



Frequently Asked Questions about the Susquehanna River Basin Shale Gas Development Water Monitoring Study

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Questions about the study scope

What is the purpose of this study?

The purpose of this study was to identify the monitoring design and water data needed to answer the case-study policy question, “Do shale gas development activities contaminate surface water or groundwater?” in the Susquehanna River Basin, evaluate the availability and usability of existing data to answer the case-study policy question, and identify approaches for filling data gaps to answer the case-study policy question.

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Why assess the availability of water data?

As policy issues evolve, new priorities and challenges arise for natural resource assessment, and new approaches to monitoring are needed. There is a need to evaluate whether today’s water monitoring programs are generating the information needed to answer questions surrounding new policy priorities. Hydraulic fracturing and shale gas development in the Marcellus shale of Pennsylvania grew from less than 200 wells in 2007 to more than 9,300 as of August, 2015. A lack of information on water quality before and after development has fueled worries about contamination of surface water and groundwater that could result from shale gas development. This report evaluates whether the water data needed to measure water quality change related to shale gas development are being collected so they can be used to inform the protection of water resources as new oil and gas resources are being developed.

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How was the case-study policy question selected?

Shale gas development was selected by the project team as the case-study subject due to the importance of the issue to policy makers and the Northeast Midwest region. The Northeast-Midwest Institute interviewed Congressional and Senate staff and decision-makers participating in the Blue Ribbon Project Steering Committee to identify their most urgent water-quality questions related to shale gas development to help design a relevant case study. Twelve Congressional offices and 18 Steering Committee members, including representatives from the federal government, states, cities, industry, and environmental groups, participated in these discussions and their responses were distilled into priority policy questions.

With respect to shale gas development, the respondents raised questions about human and ecological health and safety related to the chemicals used in hydraulic fracturing, produced water brines generated by shale gas production, and methane mobilization. Decision-makers were unsure of the extent to which water resources are affected by shale gas development activities, so this study explored the fundamental question, “Do shale gas development activities contaminate surface water or groundwater?”

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How was the geographic scope of this study selected?

The Susquehanna River Basin was selected because the rapid growth of high-volume hydraulic fracturing (HVHF) in the Susquehanna River Basin has raised concerns about the potential for degraded water quality and potential impacts on drinking water aquifers throughout the basin. Government agencies, academia, and volunteer groups have been collecting water quality data since shale gas development started in the Susquehanna River Basin in 2007, making the basin a best-case scenario for having the water data available to measure whether contamination is occurring in surface water or groundwater.

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What is high-volume hydraulic fracturing (HVHF)?

High-volume hydraulic fracturing (HVHF) wells employ hydraulic fracturing at multiple stages along horizontal sections of unconventional wells that can extend several thousand feet in the target formation. Unconventional wells target low permeability source-rock formations such as shale, coal seams, tight sands, and others; they can be vertical or horizontal. Horizontal unconventional wells typically require high volumes of hydraulic fracturing fluids.

In the Susquehanna River Basin, HVHF wells typically use high volumes (2-10 millions of gallons) of hydraulic fracturing fluids in the Marcellus formation. In this report, horizontal unconventional wells are presumed to require high-volume hydraulic fracturing.

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What is shale gas development?

The term “shale gas development” in this report refers to the complete life-cycle of gas development activities for hydrocarbon extraction from shale formations, including high-volume hydraulic fracturing.

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What are the potential contamination pathways that would allow shale gas development activities to contaminate surface water or groundwater?

Hydraulic fracturing is just one step of shale gas development that could result in water contamination. The study’s Technical Advisory Committee (TAC) considered the full life-cycle of shale gas development activities, from land clearing and construction through well closure, and the potential contamination pathways that might allow a contaminant from the development activity to come in contact with surface water or groundwater. The TAC prioritized shale gas activities they determined to have the highest potential for water-quality impacts, and those in which the water-quality data are most relevant for identifying contamination events that are not otherwise easily observed, such as groundwater contamination or long-term migration of contaminants. The priority shale gas activities identified by the TAC include:

- land clearing and construction activities,
- well drilling,
- hydraulic fracturing and the well completion process,
- well production, and
- cumulative impacts.

Water-quality concerns associated with shale gas development include:

- the potential for methane contamination in groundwater,
- the effects of land clearing and construction on surface water,
- the potential contamination of surface water or groundwater from surface spills,
- subsurface migration of injected chemicals and underground contaminants such as brine and naturally occurring radioactive constituents, and
- the handling and disposal of waste (solids and fluids) created during these processes.

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Questions related to compiling multi-agency water data and its usability for this study

Who are the major water monitoring organizations in the Susquehanna River Basin?

Major surface water monitoring organizations are:

- Susquehanna River Basin Commission (SRBC)
- Pennsylvania Fish and Boat Commission
- Pennsylvania Department of Environmental Protection (PADEP)
- Dickinson College Alliance for Aquatic Resource Monitoring (ALLARM)
- Community Science Institute
- County Conservation Districts in Pennsylvania and New York, including Dauphin, Otsego, and Cortland
- U.S. Geological Survey, which operates the majority of streamgages described in the report

Major groundwater monitoring organizations are:

- U.S. Geological Survey (USGS)
- Pennsylvania Department of Environmental Protection (PADEP)
- Pennsylvania Topographic and Geologic Survey
- Community Science Institute

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What types of water data were compiled and assessed through this study?

The data compiled for this study focused on electronically available water-quality records for surface water and groundwater, and aquatic macroinvertebrate bioassessments in the Susquehanna River Basin. Water-quality records for surface water and groundwater consisted of inorganic, organic, and physical parameters, while the bioassessments included information on presence and diversity of macroinvertebrates at the stream site. Information was also compiled showing the available period of record for continuous surface-water monitoring sites.

These water-quality data were collected by at least 40 different organizations in the Susquehanna River Basin, and came mostly from a national-scale multi-agency compilation of water-quality data assembled by the U.S. Geological Survey (USGS), called the “National Data Aggregation” (Argue et al., 2014). The National Data Aggregation consists of water-quality and associated hydrologic data collected by federal, state, and regional governmental agencies and non-governmental organizations. The largest online data sources were the U.S. Environmental Protection Agency (USEPA) Storage and Retrieval (STORET) Data Warehouse (U.S. Environmental Protection Agency, 2014) and the USGS National Water Information System (U.S. Geological Survey, 2002 and U.S. Geological Survey, 2014b).

A subset of the National Data Aggregation covering the Susquehanna River Basin (“Susquehanna data set” in this report) served as the primary data set for assessing existing water-quality monitoring data in this case study. The Susquehanna data set also includes subsequent updates and additions made specifically for this project, resulting in part from suggestions by study TAC members familiar with local monitoring programs. Data records in the Susquehanna data set span the period 1923 through 2013, with date ranges varying by organization, site, and parameter; record end dates range from 2010 to 2013 among the primary organizations actively collecting data.

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What items were important to include in the water data compilation used in this study?

To develop the data compilation required for this study, it was important to convert data in various formats from multiple agencies into a standardized format to be able to query the data set. Assembling this standardized data compilation required reviewing metadata (consisting of data-code definitions, quantification qualifiers, and other information describing the laboratory analysis or sample results) to determine the chemicals (or combined chemicals) measured, fraction of sample analyzed (e.g. total or dissolved), and removal of duplicate sites. There also was a need to match water quality monitoring sites with streamgages and to acquire drainage area data. If this information was not available, Geographic Information System (GIS) methods were used to identify the nearest streamgage and to determine the drainage area upstream of each monitoring site. Many sampling sites did not include metadata identifying the aquifer for groundwater sampling sites, so GIS methods were used to identify the aquifer at groundwater sampling sites where well type or well depth metadata were available.

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What issues and challenges were encountered when compiling water data for this study?

Some agencies report their water data to a centralized database that can be accessed online while others do not, which makes the data more difficult to find and obtain. To obtain water quality data not residing in existing individual or multi-agency database was a time-intensive process involving online searches, knowledge of monitoring organizations and(or) assistance from local water researchers to provide this information, locating monitoring staff contacts and communicating via email or phone to identify relevant data sets and request the data. Some challenges in compiling these data included time lags between the data request and data sharing, variations between agencies in naming conventions for the same or similar constituents, and in the completeness of metadata provided. Metadata important for the data compilation sometimes resided in a database separate from the monitoring data (which had to be located and (or) searched through) or for some data sets the metadata were incomplete. The lack of important metadata limited the usefulness of some data sets for interpretive evaluation. The end

date of the monitoring records varied among organizations; some organizations maintain their data archives on a regular schedule, whereas other organizations' records for public release had not been updated for several years. These issues can reflect limitations in the number of staff available in the monitoring organization to prepare, document, and quality-assure their internal records for public data sharing.

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Questions related to water data availability in the Susquehanna River Basin

What data are needed to answer the case-study policy question?

There are three parts to the study design that must be in place to be able to generate answers to this policy question. First, appropriate monitoring sites are needed. Surface water monitoring sites must be located in watersheds with HVHF wells and in reference watersheds that have minimal or no shale gas activity in each of the ecoregions with active or planned shale gas development in the Susquehanna River Basin. Second, water-quality and streamflow data must be collected at these monitoring sites with sufficient sampling frequency and longevity to evaluate trends in concentration over time. Third, data on shale gas development, geology, climate, and other changes in land use throughout the monitored watershed must be available to correlate water-quality change with shale gas development activity. Details can be found in Chapter 6 of the report.

The study design for groundwater requires networks of groundwater sampling sites with each sampling site located within 1 mile of an HVHF well. Water-quality data collected before and after shale gas development at the nearby HVHF well sites are necessary to identify groundwater quality change. Again, information on the shale gas development, geology, other changes in land use, and climate near those sampling sites must be available to correlate water-quality change with shale gas development activity.

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Are the needed water data available?

The study found that current water quality monitoring in the Susquehanna River Basin is inadequate for measuring whether shale gas development activities contaminate surface water or groundwater. Out of approximately 14,700 surface water monitoring sites in the Susquehanna River Basin, only 10 monitoring sites have enough barium data (an indicator associated with HVHF development) for a water quality trend analysis, and none of these sites are located in watersheds with a substantial number of active HVHF wells. Recent targeted monitoring programs through the SRBC and PADEP are monitoring in appropriate locations, but additional sampling frequency, parameters, and streamflow data are needed before water quality trends can begin to be detected.

The groundwater data needed for answering the case-study policy question are also not being collected. The groundwater sampling sites with existing data are rarely located within 1 mile of an HVHF well, but even when they are in the right locations they lack data for most of the priority groundwater parameters. The available groundwater data lack the sampling frequency needed for a water quality trend analysis and lack the number and location of sampling sites needed for a spatial water quality network analysis.

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Why is it difficult to access water quality data collected by the shale gas development industry?

Data collected at domestic wells are often subject to confidentiality agreements and can be unavailable for researchers. This can be an issue for data collected by both public entities and private industry. Pennsylvania assumes oil and gas companies are liable for water contamination, unless they can demonstrate otherwise. Industry typically takes water samples from nearby domestic wells prior to drilling a HVHF well to document pre-existing water-quality conditions.

PADEP maintains electronic documents or paper copies of each groundwater monitoring report that is collected from domestic wells by industry, and PADEP does not have the data available in an electronic database. To obtain the data, a formal request must be submitted under Pennsylvania's Right-to-Know Law, Section 404, 65 P.S. §67.101 et seq. To comply with the request, PADEP staff makes photocopies of individual reports, and the homeowner name and address are redacted due to privacy concerns. Latitude and longitude, when provided in the report, would be provided to the person making the Right-to-Know-Law request. Collaboration with industry may be an alternative to going through PADEP to obtain access to industry data. Pre-drill data from Chesapeake Energy was published in Reese et al. (2014). Chesapeake Energy is just one of multiple companies that have collected groundwater data in the Susquehanna River Basin; this publication may lead the way for other companies to begin sharing the groundwater data they have collected.

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How accessible are the existing water data?

The Water Quality Portal is a cooperative service that integrates publicly available water-quality data from the U.S. Geological Survey National Water Information System (NWIS), U.S. Environmental Protection Agency STorage and RETrieval (STORET) Data Warehouse, and the U.S. Department of Agriculture Sustaining The Earth's Watersheds - Agricultural Research Database System (STEWARDS), and includes data collected by more than 400 state, tribal, and local organizations. The Water Quality Portal provides an interface that allows a user to download water-quality data from these systems in a consistent format. Data collected at only 19 percent of the surface water monitoring sites identified through this case study in the Susquehanna River Basin were available through the Water Quality Portal, but 85 percent of the surface water-quality data records are available through the Portal. This indicates that the monitoring sites from the Susquehanna data set that are available through the Water Quality Portal are sites with longer data records, monitoring sites that are more likely to have the data necessary to identify a water-quality trend. The data that are missing from the Water Quality Portal are primarily collected by volunteer organizations, local governments, and academia, although some state and federal data are also not available through the Water Quality Portal (e.g., the Pennsylvania Fish and Boat Commission, and the US Army Corps of Engineers).

The Water Quality Portal includes data collected at 45 percent of the groundwater monitoring sites identified through this case study in the Susquehanna River Basin, and 61 percent of the water-quality data records are available through the Portal. The only groundwater data in the Susquehanna data set that are available through the Water Quality Portal are available through NWIS. In the case of groundwater data, the most significant data sets are generally not publicly available, but recent publications indicate this might be changing (Reese et al., 2014).

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Questions related to next steps

What are the study recommendations for filling the data gaps?

- Increase monitoring at a minimum of 8 targeted surface water monitoring sites; additional monitoring sites are highly recommended. The water data identified in Table ES-1 must be collected for each of these sites.
- Maintain data collection and analysis at enhanced surface water monitoring sites for a minimum of 10 years and as long as shale gas development activities continue in the Susquehanna River Basin.
- Design and implement a systematic, long-term groundwater monitoring program for detecting groundwater quality change related to shale gas development in the Susquehanna River Basin, building on data collected by shale gas development companies if possible.
- Establish a coordinating entity to develop and implement surface water and groundwater monitoring plans in the Susquehanna River Basin, with representation from water monitoring organizations, shale gas development industry, domestic well owners, and public citizens.

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What are the next steps in this project?

The Northeast-Midwest Institute and the U.S. Geological Survey undertook two case studies to illustrate the types and amounts of data needed to answer urgent water policy questions and to determine how much of those water-quality data are currently available. This report summarizes one case study: our investigation of water-quality data relating to shale gas development in the Susquehanna River Basin. A companion case-study investigating the availability of water-quality data for measuring the effectiveness of agricultural management practices in the Lake Erie drainage basin is available [here](#). The results of these case studies will inform a qualitative review of water data availability across the Northeast-Midwest region in an upcoming State of the Region Report.

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How will the Northeast-Midwest Institute use this information?

The Northeast-Midwest Institute will share study results with national and regional decision makers through a policy education program that includes briefings and congressional office visits to describe the availability of water-quality data for answering urgent water policy questions, implications for effective decision making, and strategies for improving our water knowledge base for addressing future water issues.

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Where can I learn more about the Northeast-Midwest Institute?

Information about the Northeast-Midwest Institute can be found on their [website](#).

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Where can I learn more about the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program?

Information about the NAWQA Program can be found on their [homepage](#).

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