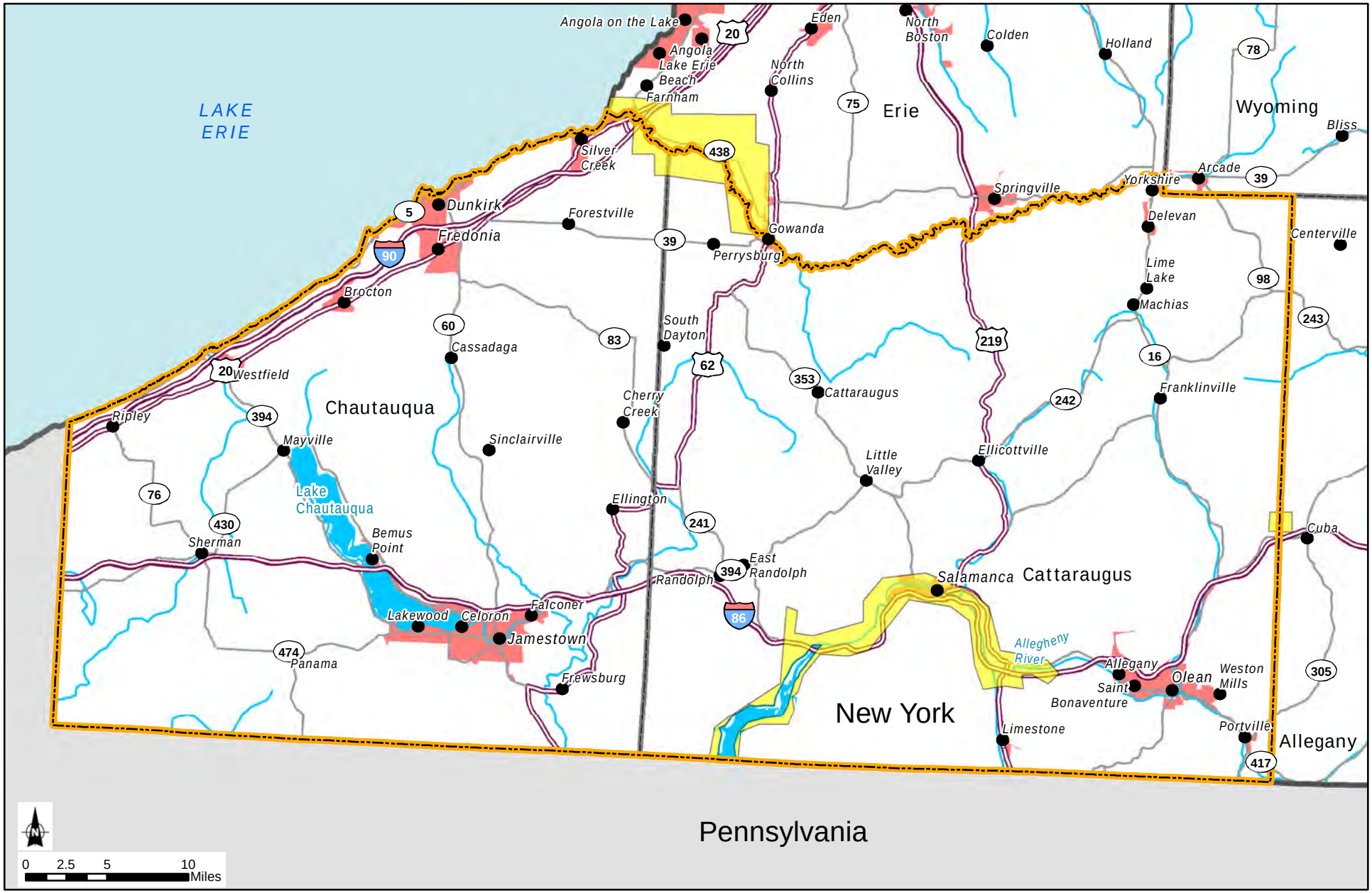


Figure 2.**4**c: Representative Region C

Source: NESRI, 2010; USGS, 2002

While these regions are being analyzed as a way to assess the impacts on representative local communities, actual development would not be limited to these regions, and impacts similar to those described in Section 6 could occur anywhere where high-volume hydraulic-fracturing wells are developed. Therefore, this section also provides the socioeconomic baseline for the state as a whole.

A description of the baseline socioeconomic conditions includes Economy, Employment and Income (Subsection 2.4.11.1); Population (Subsection 2.4.11.2); Housing (Subsection 2.4.11.3); Government Revenues and Expenditures (Subsection 2.4.11.4); and Environmental Justice (EJ) (Subsection 2.4.11.5). Socioeconomic impacts are discussed in Chapter 6, and socioeconomic mitigation measures are discussed in Chapter 7.

2.4.11.1 Economy, Employment, and Income

This subsection provides a discussion of the economy, employment and income for New York State, and the local areas within each of the three representative regions (Region A, B and C), focusing on the agricultural and tourism industries, as well as existing natural gas development.

Natural gas development is expected to benefit other industries as equipment, material, and supplies are purchased by the natural gas industry and workers spend their wages in the local economy. These positive impacts are discussed in more detail in Section 6. However, as agriculture and tourism relate to uses of the land that may be impacted by natural gas development, those industries are discussed in more detail herein, and potential impacts from both a land use and economic perspective are discussed in Chapter 6.

Several data sources were used to describe the baseline economy, employment, and income for New York State and the local areas, including the U.S. Census Bureau (USCB) and the New York State Department of Labor (NYSDOL). Data from the *2010 Census of Population and Housing* were used to identify major employment sectors for the state and the representative regions. Data from the census is self-reported by individuals and is aggregated to provide general information about the labor force from very small to large geographic areas on a cross-sectional or one-time basis.

Detailed data on employment and wages, by industry, was obtained from the NYSDOL's quarterly census of employment and wages (QCEW). The NYSDOL collects employment and wage data for all employers liable for unemployment insurance. These data were used to provide information on wages and for more detailed information on employment in the travel and tourism and oil and gas sectors. All of the labor statistics from the NYSDOL and USCB are based on the North American Industry Classification System, which is the standard system used by government agencies to classify businesses, although the data may be grouped differently for reporting purposes. Data on agricultural workers is taken from the U.S. Census of Agriculture, which is collected every 5 years, and provides information on the value of farm production and agricultural employment in the state and local areas. Although the data referenced within this section were collected by government agencies using different methodologies, all data were used to support an overall portrait of the statewide and local economies.

New York State

Table 2.6 presents total employment by industry within New York State. As shown, New York State has a large and diverse economy. The largest employment sector in the state is educational, health, and social services, accounting for approximately 26.2% of the total employed labor force (USCB 2009a). Other large sectors are professional, scientific, management, administrative, and waste management services (10.8%); and retail trade (10.5%). Several of the largest private employers in New York State include NY Presbyterian Healthcare System (29,000 employees); Walmart (28,000 employees); Citigroup (27,000 employees); IBM Corporation (21,000 employees); and JP Morgan Chase (21,000 employees).

Table 2.6 - New York State: Area Employment by Industry, 2009 (New August 2011)

Sector	Number of Jobs	% of Total
Agriculture, forestry, fishing, hunting, and mining	54,900	0.6
Construction	548,018	6.0
Manufacturing	672,481	7.4
Wholesale trade	266,946	2.9
Retail trade	959,414	10.5
Transportation and warehousing, utilities	482,768	5.3
Information	299,378	3.3
Finance, insurance, real estate, and renting/leasing	789,372	8.7
Professional, scientific, management, administrative, and waste management services	981,317	10.8
Educational, health, and social services	2,385,864	26.2
Arts, entertainment, recreation, accommodation, and food services	764,553	8.4
Other services (except public administration)	449,940	4.9
Public administration	447,645	4.9
Total	9,102,596	

Source: USCB 2009a.

In 2010, New York State had a total gross domestic product (GDP, i.e., the value of the output of goods and services produced by labor and property located in New York State) of approximately $1.16 trillion (USDOC 2010).

Each region of the state contributes to the state's GDP in different ways. New York City is the leading center of banking, finance, and communications in the United States, and thus has a large number of workers employed in these industrial sectors. In contrast, the economies of large portions of western and central New York are based on agriculture. Manufacturing also plays a significant role in the overall economy of New York State; most manufacturing occurs in the upstate regions, predominantly in the cities of Albany, Buffalo, Rochester, and Syracuse.

Table 2.7 provides total and average wages, by industry, as reported by NYSDOL for 2009.

Table 2.7 - New York State: Wages by Industry, 2009 (New August 2011)

Industry	Total Wages ($ millions)	Average Wage
Total, all industries	$481,690.6	$57,794
Agriculture, forestry, fishing, hunting	640.4	$28,275
Mining	265.5	$55,819
Construction	19,336.0	$59,834
Manufacturing	27,098.4	$57,144
Wholesale trade	22,797.7	$69,282
Retail trade	25,130.8	$29,202
Transportation and warehousing	9,302.9	$42,477
Utilities	3,633.7	$92,469
Information	22,124.3	$87,970
Finance and insurance	86,303.4	$173,899
Real estate and renting/leasing	9,360.2	$52,417
Professional and technical services	48,815.9	$87,136
Management of companies and enterprises	15,648.4	$119,804
Administrative and waste services	16,354.4	$40,546
Educational services	13,606.9	$46,772
Health, and social assistance	55,486.7	$44,104
Arts, entertainment, and recreation	6,154.3	$44,246
Accommodation, and food services	12,178.7	$21,369
Other services (except public administration)	10,732.4	$33,602
Public administration	75,828.4	$52,594

Source: NYSDOL 2009a.

The total labor force in New York State in 2010 was approximately 9,630,900 workers. In 2010, the annual average unemployment rate across New York State was 8.6% (Table 2.8). Between 2000 and 2010, the size of the labor force increased by 5.1%, while the unemployment rate nearly doubled.

Table 2.8 - New York State: Labor Force Statistics, 2000 and 2010 (New August 2011)

	2000	2010
Total labor force	9,167,000	9,630,900
Employed workers	8,751,400	8,806,800
Unemployed workers	415,500	824,100
Unemployment rate (%)	4.5	8.6

Source: NYSDOL 2010a.

In 2009, the per capita income for New York State was $30,634, and 13.9% of the population lived below the poverty level (Table 2.9). Over the past decade, per capita income has increased by 31.0%, and the percentage of individuals living below the poverty level has decreased by 0.7%.

Table 2.9 - New York State: Income Statistics, 1999 and 2009 (New August 2011)

	1999	**2009**
Per capita income	$23,389	$30,634
% Below the poverty level[1]	14.6	13.9

Source: USCB 2000a, 2009b.

[1] If the total income for an individual falls below relevant poverty thresholds, updated annually relative to the Consumer Price Index for All Urban Consumers, then the individual is classified as being "below the poverty level."

The Empire State Development Corporation has identified 16 industry clusters for New York State. Industry clusters define a set of interdependent and connected companies and businesses that help to support a local economy, such as automobile manufacturing in Detroit, Michigan, and information technology in the Silicon Valley of California. Industry clusters for the state include: back office and outsourcing; biomedical; communications, software, and media services; distribution; electronics and imaging; fashion, apparel, and textiles; financial services; food processing; forest products; front office and producer services; industrial machinery and services; information technology services; materials processing; miscellaneous manufacturing; transportation equipment; and travel and tourism.

Travel and tourism is a large industry in New York State, ranking third in employment of the 16 industry clusters in the state. New York State has many notable attractions, including natural areas (Niagara Falls, the Finger Lakes, and the Adirondack, Catskill, and Allegany Mountains); cultural attractions (museums, arts, theater), and historic sites, many of which are described in Section 2.4.12, Visual Resources. The travel and tourism sector draws from several industries, as shown in Table 2.10 and Table 2.11. Approximately 351,130 persons were employed in the travel and tourism sector in New York State in 2009, including food service (96,990 jobs); culture, recreation, and amusements (84,550 jobs); accommodations (81,780 jobs); passenger transportation (73,180 jobs); and travel retail (14,630) (see Table 2.10). In 2009, wages earned by persons employed in the travel and tourism sector was approximately $12.9 billion dollars, or approximately 2.7% of all wages earned in New York State (NYSDOL 2009b) (see Table 2.11).

In 2009, visitors to New York State spent approximately $4.5 billion in the state (Tourism Economics 2010).

Table 2.10 - New York State: Employment in Travel and Tourism, 2009 (New August 2011)

Industry Group	Number of Jobs	% of Total
Accommodations	81,780	23.3%
Culture, recreation and amusements	84,550	24.1%
Food service	96,990	27.6%
Passenger transportation	73,180	20.8%
Travel retail	14,630	4.2%
Total	351,130	100%

Source: NYSDOL 2009b.

Table 2.11 - New York State: Wages in Travel and Tourism, 2009 (New August 2011)

	Total Wages ($ millions)	Average Wage
Accommodations	$2,928.3	$35,800
Culture, recreation and amusements	$4,355.5	$51,500
Food service	$1,840.9	$18,980
Passenger transportation	$3,478.4	$47,532
Travel retail	$324.1	$22,153
Total	$12,927.3	$36,800

Source: NYSDOL 2009b.

Agriculture is also an important industry for New York State. Table 2.12 provides agricultural statistics for New York State. Approximately 36,352 farms are located in New York State, encompassing 7.2 million acres of land, or 23% of the total land area of the state.

The value of agricultural production in 2009 was $4.4 billion dollars. New York State is a leading producer of milk, fruits (apples, grapes, cherries, pears), and fresh vegetables (sweet corn, onions, and cabbage). Most of the state's field crops (corn, soybeans, and wheat) support its dairy industry (USDA 2007).

Most counties in New York State have placed agricultural land in state-certified agricultural districts, which are managed by the New York State Department of Agriculture and Markets. Farmlands within agricultural districts are provided legal protection, and farmers benefit from preferential real property tax assessment and protection from restrictive local laws, government-funded acquisition or construction projects, and private nuisance suits involving agricultural

practices. Article 25-AA of Agriculture and Markets Law authorizes the creation of local agricultural districts pursuant to landowner initiative, preliminary county review, state certification, and county adoption.

The acreage of land in agricultural districts in New York State is provided on Table 2.12.

Table 2.12 - New York State: Agricultural Data, 2007 (New August 2011)

Number of farms	36,352
Land in farms	7,174,743 acres
Average size of farm	197 acres
Market value of products sold	$4,418.6 million
Principal operator by primary occupation	
Farming	19,624
Other	16,728
Hired farm labor	59,683
Land in state-designated agricultural districts	8,873,157 acres

Source: USDA 2007; NYSDAM 2011.

The oil and gas extraction industry is a relatively small part of the economy of New York State. According to data provided by the U.S. Department of Commerce (USDOC), Bureau of Economic Analysis (BEA), the oil and gas extraction industry accounted for only 0.004% of New York State's GDP in 2009. For comparison purposes, at the national level, the oil and gas extraction industry's 2009 share of the U.S. GDP was 1.01% (USDOC 2010). Consequently, the oil and gas extraction industry is currently of less relative economic importance in New York State than it is at the national level.

The natural gas extraction industry is linked to other industries in New York State through its purchases of their output of goods and services. As a natural gas extraction company increases the number of wells it drills, it needs additional supplies and materials (e.g., concrete) from other industries to complete the wells. The other industries, in turn, need additional goods and services from their suppliers to meet the additional demand. The interrelations between various industries are known as linkages in the economy.

To provide a sense of the direction and magnitude of the linkages for the oil and gas extraction industry, Table 2.13 shows the impact of a $1 million increase in the final demand in the oil and gas extraction industry on the value of the output of other industries in New York State. The data

used to construct the table were drawn from the estimates contained in the BEA's Regional Input-Output Modeling System II (RIMS II). In constructing the table, the initial $1 million increase in the final demand for the output of the oil and gas extraction industry was deducted from the change in its output value to leave just the increase in its output value caused by its purchases of goods and services from other companies in the mining industry, of which it forms a part.

Table 2.13 - New York: Impact of a $1 Million Dollar Increase in the Final Demand in the Output of the Oil and Gas Extraction Industry on the Value of the Output of Other Industries (New August 2011)

Industry	Change in the Value of Output
Real estate and rental and leasing	$47,100
Professional, scientific, and technical services	$30,500
Management of companies and enterprises	$27,600
Construction	$24,300
Manufacturing	$21,000
Finance and insurance	$15,700
Utilities	$12,300
Wholesale trade	$10,800
Information	$7,700
Administrative and waste management services	$5,900
Transportation and warehousing	$3,900
Retail trade	$3,100
Other services	$2,600
Arts, entertainment, and recreation	$1,600
Mining	$1,500
Food services and drinking places	$700
Accommodation	$600
Health care and social assistance	$300
Educational services	$200

Source: US Bureau of Economic Analysis 2011.

As shown in the table above, the oil and gas extraction industry is linked through its purchases of inputs to 18 other major industries (out of a total of 20 industries used by the Regional Input-Output Modeling System II). The largest linkages are to real estate and rental and leasing; professional, scientific, and technical services; management of companies and enterprises; and construction. In total, a $1 million increase in the final demand for the output of the mining industry is estimated to lead to an increase of an additional $217,400 in final output across all industries.

The oil and gas extraction industry accounts for a very small proportion of total employment in New York State. According to the NYSDOL, the oil and gas extraction industry employed 362 people in the state (i.e., less than 0.01% of the state's total employment) (NYSDOL 2009a). Although the number of people employed in the oil and gas extraction industry in New York State is relatively small, the industry has experienced sustained growth in employment during the last few years. Employment in the oil and gas extraction industry in New York State between 2000 and 2010 is shown on Table 2.14. As shown, employment in the industry more than doubled from 2003 to 2010, with the addition of 252 employees during that period.

Table 2.14 - New York State: Employment in the Oil and Gas Extraction Industry, 2000-2010 (New August 2011)

Year	Employment
2000	165
2001	188
2002	193
2003	196
2004	137
2005	163
2006	236
2007	281
2008	341
2009	362
2010	448

Source: NYSDOL 2000 -2008, 2009a, 2010b.
Note: 2010 data are provisional.

A general indication of the types of jobs held by those working in the natural gas extraction industry is provided by looking at the occupational distribution of employment within the oil and gas extraction industry at the national level. Table 2.15 presents employment data on the 20 occupations that accounted for the largest shares of employment in the oil and gas extraction industry at the national level in 2008 (BLS 2011).

Table 2.15 - Most Common Occupations in the U.S. Oil and Gas Extraction Industry, 2008 (New August 2011)

Occupation	% of Industry Employment
Roustabouts, oil and gas	7.45
Petroleum pump system operators, refinery operators, and gaugers	6.07
Petroleum engineers	5.43
Wellhead pumpers	5.41
Accountants and auditors	4.88
General and operations managers	4.18
Geoscientists, except hydrologists and geographers	3.88
Geological and petroleum technicians	3.27
Office clerks, general	3.03
Bookkeeping, accounting, and auditing clerks	2.93
Executive secretaries and administrative assistants	2.77
Secretaries, except legal, medical, and executive	2.49
Service unit operators, oil, gas, and mining	2.50
First-line supervisors/managers of construction trades and extraction workers	2.27
All other engineers	1.74
Business operation specialists, all others	1.72
Financial analysts	1.56
Maintenance and repair workers, general	1.43
Real estate sales agents	1.35
Rotary drill operators, oil and gas	1.33

Source: BLS 2011.

The oil and gas extraction industry is a relatively high-wage industry. In 2009, the average annual wage paid to employees in the industry was $83,606, which is almost 45% above the average annual wages of $57,794 paid to employees across all industries in the state (NYSDOL 2009a). However, national data show that workers in the mining, quarrying, and oil and gas extraction industry have the longest work week among all of the nonagricultural industries. The average work week for all workers aged over 16 in the nonagricultural industries was 38.1 hours long, while the average work week for those in the mining, quarrying, and oil and gas extraction industry was 49.4 hours long (i.e., an almost 30% longer average work week) (BLS 2010).

Table 2.16 presents total and average wages for the oil and gas industry and all industries in New York State. The oil and gas industry was a marginal contributor to total wages in New York State, accounting for $30 million in 2009, or less than 1/100th of a percentage point of total wages across all industries (NYSDOL 2009a).

Table 2.16 - New York State: Wages in the Oil and Gas Industry, 2009 (New August 2011)

	Total Wages ($ million)	**Average Wage**
Oil and gas industry	$30.3	$83,606
Total, all industries	$481,690.6	$57,794

Source: NYSDOL 2009a.

Compared to other parts of the country, New York State currently is a relatively minor natural gas producer. Based on data on natural gas gross withdrawals and production published by the Energy Information Administration (EIA), New York State accounted for 0.2% of the United States' total marketed natural gas production in 2009. During the same period, New York ranked 23rd out of 34 gas-producing areas in the U.S., which included states and the federal Offshore Gulf of Mexico (EIA 2011).

New York State is, however, a major natural gas consumer. Based on data on natural gas consumption by end-use published by the EIA, New York State accounted for 5% of the United States' total consumption of natural gas in 2009. During the same period, New York State was ranked as the 4th largest natural gas consumer among the nation's states (EIA 2011).

By combining the EIA's data on the total consumption and marketed production of natural gas in 2009, there was a difference of approximately 1.1 Tcf between New York State's total consumption and marketed production of natural gas. In 2009, New York State's marketed production was equal to 3.9% of its total consumption.

Table 2.17 shows natural gas production in New York State between 1985 and 2009.

Table 2.17 - New York State: Natural Gas Production, 1985-2009 (New August 2011)

Year	Natural Gas Production (Bcf)
1985	33.1
1986	34.8
1987	29.5
1988	28.1
1989	25.7
1990	25.1
1991	23.4
1992	23.6
1993	22.1
1994	20.5
1995	18.7
1996	18.3
1997	16.2
1998	16.7
1999	16.1
2000	17.7
2001	28.0
2002	36.8
2003	36.0
2004	46.9
2005	55.2
2006	55.3
2007	54.9
2008	50.3
2009	44.9

Source: NYSDEC 1994-2009.

As shown in the table, natural gas production in New York State generally declined between 1986 and 1999, increased steeply until 2005, and then declined toward the end of that decade.

Other indicators of the level of activity in the natural gas extraction industry in New York State are the number of well permits granted, the number of wells completed, and the number of active wells in each year. Table 2.18 shows the number of permits granted for gas wells, the number of gas wells completed, and the number of active gas wells in New York State between 1994 and 2009.

Table 2.18 - Permits Issued, Wells Completed, and Active Wells, NYS Gas Wells, 1994-2009 (New August 2011)

Year	Permits for Gas Wells	Gas Wells Completed	Active Gas Wells
1994	58	97	6,019
1995	38	31	6,216
1996	45	31	5,869
1997	53	22	5,741
1998	68	41	5,903
1999	74	28	5,756
2000	78	112	5,775
2001	127	103	5,949
2002	97	43	5,773
2003	81	31	5,906
2004	133	70	6,076
2005	180	104	5,957
2006	353	191	6,213
2007	386	271	6,683
2008	429	270	6,675
2009	246	134	6,628

Source: NYSDEC 1994-2009.

As with natural gas production, well permits and completions experienced a considerable increase in the 2000s compared to the 1990s, before declining in the late 2000s. This trend most likely reflects the discovery and development of commercial natural gas reserves in the Black River formation in the southern Finger Lakes area along with the impact of higher natural gas prices in the 2000s compared to the 1990s (see Table 2.19). As shown in Table 2.18, active natural gas wells reached a low point in 1997 when only 5,741 wells were active. By 2007, this figure had reached a peak of 6,683 wells.

The level of activity in the natural gas extraction industry is related to the price of natural gas. Table 2.19 shows the average wellhead price for New York State's natural gas for the years 1994 to 2009 inclusive.

Table 2.19 - Average Wellhead Price for New York State's Natural Gas, 1994-2009 (New August 2011)

Year	Price per Mcf
1994	$2.35
1995	$2.30
1996	$2.21
1997	$2.56
1998	$2.46
1999	$2.19
2000	$3.75
2001	$4.85
2002	$3.03
2003	$5.78
2004	$6.98
2005	$7.78
2006	$7.13
2007	$8.85
2008	$8.94
2009	$4.25

Source: NYSDEC 1994-2009.

As shown in the table, the average wellhead price for natural gas remained at relatively low levels in the 1990s, generally increased thereafter, reaching a peak in 2008, and then fell sharply in 2009.

Table 2.20 shows the market value of New York State's natural gas production, which is the price multiplied by the total production.

Table 2.20 - Market Value of New York State's Natural Gas Production, 1994-2009 (New August 2011)

Year	Millions of Dollars
1994	$48.1
1995	$43.0
1996	$40.6
1997	$41.5
1998	$41.1
1999	$34.7
2000	$66.4
2001	$135.5
2002	$111.7
2003	$207.4
2004	$327.7
2005	$429.5
2006	$394.6
2007	$486.0
2008	$450.0
2009	$188.8

Source: NYSDEC 1994-2009.

The combination of generally rising natural gas production and increasing average wellhead prices for much of the 2000s resulted in a substantial increase in the market value of New York State's natural gas production in the 2000s compared to the 1990s. The peak value of $486 million in 2007 was approximately 12 times larger than the average value for the years 1994 to 1999 inclusive (i.e., $41.51 million). However, between 2008 and 2009 the combination of a 10.7% decline in natural gas production and a 52.5% decline in the average wellhead price of natural gas resulted in a 58% decline in the market value of New York State's natural gas production.

Region A

Table 2.21 presents employment, by industry, within Tioga, Broome, and Chemung Counties, and for Region A. The largest employment sector in Region A is the educational, health, and social services sector, with approximately 28.7% of total employment in Region A (USCB 2009a). Manufacturing was the next largest employment sector, accounting for approximately 14.6% of total employment within the region. The economic center for Broome and Tioga Counties is the tri-city area of Binghamton, Endicott, and Johnson City, within the Binghamton Metropolitan Statistical Area (MSA). For Chemung County, the economic center is the city of Elmira.

Table 2.21 - Region A: Area Employment by Industry, 2009 (New August 2011)

	Region A		**Broome County**		**Chemung County**		**Tioga County**	
Sector	**Number of Jobs**	**% of Total**	**Number of Jobs**	**% of Total**	**Number of Jobs**	**% of Total**	**Number of Jobs**	**% of Total**
Agriculture, forestry, fishing, hunting, and mining	1,464	1.0	558	0.6	335	0.9	571	2.3
Construction	8,572	5.6	4,846	5.3	2,054	5.4	1,672	6.8
Manufacturing	22,522	14.6	11,957	13.1	6,030	15.8	4,535	18.5
Wholesale trade	4,749	3.1	3,123	3.4	959	2.5	667	2.7
Retail trade	18,358	11.9	10,721	11.8	4,599	12.1	3,038	12.4
Transportation and warehousing, utilities	5,808	3.8	3,840	4.2	1,228	3.2	740	3.0
Information	3,096	2.0	2,016	2.2	706	1.9	374	1.5
Finance, insurance, real estate, and renting/leasing	7,554	4.9	5,022	5.5	1,719	4.5	813	3.3
Professional, scientific, management, administrative, and waste management services	11,847	7.7	7,140	7.8	2,575	6.8	2,132	8.7

Sector	Region A		Broome County		Chemung County		Tioga County	
	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total
Educational, health, and social services	44,084	28.7	26,764	29.3	10,869	28.5	6,451	26.4
Arts, entertainment, recreation, accommodation, and food services	11,723	7.6	7,198	7.9	2,928	7.7	1,597	6.5
Other services (except public administration)	6,620	4.3	3,898	4.3	1,786	4.7	936	3.8
Public administration	7,435	4.8	4,154	4.6	2,348	6.2	933	3.8
Total	153,832		91,237		38,136		24,459	

Source: USCB 2009a.

Table 2.22 presents total and average wages across all industries for Region A. The average wages for persons employed across all industries in Region A was $37,875 in 2009.

Table 2.22 - Region A: Wages by Industry, 2009 (New August 2011)

	2009	
	Total Wages ($ millions)	Average Wages
Region A		
Total, all industries	$5,435.03	$37,875
Broome County		
Total, all industries	$3,390.12	$36,802
Chemung County		
Total, all industries	$1,379.61	$36,979
Tioga County		
Total, all industries	$665.30	$47,268

Source: NYSDOL 2009a, 2010b.

The total labor force for Region A is approximately 162,000 workers, of which 60% are in Broome County, 25% are in Chemung County, and 15% are in Tioga County. The annual average unemployment rate in Region A in 2010 was consistent with the overall state average unemployment rate of approximately 8.6% (Table 2.23). The rate of unemployment was slightly higher in Broome County than in Chemung or Tioga Counties. Overall, the size of the labor force has declined between 2000 and 2010 across the region, while the unemployment rate has generally doubled.

Table 2.23 - Region A: Labor Force Statistics, 2000 and 2010 (New August 2011)

	2000	2010
Region A		
Total labor force	167,700	162,000
Employed workers	161,400	148,000
Unemployed workers	6,300	14,000
Unemployment rate (%)	3.8	8.6
Broome County		
Total labor force	98,300	95,700
Employed workers	94,800	87,200
Unemployed workers	3,600	8,500
Unemployment rate (%)	3.6	8.9
Chemung County		
Total labor force	42,800	40,700
Employed workers	41,000	37,300
Unemployed workers	1,800	3,400
Unemployment rate (%)	4.3	8.4
Tioga County		
Total labor force	26,600	25,600
Employed workers	25,600	23,500
Unemployed workers	900	2,100
Unemployment rate (%)	3.4	8.2

Source: NYSDOL 2010a.

Table 2.24 presents per capita income for Region A. Per capita income rose approximately 26.8% between 1999 and 2009. The percentage of individuals living below the poverty level in Region A increased from 12.2% in 1999 to 14.4% in 2009. During the same period, individuals living below the poverty level in New York State as a whole decreased from 14.6% to 13.9% (USCB 2000a, 2009b).

Table 2.24 - Region A: Income Statistics, 1999 and 2009 (New August 2011)

	1999	2009
Region A		
Per capita income	$18,854	$23,912
% Below the poverty level[1]	12.2	14.4
Broome County		
Per capita income	$19,168	$24,432
% Below the poverty level[1]	12.8	15.0
Chemung County		
Per capita income	$18,264	$22,691
% Below the poverty level[1]	13.0	15.8
Tioga County		
Per capita income	$18,673	$24,034
% Below the poverty level[1]	8.4	10.0

Source: USCB 2000a, 2009b.

1 If the total income for an individual falls below relevant poverty thresholds, updated annually relative to the Consumer Price Index for All Urban Consumers, then the individual is classified as being "below the poverty level."

The five largest employers in the Binghamton MSA, which includes Broome and Tioga Counties are United Health Services, (3,300 employees); Lockheed Martin, (3,000 employees); Broome County (2,500 employees); the State University of New York Binghamton University (2,300 employees); and Lourdes Hospital (2,300 employees) (BCIDA 2010). The largest employer in Chemung County is St. Joseph's Hospital (1,000-1,200 employees) (STC Planning 2009).

The Empire State Development Corporation has identified 16 industry clusters for the Southern Tier Region of the state, which encompasses Region A (Broome, Chemung, and Tioga Counties) as well as Chenango, Delaware, Schuyler, Steuben, and Tompkins Counties. The industry clusters that support the largest number of jobs are industrial machinery and services, travel and tourism, financial services, front office and producer services, and electronics and imaging.

Travel and tourism is a large industry for the Southern Tier Region (which includes Region A), ranking second in employment of the 16 industry clusters in the Southern Tier Region. Broome and Tioga Counties are part of the Susquehanna Heritage Area, and Chemung County considers itself the gateway to the Finger Lakes Region. Various attractions and natural areas are described in more detail in Section 2.4.11, Visual Resources, and Section 2.4.14, Community Character. The travel and tourism industry employs approximately 4,590 persons throughout Region A (NYSDOL 2009b), primarily in food service (2,000 workers) and accommodations (1,190 workers) (Table 2.25). In 2009, wages earned by persons employed in the travel and tourism sector were approximately $78.6 million, or about 1.5% of all wages earned in Region A (NYSDOL 2009b) (Table 2.26).

Table 2.25 - Region A: Employment in Travel and Tourism, 2009 (New August 2011)

Industry Group	Region A		Broome County		Chemung County		Tioga County	
	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total
Accommodations	1,190	25.9	830	27.8	210	18.3	150	33.3
Culture, recreation, and amusements	530	11.5	320	10.7	100	8.7	110	24.4
Food service	2,000	43.6	1,340	44.8	530	46.1	130	28.9
Passenger transportation	540	11.8	330	11.0	210	18.3	0	-
Travel retail	330	7.2	170	5.7	100	8.7	60	13.3
Total	4,590		2,990		1,150		450	

Source: NYSDOL 2009b.

Table 2.26 - Region A: Wages in Travel and Tourism, 2009 (New August 2011)

	2009	
	Total Wages (millions)	Average Wages
Region A	$78.6	$17,100
Broome County	$50.3	$16,800
Chemung County	$20.9	$18,100
Tioga County	$7.4	$16,100

Source: NYSDOL 2009b.

Agriculture is also an important industry within Region A. Table 2.27 provides agricultural statistics for Broome, Chemung, and Tioga Counties. Approximately 1,518 farms are located in Region A, encompassing 258,571 acres of land. The value of agricultural production in 2009 was $83.2 million dollars (USDA 2007). The principal source of farm income is dairy products, which account for 70% of the agricultural sales in Broome County, and 75% of the sales in Tioga County (USDA 2007).

Table 2.27 - Region A: Agricultural Data, 2007 (New August 2011)

	Region A	Broome County	Chemung County	Tioga County
Number of farms	1,518	580	373	565
Land in farms (acres)	258,571	86,613	65,124	106,834
Average size of farm (acres)	170	149	175	189
Market value of Products Sold ($ millions)	83.2	29.9	16.6	36.7
Principal operator by primary occupation				
Farming	681	252	183	246
Other	837	328	190	319
Hired farm labor	971	340	238	393
Land in state-designated agricultural districts	278,935	153,233	41,966	83,736

Source: USDA 2007; NYSDAM 2011.

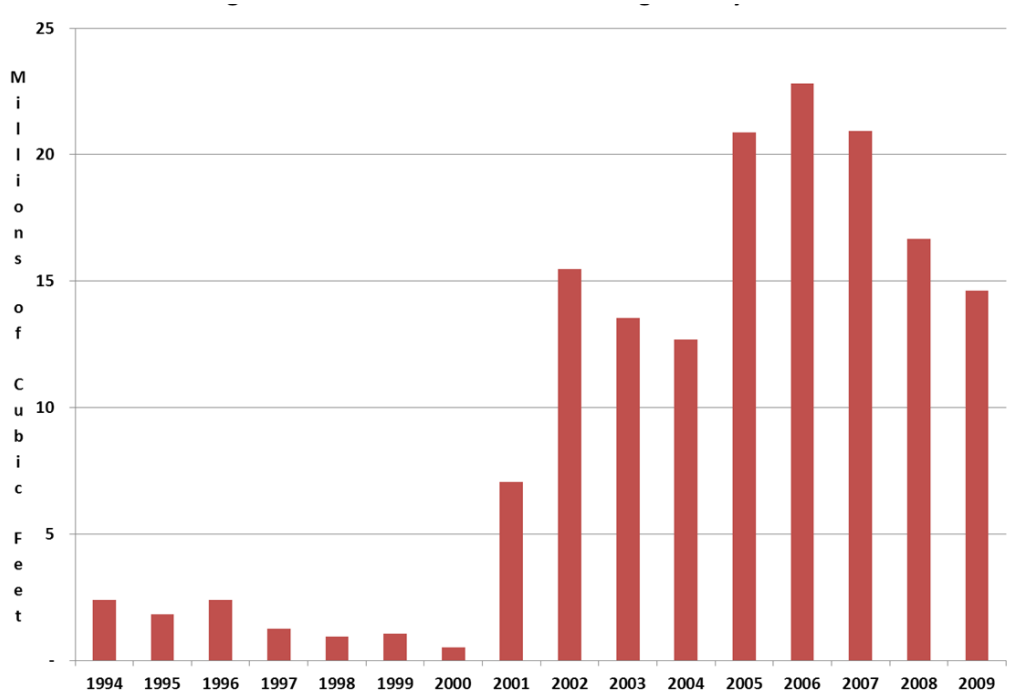
Approximately 125 persons are employed in the oil and gas industry in Region A, or about 34.5% of persons working in the oil and gas industry in New York State (NYSDOL 2009a, 2010b). Workers are primarily employed in Chemung County, as the data on oil and gas industry employment in Broome and Tioga Counties is so low as to not be reported due to business confidentiality reasons.

The oil and gas industry was a marginal contributor to total wages in Region A in 2009. Total wages for persons employed in the oil and gas industry in Chemung County were $12.5 million, or about 0.2% of total wages across all industries (NYSDOL 2009a, 2010b). The average annual wage for workers employed in the oil and gas sector in Chemung County was $99,600 in 2009.

In the 1990s, Region A was a minor contributor to New York State's natural gas production. However, starting in 2001, Region A experienced a substantial increase in its gas production, reaching a peak in 2006 before declining in each of the following three years (Figure 2.5).

Table 2.28 shows the number of active natural gas wells operating in Region A from 1994 to 2009. As shown on the table, the number of active wells in Region A has been steadily increasing since 1995.

Figure 2.5 - Region A: Natural Gas Production, 1994 to 2009 (New August 2011)



Source: NYSDEC 1994-2009.

Table 2.28 - Region A: Number of Active Natural Gas Wells, 1994-2009 (New August 2011)

Year	No. of Gas Wells
1994	15
1995	12
1996	15
1997	16
1998	17
1999	20
2000	19
2001	25
2002	29
2003	30
2004	36
2005	38
2006	37
2007	40
2008	41
2009	46

Source: NYSDEC 1994-2009.

In 2009, the average annual output per well in Region A was 317.9 MMcf of natural gas. The average production per well in Region A was greater (by a factor of 47) than the statewide average of 6.8 MMcf (NYSDEC 2009).

Table 2.29 shows the production of natural gas and the number of active wells, by town, within each county in Region A for 2009. As shown in the table, Chemung County accounted for nearly all of the natural gas production and active wells in Region A. There were no active natural gas wells in Broome County in 2009.

Table 2.29 – Natural Gas Production and Active Wells by Town within each County in Region A, 2009 (New August 2011)

Location	Natural Gas Production (Mcf)	Number of Active Gas Wells
Region A	**14,623,232**	**46**
Chemung County	13,890,161	45
Baldwin	327,738	1
Big Flats	2,095,184	4
Catlin	1,441,322	9
Elmira City	2,685	1
Erin	4,037,072	6
Horseheads	4,910	0
Southport	1,752,131	5
Van Etten	3,048,850	12
Veteran	1,180,269	7
Tioga County	733,071	1
Spencer	733,071	1

Source: NYSDEC 2009.

Region B

Table 2.30 presents employment, by industry, within Sullivan, Delaware, and Otsego Counties (Region B). The largest employment sectors are educational, health, and social services (30.1% of workers); retail trade (11.6%) arts, entertainment, recreation, accommodation, and food services (10.1%). This region also has a comparatively high number of employment in the agriculture, forestry, fishing, hunting, and mining sector (2.9%), particularly Delaware County (5.2%), compared to New York State as a whole (0.6%) (USCB 2009a).

Table 2.30 - Region B: Area Employment, by Industry, 2009 (New August 2011)

Industry Sector	Region B		Sullivan County		Delaware County		Otsego County	
	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total
Agriculture, forestry, fishing, hunting, and mining	2,498	2.9	591	1.7	1,102	5.2	805	2.7
Construction	7,276	8.5	3,178	9.2	2,051	9.7	2,047	6.8
Manufacturing	6,442	7.5	1,504	4.4	2,565	12.2	2,373	7.9
Wholesale Trade	2,134	2.5	924	2.7	432	2.0	778	2.6
Retail Trade	9,900	11.6	3,740	10.9	2,362	11.2	3,798	12.6
Transportation and warehousing, utilities	3,626	4.3	1,710	5.0	897	4.2	1,019	3.4
Information	1,493	1.7	696	2.0	323	1.5	474	1.6
Finance, insurance, real estate, and renting/leasing	4,373	5.1	2,034	5.9	737	3.5	1,602	5.3
Professional, scientific, management, administrative, and waste management services	4,618	5.4	2,006	5.8	1,113	5.3	1,499	5.0
Educational, health, and social services	25,788	30.1	10,368	30.1	5,564	26.4	9,856	32.8
Arts, entertainment, recreation, accommodation, and food services	8,630	10.1	3,494	10.1	1,845	8.7	3,291	11.0
Other services (except public administration)	4,248	5.0	1,818	5.3	1,069	5.1	1,361	4.5
Public administration	4,571	5.3	2,377	6.9	1,051	5.0	1,143	3.8
Total	**85,597**		**34,440**		**21,111**		**30,046**	

Source: USCB 2009a.

Table 2.31 presents total and average wages across all industries for Region B. The average wages for persons employed across all industries in Region B was $35,190 in 2009.

Table 2.31 - Region B: Wages, by Industry, 2009 (New August 2011)

	2009	
	Total Wages (millions)	Average Wages
Region B		
Total, all industries	$2,266.66	$35,190
Delaware County		
Total, all industries	$544.78	$34,655
Chemung County		
Total, all industries	$830.49	$35,310
Tioga County		
Total, all industries	$891.39	$35,412

Source: NYSDOL 2000ba, 2010b.

The total labor force for Region B is approximately 88,500 workers, of which 40% are in Sullivan County, 35% are in Otsego County, and 25% are in Delaware County. As shown in Table 2.32, the 2010 annual average unemployment rate in Region B was approximately 8.5%, similar to New York State as a whole. Among the counties that comprise Region B, Sullivan County had the highest average unemployment rate, approximately 9.2% (NYSDOL 2010a).

Table 2.32 - Region B: Labor Force Statistics, 2000 and 2010 ((New August 2011))

	2000	2010	Percent Change
Region B			
Total labor force	85,200	88,500	3.9
Employed workers	81,500	81,000	-0.6
Unemployed workers	3,600	7,500	108.3
Unemployment rate	4.2	8.5	102.3
Delaware County			
Total labor force	22,200	22,000	-0.9
Employed workers	21,300	20,100	-5.6
Unemployed workers	900	1,900	111.1
Unemployment rate (%)	4.2	8.7	107.1
Otsego County			
Labor force	29,800	31,500	5.7
Employed workers	28,500	29,100	2.1
Unemployed workers	1,300	2,400	84.6
Unemployment rate (%)	4.2	7.7	83.3
Sullivan County			
Labor force	33,200	35,000	5.4
Employed workers	31,700	31,800	0.3
Unemployed workers	1,400	3,200	128.6
Unemployment rate (%)	4.3	9.2	114.0

Source: NYSDOL 2010a.

Table 2.33 presents per capita income data for Region B. From 1999 to 2009, per capita income across the region increased by 27.9%. Individuals living below the poverty level in Region B increased from 14.9% in 1999 to 15.0% in 2009 (USCB 2000a, 2009b).

Table 2.33 - Region B: Income Statistics, 1999 and 2009 (New August 2011)

	1999	2009
Region B		
Per capita income	$17,790	$22,750
% Below the poverty level[1]	14.9	15.0
Delaware County		
Per capita income	$17,357	$22,199
% Below the poverty level[1]	12.9	15.1
Otsego County		
Per capita income	$16,806	$22,255
% Below the poverty level[1]	14.9	15.2
Sullivan County		
Per capita income	$18,892	$23,491
% Below the poverty level[1]	16.3	14.7

Source: U.S. Census 2000a, 2009b.

[1] If the total income for an individual falls below relevant poverty thresholds, updated annually relative to the Consumer Price Index for All Urban Consumers, then the individual is classified as being "below the poverty level."

The five largest employers in Delaware and Otsego Counties are: Bassett Healthcare (3,200+ employees), Amphenol Corporation (1,400 employees), State University of New York College Oneonta (1,181 employees); New York Central Mutual Fire Insurance Company (1,000 employees) and A.O. Fox Hospital (1,000 employees) (Bassett Healthcare 2011; Delaware County Economic Development 2010; Otsego County 2010).

The counties within Region B are part of three economic development regions, as defined by the Empire State Development Corporation, including the Southern Tier Region (Delaware County), Mid-Hudson Region (Sullivan County), and Mohawk Valley Region (Otsego County). Ranked by employment, travel and tourism is the lead employment industry cluster for the Mid-Hudson Region, and the second largest employment industry cluster in the Southern Tier and Mohawk Valley Regions. The tourism industry is an important economic driver in Region B, particularly in Otsego and Sullivan Counties, with the Catskill Mountains, as well as popular destinations such as the Baseball Hall of Fame in the village of Cooperstown (Otsego County) and the Monticello Raceway in the village of Monticello (Sullivan County). Approximately 4,560 persons were employed in the travel and tourism sector in Region B in 2009, including accommodations (1,820 jobs), and culture, recreation, and amusements (960 jobs), food service (930 jobs), passenger transportation (250 jobs), and travel retail (600 jobs) (Table 2.34). In 2009

wages earned by persons employed in the travel and tourism sector was approximately $72.3 million, or about 3.4% of all wages earned in Region B (NYSDOL 2009b) (Table 2.35).

Table 2.34 - Region B: Travel and Tourism, by Industrial Group, 2009 (New August 2011)

Industry Group	Region B		Delaware County		Otsego County		Sullivan County	
	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total
Accommodations	1,820	39.9%	150	11.7%	530	35.3%	1,140	64.0%
Culture, recreation, and amusements	960	21.1%	100	7.8%	500	33.3%	360	20.2%
Food service	930	20.4%	360	28.1%	360	24.0%	210	11.8%
Passenger transportation	250	5.5%	150	11.7%	60	4.0%	40	2.2%
Travel retail	600	13.2%	520	40.6%	50	3.3%	30	1.7%
Total	4,560		1,280		1,500		1,780	

Source: NYSDOL 2009b.

Table 2.35 - Region B: Wages in Travel and Tourism, 2009 (New August 2011)

	2009	
	Total Wages (millions)	Average Wage
Region B	$72.3	$19,500
Delaware County	$6.5	$15,400
Otsego County	$28.6	$19,200
Sullivan County	$37.2	$20,900

Source: NYSDOL 2009b.

Agriculture also is an important industry within Region B. Table 2.36 provides agricultural statistics for Delaware, Otsego, and Sullivan Counties. Approximately 2,050 farms are located in Region B, encompassing 392,496 acres of land. The value of agricultural production in 2009 was $148.7 million dollars (USDA 2007). The principal sources of farm income in the region are dairy products (particularly in Otsego and Delaware Counties, where dairy products accounted for 70% and 62% of the agricultural sales in the county, respectively) and poultry and eggs (particularly in Sullivan County, where poultry and eggs accounted for 65% of the sales in the county) (USDA 2007).

Table 2.36 - Region B: Agricultural Data, 2007 (New August 2011)

	Region B	Delaware County	Otsego County	Sullivan County
Number of farms	2,050	747	980	323
Land in farms (acres)	392,496	165,572	176,481	50,443
Average size of farm (acres)	191	222	180	156
Market value of Products Sold ($ millions)	$148.7	$55.1	$51.4	$42.1
Principal operator by primary occupation				
Farming	1,139	437	538	164
Other	911	310	442	159
Hired farm labor	1,746	760	574	412
Land in state designated agricultural districts	588,443	237,385	189,291	161,767

Source: USDA 2007; NYSDAM 2011.

Currently, there are no producing natural gas wells in Region B, although some exploratory well activity occurred in 2007 and 2009.

Region C

Table 2.37 presents employment by industry within Chautauqua and Cattaraugus Counties, and for Region C. The largest employment sectors in Region C are education, health, and social services sector (26.7% of total employment), manufacturing (16.5% of total employment), and retail trade (11.6%). The agriculture, forestry, fishing, hunting, and mining sector accounted for about 2.9% of total employment in the region, which is relatively high compared to New York State as a whole, which had 0.6% of its workforce employed in this sector (USCB 2009a).

Table 2.37 - Region C: Area Employment by Industry, 2009 (New August 2011)

Sector	Region C		Cattaraugus County		Chautauqua County	
	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total
Agriculture, forestry, fishing, hunting, and mining	2,813	2.9	1,136	3.1	1,677	2.8
Construction	6,042	6.2	2,825	7.6	3,217	5.3
Manufacturing	16,194	16.6	5,752	15.5	10,442	17.2
Wholesale trade	2,620	2.3	879	2.4	1,741	2.9
Retail trade	11,392	11.7	4,432	11.9	6,960	11.5
Transportation and warehousing, utilities	4,116	4.2	1,398	3.7	2,718	4.4
Information	1,578	1.6	525	1.4	1,053	1.7
Finance, insurance, real estate, and renting/leasing	3,486	3.6	1,289	3.5	2,197	3.6
Professional, scientific, management, administrative, and waste management services	4,816	4.9	1,898	5.1	2,918	4.8
Educational, health, and social services	26,161	26.8	9,575	25.7	16,586	27.3
Arts, entertainment, recreation, accommodation, and food services	9,581	9.8	3,893	10.4	5,688	9.4
Other services (except public administration)	4,225	4.3	1,468	3.9	2,757	4.5
Public administration	4,960	5.1	2,150	5.8	2,810	4.6
	97,984		37220		60,764	

Source: USCB 2009a.

Table 2.38 presents total and average wages across all industries for Region C. The average wages for persons employed across all industries in Region C was $32,971 in 2009.

Table 2.38 - Region C: Wages, by Industry, 2009 (New August 2011)

	2009	
	Total Wages (millions)	Average Wages
Region C		
Total, all industries	$2,732.72	$32,971
Cattaraugus County		
Total, all industries	$1,046.92	$34,428
Chautauqua County		
Total, all industries	$1,685.80	$32,127

Source: NYSDOL 2009a, 2010b.

The total labor force for Region C is approximately 105,800 workers, of which 61% are in Chautauqua County, and 39% are in Cattaraugus County. As shown in Table 2.39, the 2010 annual average unemployment rate in Region C was approximately 8.9%. The size of the labor force decreased by 3.1% between 2000 and 2010 across the region, and the unemployment rate has generally doubled.

Table 2.39 - Region C: Labor Force Statistics, 2000 and 2010 (New August 2011)

	2000	2010
Region C		
Labor force	109,200	105,800
Employed workers	104,700	96,400
Unemployed workers	4,600	9,400
Unemployment rate (%)	4.2	8.9
Cattaraugus County		
Labor force	41,100	41,200
Employed workers	39,300	37,400
Unemployed workers	1,900	3,800
Unemployment rate (%)	4.5	9.2
Chautauqua County		
Labor force	68,100	64,600
Employed workers	65,400	59,000
Unemployed workers	2,700	5,600
Unemployment rate (%)	4.0	8.7

Source: NYSDOL 2010a.

Table 2.40 presents per capita income data for Region C. Per capita income in Region C rose approximately 26.2% between 1999 and 2009. The number of individuals living below the poverty level in Region C increased from 13.8% in 1999 to 16.1% in 2009.

Table 2.40 - Region C: Income Statistics, 1999 and 2009 (New August 2011)

	1999	2009
Region C		
Per capita income	$16,509	$20,830
% Below the poverty level[1]	13.8	16.1
Cattaraugus County		
Per capita income	$15,959	$20,508
% Below the poverty level[1]	13.7	15.7
Chautauqua County		
Per capita income	$16,840	$21,023
% Below the poverty level[1]	13.8	16.3

Source: U.S. Census 2000a, 2009b.

[1] If the total income for an individual falls below relevant poverty thresholds, updated annually relative to the Consumer Price Index for All Urban Consumers, then the individual is classified as being "below the poverty level."

The five largest employers in Region C are Dresser-Rand Company (3,300 employees); The Resource Center, Chautauqua County (1,748 employees); Chautauqua County (1,366 employees); Cummins Engine, Chautauqua County (1,300 employees); and Cattaraugus County (1,180 employees) (Buffalo Business First 2011).

The Empire State Development Corporation has identified 16 industry clusters for the Western New York Region of the state, which encompasses Cattaraugus and Chautauqua Counties, as well as Erie (City of Buffalo), Niagara (City of Niagara Falls), and Allegany Counties. The industry clusters that support the largest number of jobs are front office and producer services, financial services, travel and tourism, industrial machinery and services, and distribution. Travel and tourism is the third largest industry cluster in terms of employment in the Western New York Region.

Tourism is a significant component of the economy in Region C. Cattaraugus County, known as the Enchanted Mountains Region, boasts abundant recreational opportunities that primarily revolve around its natural resources. Popular tourist destinations include Allegany State Park, the Amish Trail, Holiday Valley Ski Resort, Rock City Park, Griffis Sculpture Park, and the Seneca-Allegany Casino. Chautauqua County is also recognized for its natural resources and unique learning destinations associated with the Chautauqua Institute. Approximately 4,040 persons were employed in the travel and tourism sector in Region C in 2009, including accommodations (1,110 jobs); culture, recreation, and amusements (1,220 jobs); food service (1,210 jobs); passenger transportation (280 jobs); and travel retail (220 jobs) (Table 2.41). In 2009, wages earned by persons employed in the travel and tourism sector were approximately $77.5 million, or about 3.0% of all wages earned in Region C (NYSDOL 2009b) (Table 2.42).

Table 2.41 - Region C: Travel and Tourism, by Industrial Group, 2009 (New August 2011)

Industry Group	Region C		Cattaraugus County		Chautauqua County	
	Number of Jobs	% of Total	Number of Jobs	% of Total	Number of Jobs	% of Total
Accommodations	1,110	27.5%	180	10.5%	930	40.1%
Culture, Recreation and Amusements	1,220	30.2%	1,050	61.0%	170	7.3%
Food Service	1,210	30.0%	380	22.1%	830	35.8%
Passenger Transportation	280	6.9%	30	1.7%	250	10.8%
Travel Retail	220	5.4%	80	4.7%	140	6.0%
Total	**4,040**		**1,720**		**2,320**	

Source: NYSDOL 2009b.

Table 2.42 - Region C: Wages in Travel and Tourism, 2009 (New August 2011)

	2009	
	Total Wages (millions)	Average Wage
Region C	$77.5	$19,200
Cattaraugus County	$39.7	$23,300
Chautauqua County	$37.8	$16,300

Source: NYSDOL 2009b.

Agriculture is also an important industry within Region C. Table 2.43 provides agricultural statistics for Cattaraugus and Chautauqua Counties. Approximately 2,770 farms are located in Region C, encompassing 419,297 acres of land. The value of agricultural production in 2009 was $213.7 million dollars (USDA 2007). Dairy products account for approximately 68% of agricultural sales in Cattaraugus County. In Chautauqua County, the principal sources of farm income are grape and dairy products (USDA 2007). Grapes and grape products account for approximately 30% of agricultural sales in Chautauqua County, and dairy products account for approximately 51% of agricultural sales (USDA 2007).

Table 2.43 - Region C: Agricultural Data, 2007 (New August 2011)

	Region C	Cattaraugus County	Chautauqua County
Number of farms	2,770	1,112	1,658
Land in farms (acres)	419,297	183,439	235,858
Average size of farm (acres)	151	163	142
Market value of Products Sold ($ millions)	$213.7	$75.2	$138.6
Principal operator by primary occupation			
Farming	1,437	550	887
Other	1,343	572	771
Hired farm labor	4,341	994	3,347
Land in state-designated agricultural districts	631,686	239,641	392,045

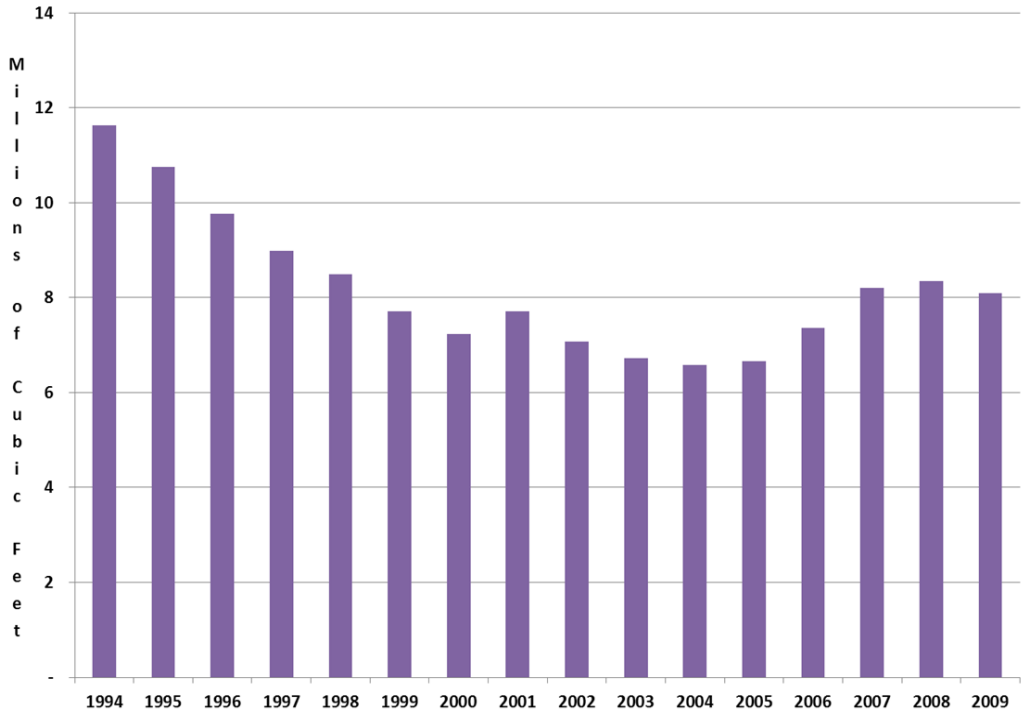
Source: USDA 2007; NYSDAM 2011.

Approximately 157 persons are employed in the oil and gas industry in Region C, or approximately 43.4% of all persons working in the oil and gas industry in New York State in 2009 (NYSDOL 2009a, 2010b).

The oil and gas industry was a marginal contributor to total wages in Region C in 2009. The total wages for persons employed in the oil and gas industry in the region were $10.8 million, or about 0.4% of the total wages across all industries (NYSDOL 2009a). The average annual wages for workers employed in the oil and gas sector varied greatly between the counties in Region C. The average annual wage for oil and gas workers in Cattaraugus County was $44,978 in 2009, whereas the average annual wage for oil and gas workers in Chautauqua County was $76,970 during the same time period (NYSDOL 2009a).

Natural gas production in Region C is shown on Figure 2.6. In the mid-1990s, Region C produced nearly 12 MMcf of natural gas per year. Production has declined from that level over the last 15 years, and the region is now producing slightly more than 8 MMcf of natural gas per year.

Figure 2.6 - Region C: Natural Gas Production, 1994-2009 (New August 2011)



Source: NYSDEC 1994-2009.

The total number of active natural gas wells in Region C over the period 1994 to 2009 is shown on Table 2.44. As shown in the table, the number of active natural gas wells in Region C has increased by nearly 400 wells since 1994, to a total of 3,917 wells.

Table 2.44 - Number of Active Natural Gas Wells in Region C, 1994-2009 (New August 2011)

Year	No. of Gas Wells
1994	3,523
1995	3,759
1996	3,512
1997	3,427
1998	3,585
1999	3,590
2000	3,545
2001	3,579
2002	3,350
2003	3,470
2004	3,645
2005	3,629
2006	3,740
2007	3,935
2008	3,984
2009	3,917

Source: NYSDEC 1994-2009.

In 2009 the average annual output per well in Region C was only 2.1 MMcf of natural gas. Production per well was significantly less than the average annual output per well in Region A (317.9 MMcf) or the statewide average per well (6.8 MMcf) (NYSDEC 2009). Because of this low productivity per well, Region C is currently a minor contributor to New York State's natural gas production, even though it accounts for the largest number of active wells in the state (NYSDEC 2009).

Table 2.45 shows the production of natural gas and the number of active wells, by town, within each county in Region C in 2009. As shown in the table, in 2009 there were 530 active gas wells in Cattaraugus County and 3,387 active gas wells in Chautauqua County (NYDEC 2009).

Table 2.45 - Natural Gas Production and the Number of Active Gas Wells by Town within each County in Region C, 2009 (New August 2011)

Location	Natural Gas Production (Mcf)	Number of Active Gas Wells
Region C	**14,623,232**	**46**
Cattaraugus County	1,615,243	530
Allegany	255,057	6
Ashford	10,416	11
Carrollton	89,633	3
Conewango	154,745	76
Dayton	113,159	59
East Otto	96,897	15
Ellicottville	737	3
Farmersville	214	2
Freedom	3,845	4
Leon	249,247	88
Machias	100	1
Napoli	1,187	2
New Albion	7,220	9
Olean	7,163	5
Otto	69,647	70
Perrysburg	343,006	42
Persia	99,100	43
Randolph	72,434	72
South Valley	892	2
Yorkshire	40,544	17
Chautauqua County	6,473,408	3,387
Arkwright	106,655	122
Busti	321,152	121
Carroll	181,427	70
Charlotte	230,836	127

Location	Natural Gas Production (Mcf)	Number of Active Gas Wells
Chautauqua	469,915	314
Cherry Creek	179,037	123
Clymer	159,828	101
Dunkirk	69,003	36
Dunkirk City	10,169	6
Ellery	180,187	82
Ellicott	204,129	66
Ellington	264,581	180
French Creek	26,003	40
Gerry	437,202	152
Hanover	450,439	152
Harmony	231,897	116
Jamestown	4,183	3
Kiantone	425,027	84
Mina	53,986	71
North Harmony	352,930	159
Poland	554,983	159
Pomfret	189,905	174
Portland	235,705	149
Ripley	185,487	182
Sheridan	142,294	86
Sherman	106,236	84
Stockton	169,836	118
Villanova	141,171	57
Westfield	389,205	253

Source: NYSDEC 2009.

2.4.11.2 Population

The following subsection discusses the past, current and projected population for New York State, and the local areas within each of the three regions (Region A, B and C).

New York State

New York State is the third most populous state in the country, with a 2010 population of approximately 19.38 million (USCB 2010) (see Table 2.46). The population density of the state is 410 persons per square mile. Nearly half of the population in the state is located within NYC (8.1 million persons). Subtracting out the population of NYC, the average population density of the rest of New York State is 237.3 persons per square mile. New York State's population has continually increased during the past 20 years, though the rate of growth was faster from 1990 to 2000 than it was from 2000 to 2010 (see Table 2.46).

Table 2.46 - New York State: Historical and Current Population, 1990, 2000, 2010 (New August 2011)

	Total Population	Percent Change	Average Annual Growth Rate	Average Population Density
2010	19,378,102	2.1%	0.2%	410.4
2000	18,976,457	5.5%	0.5%	401.9
1990	17,990,455	--	--	381.0

Source: USCB 1990a, 2000b, and 2010.

Table 2.47 shows the state's total 2010 population and presents population projections for 2015 to 2030. As shown, the population in New York State is projected to continue to grow through 2030. The state's population is projected to grow at an average annual rate of 0.2% between 2015 and 2030. By 2030, New York State's population is projected to reach 20,415,446 persons.

Table 2.47 - New York State: Projected Population, 2015 to 2030 (New August 2011)

Population 2010[a] (actual)	Population 2015[b] (projected)	Population 2020[b] (projected)	Population 2025[b] (projected)	Population 2030[b] (projected)	Average Annual Growth Rate 2015-2030
19,378,102	19,876,073	20,112,402	20,299,512	20,415,446	0.2%

Sources:
[a] USCB 2010.
[b] Cornell University 2009.

Region A

Table 2.48 provides the 1990, 2000 and 2010 population for Region A and for each of the three counties within this region. The population of Region A is 342,390 persons (USCB 2010), with an average population density of 209 persons per square mile. Since 1990, all three counties within Region A have lost population. Between 1990 and 2000, the region lost population at a rate of approximately 0.5% per year, and between 2000 and 2010, the region lost population at a rate of approximately 0.1% per year.

Table 2.48 - Region A: Historical and Current Population, 1990, 2000, 2010 (New August 2011)

Year	1990	2000	2010
Region A			
Total Population	359,692	343,390	340,555
Percent Change	--	-4.5%	-0.8%
Average Annual Growth Rate	--	-0.5%	-0.1%
Average Population Density	220.1	210.2	208.5
Broome County			
Population	212,160	200,536	200,600
Percent Change	--	-5.5%	<0.1%
Average Annual Growth Rate	--	-0.6%	< 0.1%
Average Population Density	300.2	283.7	283.8
Chemung County			
Population	95,195	91,070	88,830
Percent Change	--	-4.3%	-2.5%
Average Annual Growth Rate	--	-0.4%	-0.3%
Average Population Density	233.2	223.1	217.6
Tioga County			
Population	52,337	51,784	51,125
Percent Change	--	-1.1%	-1.3%
Average Annual Growth Rate	--	-0.1%	-0.1%
Average Population Density	100.9	99.8	98.6

Source: USCB 1990a, 2000b, and 2010.

The City of Binghamton has the largest population in the region, with a population in 2010 of 47,376; this is 13.9% of Region A's population as a whole. Other large population centers in the region include City of Elmira (29,200 persons), Village of Johnson City (15,174), and Village of Endicott (13,392 persons).

Region A's population has continually decreased during the past 20 years, though the rate of decline was faster from 1990 to 2000 than it was from 2000 to 2010 (see Table 2.48).

Table 2.49 shows Region A's total 2010 population and presents population projections for 2015 to 2030 (Cornell University 2009). As shown in Table 2.49, the population of Region A is projected to continue to decrease through 2030. The population of the Region is projected to decrease at an average annual rate of 0.7% between 2015 and 2030. By 2030, Region A's population is projected to be 279,675, which would be a decrease of 19% from the 2010 census population.

Table 2.49 - Region A: Population Projections, 2015 to 2030 (New August 2011)

County/ Region	Population 2010[a] (actual)	Population 2015[b] (projected)	Population 2020[b] (projected)	Population 2025[b] (projected)	Population 2030[b] (projected)	Average Annual Growth Rate 2015-2030
Broome	200,600	183,115	176,715	169,968	162,750	-0.7%
Chemung	88,830	83,282	80,643	77,773	74,614	-0.7%
Tioga	51,125	48,089	46,412	44,481	42,311	-0.8%
Region A Total	340,555	314,486	303,770	292,222	279,675	-0.7%

Sources: [a] USCB 2010; [b] Cornell University 2009.

Region B

Table 2.50 provides the 1990, 2000 and 2010 population for Region B and for each of the three counties within this region. The population of Region B is 187,786 persons (USCB 2010), with an average population density of 59.6 persons per square mile. The region has gained population over the last 20 years, primarily in Sullivan County. Between 1990 and 2000, the population grew at a rate of approximately 0.4% per year, and between 2000 and 2010, population increased at a rate of approximately 0.2% per year. Since 1990 the population of Region B has increased by 10,767, which is an increase of approximately 6.1%.

Table 2.50 - Region B: Historical and Current Population - 1990, 2000, 2010 (New August 2011)

	1990	2000	2010
Region B			
Population	177,019	183,697	187,786
Percent Change	--	3.8%	2.2%
Average Annual Growth Rate	--	0.4%	0.2%
Average Population Density	56.2	58.3	59.6
Delaware County			
Population	47,225	48,055	47,980
Percent Change	--	1.8%	-0.2%
Average Annual Growth Rate	--	0.2%	< 0.0%
Average Population Density	32.7	33.2	33.2
Otsego County			
Population	60,517	61,676	62,259
Percent Change	--	1.9%	1.0%
Average Annual Growth Rate	--	0.2%	0.1%
Average Population Density	60.4	61.5	62.1
Sullivan County			
Population	69,277	73,966	77,547
Percent Change	--	6.8%	4.8%
Average Annual Growth Rate	--	0.7%	.5%
Average Population Density	71.4	76.3	80.0

Source: USCB 1990a, 2000b, and 2010.

The two largest population centers in Region B are the City of Oneonta (13,901 persons) in Otsego County and the Village of Monticello (6,726 persons) in Sullivan County.

Region B's population has continually increased during the past 20 years, though the rate of growth has declined from the 1990 to 2000 period to the 2000 to 2010 period (see Table 2.50). Table 2.51 shows Region B's total 2010 population and presents population projections for 2015 to 2030 (Cornell University 2009). As shown in Table 2.51, the population in Region B overall is projected to decrease through 2030, although the population in Otsego County will increase slightly through 2025, then decline in 2030, and the population in Sullivan County will increase slightly between 2015 and 2030. By 2030, Region B's population is projected to be 183,031, which would be a decrease of 2.5% from the 2010 census population.

Table 2.51 - Region B: Population Projections, 2015 to 2030 (New August 2011)

County/ Region	Population 2010[a] (actual)	Population 2015[b] (projected)	Population 2020[b] (projected)	Population 2025[b] (projected)	Population 2030[b] (projected)	Average Annual Growth Rate 2015-2030
Delaware	47,980	44,644	42,995	40,980	38,631	-0.9%
Otsego	62,259	63,820	64,344	64,597	64,508	0.1%
Sullivan	77,547	78,329	79,322	79,845	79,892	0.1%
Region B Total	**187,786**	**186,793**	**186,661**	**185,422**	**183,031**	**-0.1%**

Sources: [a] USCB 2010; [b] Cornell University 2009.

Region C

Table 2.52 provides the 1990, 2000 and 2010 population for Region C and for Cattaraugus and Chautauqua Counties. The population of Region C is 215,222 persons (USCB 2010), with an average population density of 90.7 persons per square mile. Between 2000 and 2010, the region lost population at an average annual rate of 0.4%. This rate was higher than the rate at which the region lost population between 1990 and 2000 (0.1% per year). Since 1990 the population of Region C has decreased by 10,907, or 4.8%.

Table 2.52 - Region C: Historical and Current Population - 1990, 2000, 2010 (New August 2011)

	1990	2000	2010
Region C			
Population	226,129	223,705	215,222
Percent Change	--	-1.1%	-3.8%
Average Annual Growth Rate	--	-0.1%	-0.4%
Average Population Density	95.3	94.3	90.7
Cattaraugus County			
Population	84,234	83,955	80,317
Percent Change	--	-0.3%	-4.3%
Average Annual Growth Rate	--	< 0.0%	-0.4
Average Population Density	64.3	64.1	61.3
Chautauqua County			
Population	141,895	139,750	134,905
Percent Change	--	-1.5%	-3.5%
Average Annual Growth Rate	--	-0.2%	-0.4%
Average Population Density	133.6	131.6	127.0

Source: USCB 1990a, 2000b, and 2010.

The largest population centers in Region C are the City of Jamestown (31,146 persons), City of Olean (14,452 persons), City of Dunkirk (12,563 persons), and Village of Fredonia (11,230 persons).

Region C's population has continually decreased during the past 20 years, though the rate of decline was faster from 2000 to 2010 than it was from 1990 to 2000. As shown in Table 2.53, the population of Region C is projected to continue to decrease through 2030. The population of Region C is projected to decrease at an average annual rate of 0.6% between 2015 and 2030. By 2030, Region C's population is projected to be 188,752 people, which would be a decrease of 12% from the 2010 census population.

Table 2.53 - Region C: Population Projections, 2015 to 2030 (New August 2011)

County/ Region	Population 2010[a] (actual)	Population 2015[b] (projected)	Population 2020[b] (projected)	Population 2025[b] (projected)	Population 2030[b] (projected)	Average Annual Growth Rate 2015-2030
Cattaraugus	80,317	77,870	75,651	73,048	70,075	-0.7%
Chautauqua	134,905	129,596	126,521	122,906	118,677	-0.6%
Region C Total	**215,222**	**207,466**	**202,172**	**195,954**	**188,752**	**-0.6%**

Source:
[a] USCB 2010.
[b] Cornell University 2009.

2.4.11.3 Housing

New York State

The total number of housing units in New York State in 2010 was 8.1 million. The total number of housing units has been growing over the past two decades; however, with the advent of the recent housing market crisis and recession, the rate of growth has slowed in the past few years. According to the U.S. Census Bureau, in 1990 there were a total of 7.2 million housing units in New York State. By 2000, the total number of housing units increased by 6.3% to approximately 7.7 million. Between 2000 and 2010, the total number of housing units increased by 5.6% (see Table 2.54) (USCB 1990b, 2000c, 2010).

Table 2.54 - New York State: Total Housing Units - 1990, 2000, 2010 (New August 2011)

Year	Total Housing Units	Percent Change
2010	8,108,103	5.6
2000	7,679,307	6.3
1990	7,226,891	--

Source: USCB 1990b, 2000c, and 2010.

Nearly half of all housing units in New York State are single-family units. In 2009 an estimated 3.7 million units, or 47.0% of all housing units in the state, were single-family units. Multi-family units, i.e., structures that have three or more units in them, accounted for 39.5% of the total housing units (see Table 2.55) (USCB 2009c).

Table 2.55 - New York State: Type of Housing Units, 2009[1] (New August 2011)

Type of Structure	Total Number of Units	% of Total
Single Family	3,735,364	47.0
Duplex	866,157	10.9
Multi-family	3,142,770	39.5
Mobile Home	202,773	2.6
Other	2,971	<0.1
Total	**7,905,035**	**100**

Source: USCB 2009c.

[1] Data from the *2010 Census of Population and Housing* on housing units by type of structure had not been released at the time of this report; therefore, estimated 2009 data from the 2005-2009 *American Community Survey* estimates is included herein.

Table 2.56 provides the number of sales and annual median sale price of single family homes sold in New York State over the past three years. The number of annual sales has declined over the

past three years, while the median sales price has fluctuated. In 2008 the median sales price for single-family homes was $210,000. During the height of the housing market crisis in 2009, the median sales price fell to $195,000. By 2010 prices in the statewide housing market had recovered, and median sales prices rose to $215,000 (NYS Association of Realtors 2011a, 2011b). Although the statewide housing market statistics have improved over the last year, housing is intrinsically a local or regional market; many areas of New York State are still experiencing downward pressures on house prices.

Table 2.56 - New York State: Number of Sales and Annual Median Sale Price of Single-Family Homes Sold, 2008-2010 (New August 2011)

	2008	2009	2010
Number of Sales	80,521	78,327	74,718
Median Sale Price	$210,000	$195,000	$215,000

Source: NYS Association of Realtors 2011a, 2011b.

In 2010, New York State had approximately 3.9 million owner-occupied housing units and 3.4 million renter-occupied housing units (USCB 2010).

The homeowner vacancy rate was 1.9% and the rental vacancy rate was 5.5% (USCB 2010) (see Table 2.57).

Table 2.57 - New York State: Housing Characteristics, 2010 (New August 2011)

	Housing Units
Occupied	7,317,755
Owner Occupied	3,897,837
Renter Occupied	3,419,918
Vacant	790,348
For Rent	200,039
Rented, Not Occupied	12,786
For Sale Only	77,225
Sold, Not Occupied	21,027
For Seasonal, Recreational, or Occasional Use	289,301
All Other Vacant	189,970
Total	**8,108,103**
Homeowner Vacancy Rate	1.9%
Rental Vacancy Rate	5.5%

Source: USCB 2010.

Region A

According to the U.S. Census Bureau, the housing market in Region A has experienced little growth over the past two decades. As shown in Table 2.58, the region experienced an increase of 1.7% in the total number of housing units from 1990 to 2000, and a 2.1% increase from 2000 to 2010 (USCB 1990b, 2000c, 2010).

Table 2.58 - Region A: Total Housing Units - 1990, 2000, 2010 (New August 2011)

	Total Housing Units (1990)	Total Housing Units (2000)	Total Housing Units (2010)	Percent Change (1990-2000)	Percent Change (2000-2010)
Region A	145,513	147,972	151,135	1.7%	2.1%
Broome County	87,969	88,817	90,563	1.0%	2.0%
Chemung County	37,290	37,745	38,369	1.2%	1.7%
Tioga County	20,254	21,410	22,203	5.7%	3.7%

Source: USCB 1990b, 2000c, 2010.

A majority of housing units in Region A are single-family units. In 2009 an estimated 96,956 units, or 65.0% of all housing units in the region, were single-family units. Multi-family units, i.e., structures that contained three or more housing units, accounted for 17.0% of the total housing units (see Table 2.59).

Table 2.59 - Region A: Total Housing Units by Type of Structure, 2009[1] (New August 2011)

	Number of Units	% of Total
Region A		
Single Family	96,956	65.0
Duplex	15,901	10.8
Multi-family	25,389	17.0
Mobile Home	10,756	7.2
Other	64	<0.1
	149,066	**100**
Broome County		
Single Family	56,225	63.1
Duplex	10,436	11.7
Multi-family	17,646	19.8
Mobile Home	4,795	5.4
Other	15	<0.1
	89,117	**100**

	Number of Units	% of Total
Chemung County		
Single Family	25,739	67.5
Duplex	4,291	11.3
Multi-family	5,749	15.1
Mobile Home	2,325	6.1
Other	12	<0.1
	38,116	**100**
Tioga County		
Single Family	14,992	68.7
Duplex	1,174	5.4
Multi-family	1,994	9.1
Mobile Home	3,636	16.7
Other	37	0.1
Total	**21,833**	**100**

Source: USCB 2009c.

1 Data from the *2010 Census of Population and Housing* on housing units by type of structure had not been released at the time of this report; therefore, estimated 2009 data from the 2005-2009 *American Community Survey* are provided herein.

Table 2.60 provides the number of sales and annual median sale price of single family homes sold in Region A over the past three years (New York State Association of Realtors 2011a, 2011b).

Table 2.60 - Region A: Number of Sales and Annual Median Sale Price of Single-Family Homes Sold, 2008-2010 (New August 2011)

	2008		2009		2010	
	Number of Sales	**Median Sale Price**	**Number of Sales**	**Median Sales Price**	**Number of Sales**	**Median Sales Price**
Broome County	1,412	$109,438	1,287	$115,000	1,193	$106,000
Chemung County	629	$85,000	593	$86,000	638	$100,000
Tioga County	275	$136,170	304	$120,000	227	$122,500
Region A	2,316	NA	2,184	NA	2,058	NA

Source: NYS Association of Realtors 2011a, 2011b.
NA = Not available.

In 2010, Region A had approximately 93,074 owner-occupied housing units and 44,905 renter-occupied housing units. The homeowner vacancy rate was 1.1%, and the rental vacancy rate was 7.8% (see Table 2.61) (USCB 2010).

Table 2.61 - Region A: Housing Characteristics, 2010 (New August 2011)

	Housing Units			
	Region A	**Broome County**	**Chemung County**	**Tioga County**
Occupied	137,979	82,167	35,462	20,350
Owner Occupied	93,074	53,260	24,011	15,803
Renter Occupied	44,905	28,907	11,451	4,547
Vacant	13,156	8,396	2,907	1,853
For Rent	3,824	2,522	917	385
Rented, Not Occupied	226	143	56	27
For Sale Only	1,516	956	377	183
Sold, Not Occupied	471	226	151	94
For Seasonal, Recreational, or Occasional Use	2,774	1,843	376	555
All Other Vacant	4,345	2,706	1,030	609
Total	**151,135**	**90,563**	**38,369**	**22,203**
Homeowner Vacancy Rate	1.1%	1.8%	1.5%	1.1%
Rental Vacancy Rate	7.8%	8.0%	7.4%	7.8%

Source: USCB 2010.

The *2010 Census of Population and Housing* identified 2,774 housing units in Region A that are considered seasonal, recreational, or occasional use. In addition to the permanent housing discussed above, there are also numerous short-term accommodations including hotels, motels, inns, and campgrounds available in the area. Table 2.62 lists the numbers of hotels/motels available in Region A that were registered with the I Love New York Tourism Agency. As of 2011 there were 40 hotels/motels with approximately 3,110 rooms in Region A.

Table 2.62 - Region A: Short-Term Accommodations (Hotels/Motels), 2011 (New August 2011)

	Total Hotels/Motels	**Total Rooms**
Broome County	27	2,202
Chemung County	9	676
Tioga County	4	232
Region A	**40**	**3,110**

Source: Official New York State Tourism Site (ILOVENY) 2011.