Quality Assurance Project Plan for the Evaluation of Information on Hydraulic Fracturing

Prepared for:

U.S. Environmental Protection Agency
Office of Science Policy
Office of Research and Development
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Prepared by:

Eastern Research Group, Inc.
14555 Avion Parkway
Suite 200
Chantilly, VA 20151-1102

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Disclaimer

EPA does not consider this internal planning document an official Agency dissemination of information under the Agency's Information Quality Guidelines, because it is not being used to formulate or support a regulation or guidance; or to represent a final Agency decision or position. This planning document describes the overall quality assurance approach that will be used during the research study. Mention of trade names or commercial products in this planning document does not constitute endorsement or recommendation for use.

The EPA Quality System and the HF Research Study

EPA requires that all data collected for the characterization of environmental processes and conditions are of the appropriate type and quality for their intended use. This is accomplished through an Agency-wide quality system for environmental data. Components of the EPA quality system can be found at http://www.epa.gov/quality/. EPA policy is based on the national consensus standard ANSI/ASQ E4-2004 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*. This standard recommends a tiered approach that includes the development and use of Quality Management Plans (QMPs). The organizational units in EPA that generate and/or use environmental data are required to have Agency-approved QMPs. Programmatic QMPs are also written when program managers and their QA staff decide a program is of sufficient complexity to benefit from a QMP, as was done for the study of the potential impacts of hydraulic fracturing (HF) on drinking water resources. The HF QMP describes the program's organizational structure, defines and assigns quality assurance (QA) and quality control (QC) responsibilities, and describes the processes and procedures used to plan, implement and assess the effectiveness of the quality system. The HF QMP is then supported by project-specific QA project plans (QAPPs). The QAPPs provide the technical details and associated QA/QC procedures for the research projects that address questions posed by EPA about the HF water cycle and as described in the *Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources* (EPA/600/R-11/122/November 2011/www.epa.gov/hydraulic fracturing). The results of the research projects will provide the foundation for EPA's 2014 study report.

This QAPP provides information concerning chemical mixing, well injection, and flowback in the HF water cycle as found in Figure 1 of the HF QMP and as described in the HF Study Plan. Appendix A of the HF QMP includes the links between the HF Study Plan questions and those QAPPs available at the time the HF QMP was published.

Quality Assurance Project Plan for the Evaluation of Information on Hydraulic Fracturing

APPROVAL SHEET

Signatures indicate approval of this Quality Assurance Project Plan and commitment to follow the applicable procedures noted:

/s/	4/4/2013
Betsy Bicknell – ERG Work Assignment Manager	Date
/s/	4/4/2013
Dan-Tam Nguyen – ERG Project QA Coordinator	Date
/s/	4/10/2013
Meghan Hessenauer - EPA Technical Project Officer	Date
/s/	4/1/2013
Leigh DeHaven - EPA Work Assignment Manager	Date
/s/	4/11/2013
Stephen Watkins – EPA Quality Assurance Manager/Office of Science Policy	Date

History of QAPP for Evaluation of Information on Hydraulic Fracturing

	Revision 0	Revision 1
Delivery Date	November 12, 2009, December 22, 2010, January 12, 2011	September 14, 2012, November 9, 2012
Work Assignment	7-35, 8-35	9-35, 0-35
Scope	Questionnaire data collection and management, secondary data from public comment data collection and management	Well file data collection and management, secondary data from literature reviews
Comments Received	December 9, 2010, December 28, 2010	October 26, 2012, December 6, 2012
Comments Addressed	January 6, 2012	November 9, 2012, January 14, 2013, 4/29/13
Approval	January 19, 2011	Awaiting

Major Changes to Evaluation of Information on Hydraulic Fracturing Revision 1

Section	Revision 1 Delivered November 9, 2012 EPA Comments Addressed November 9, 2012
All	Revise text to present only activities currently being or expected to be conducted under Work Assignment 0-35 that relate to evaluating hydraulic fracturing information
All	Revise text to be present or future tense
All	Provide detailed information on the types of QC activities conducted

Distribution
(Element A.3)

This Quality Assurance Project Plan (QAPP) will be distributed to staff of the U.S. Environmental Protection Agency and Eastern Research Group, Inc. (Table 1). A copy of the document will be provided to all Eastern Research Group, Inc. (ERG) staff involved in the project, including those who join the project after publication of the QAPP.

Table 1. QAPP Distribution

Name Title	Contact Information	Mailing Address
U.S. Environmental Protection Agency		
Meghan Hessenauer Technical Project Officer	(202) 566-1040 (phone) hessenauer.meghan@epa.gov	U.S. Environmental Protection Agency Office of Science and Technology 1200 Pennsylvania Avenue, NW (4303T) Washington, D.C. 20460
Leigh DeHaven Work Assignment Manager	(202) 564-1974 dehaven.leigh@epa.gov	U.S. Environmental Protection Agency Office of Research and Development 1200 Pennsylvania Avenue, NW (8104R) Washington, D.C. 20460
Jeanne Briskin Alternate Work Assignment Manager	(202) 564-4583 briskin.jeanne@epa.gov	
Steve Watkins Quality Assurance Manager Office of Science Policy	(202) 564-3744 watkins.stephen@epa.gov	
Michelle Henderson Program Quality Assurance Manager, Hydraulic Fracturing Drinking Water Study	(513) 569-7353 henderson.michelle@epa.gov	U.S. Environmental Protection Agency ORD National Exposure Research Laboratory 26 West Martin Luther King Drive (593) Cincinnati, OH 45268
ERG		
Deborah Bartram ERG Program Manager	(703) 633-1669 deborah.bartram@erg.com	Eastern Research Group, Inc. 14555 Avion Parkway Suite 200 Chantilly, VA 20151-1102
Betsy Bicknell ERG WAM & Local QA Coordinator	(703) 633-1612 betsy.bicknell@erg.com	
Dan-Tam Nguyen ERG Project QA Coordinator	(703) 633-1617 dan-tam.nguyen@erg.com	
Kurt Rindfusz TSCA CBI Document Control Officer	(703) 633-1676 kurt.rindrusz@erg.com	
Steve Strackbein Engineer	(703) 633-1656 steve.strackbein@erg.com	
Amie Aguiar Scientist	(703) 633-1623 amie.aguiar@erg.com	
Sarah Hays Engineer	(703) 633-1661 sarah.hays@erg.com	
Carissa Erickson Project Assistant	(703) 633-1688 carissa.erickson@erg.com	
Chris Krejci Petroleum Engineer	(512) 407-1835 chris.krejci@erg.com	Eastern Research Group, Inc. 3508 Far West Blvd, Suite 210 Austin, TX 78731-2281

1.0 INTRODUCTION

EPA is conducting a study on the potential impacts of hydraulic fracturing on drinking water resources at the request of the U.S. Congress, specifically the Appropriations Conference Committee of the House of Representatives. Results from the study will inform the public and provide policymakers at all levels with sound scientific knowledge that can be used in decision-making processes. From July through September 2010, EPA conducted four public hearings to discuss issues associated with hydraulic fracturing. During the hearings, EPA requested stakeholder and public comments to aid in the development of a study design to investigate the potential impact of hydraulic fracturing on drinking water resources. ERG assisted EPA in tracking and summarizing public comments submitted to EPA on the Agency's study design.

EPA is collecting information and data regarding the use and composition of hydraulic fracturing fluids used by the oil and gas industry. ERG assisted EPA in developing a technical questionnaire focused on hydraulic fracturing fluids that was sent to nine hydraulic fracturing service companies. EPA received questionnaire responses from all nine companies. EPA data sources for information on the use and composition of hydraulic fracturing fluid include both primary data collected from the technical industry questionnaire and secondary data (e.g., literature and other information submitted from public comments). EPA is also collecting information and data regarding the role of well performance during hydraulic fracturing as it relates to well design, construction, and completion practices. Data sources consist of primary data collected from nine oil and gas well operators. ERG is assisting EPA in reviewing and organizing data obtained from well operators. These data will be used by EPA staff in its study of the potential impacts of hydraulic fracturing on drinking water resources.

EPA is conducting a literature review of the many potential research areas surrounding hydraulic fracturing including the composition of flowback and produced waters in different areas of the country and impacts water from hydraulic fracturing fluids and wastewaters. ERG is assisting EPA in conducting the literature review. These data will be used by EPA staff in its study of the potential impacts of hydraulic fracturing on drinking water resources.

This Quality Assurance Project Plan (QAPP) addresses both primary and secondary data sources, as well as all technical analyses that will be conducted under this work assignment. As directed by EPA, ERG has prepared this detailed QAPP that is responsive to all applicable elements specified in *EPA Requirements for Quality Assurance Project Plans* (1). This QAPP is a project-specific supplement to ERG's *Environmental Engineering Support for Clean Water Regulations Quality Management Plan, June 2012* (QMP) (2) and ERG's corporate Quality Management Plan, July 2012 (3), which was prepared in accordance with *EPA Requirements for Quality Management Plans* (4). ERG's QMP details the responsibilities of the ERG Quality Assurance (QA) coordinators and Project Management Team and describes procedures used to plan, implement, and assess project quality. These procedures, tailored to the needs of the tasked activities, will be used on ERG's work assignments associated with this program.

References are presented in Section 6.0. Throughout this document, each time a reference is cited, a number corresponding to the Section 6.0 listing is shown in parentheses.

2.0 PROJECT MANAGEMENT ELEMENTS

This section addresses project management, including project history and objectives, roles and responsibilities, and project goals. In addition, this section presents the mechanisms EPA and ERG will use to ensure that all participants understand the goals and the approach to be used for this project. In its *Requirements of Quality Assurance Project Plans* (1), EPA identifies the following nine project management elements:

- A.1: Title and Approval Sheet;
- A.2: Table of Contents;
- A.3: Distribution List;
- A.4: Project Organization;
- A.5: Problem Definition/Background;
- A.6: Project/Task Description;
- A.7: Quality Objectives;
- A.8: Special Training/Certification; and
- A.9: Project Documents and Records.

Elements A.1 through A.3 have been provided earlier in this document. The remaining elements are presented below.

2.1 Element A.4: Project Organization

Project organization for ERG's support of this project is depicted in Figure 2-1. The ERG Program Manager will be responsible for management and administrative aspects of the work performed. The ERG WAM will be responsible for ensuring that the quality of work, schedule, and budget meet the requirements of the EPA hydraulic fracturing study. The ERG WAM will provide technical direction to ERG staff and will be responsible for the daily activities on the questionnaire task. The ERG WAM will be the principal contact for the EPA WAM on project issues, deliverables, and schedule. The ERG WAM will also keep the Project QA Coordinator and the ERG Program Manager advised of any quality problems that arise.

The Project QA Coordinator will be responsible for the development and execution of QA activities throughout the course of the project. The Project QA Coordinator will also ensure that the ERG WAM is obtaining appropriate technical review of all deliverables.

The ERG WAM will provide senior technical support for project activities (see Section 2.3) and the ERG project staff will support all tasks.

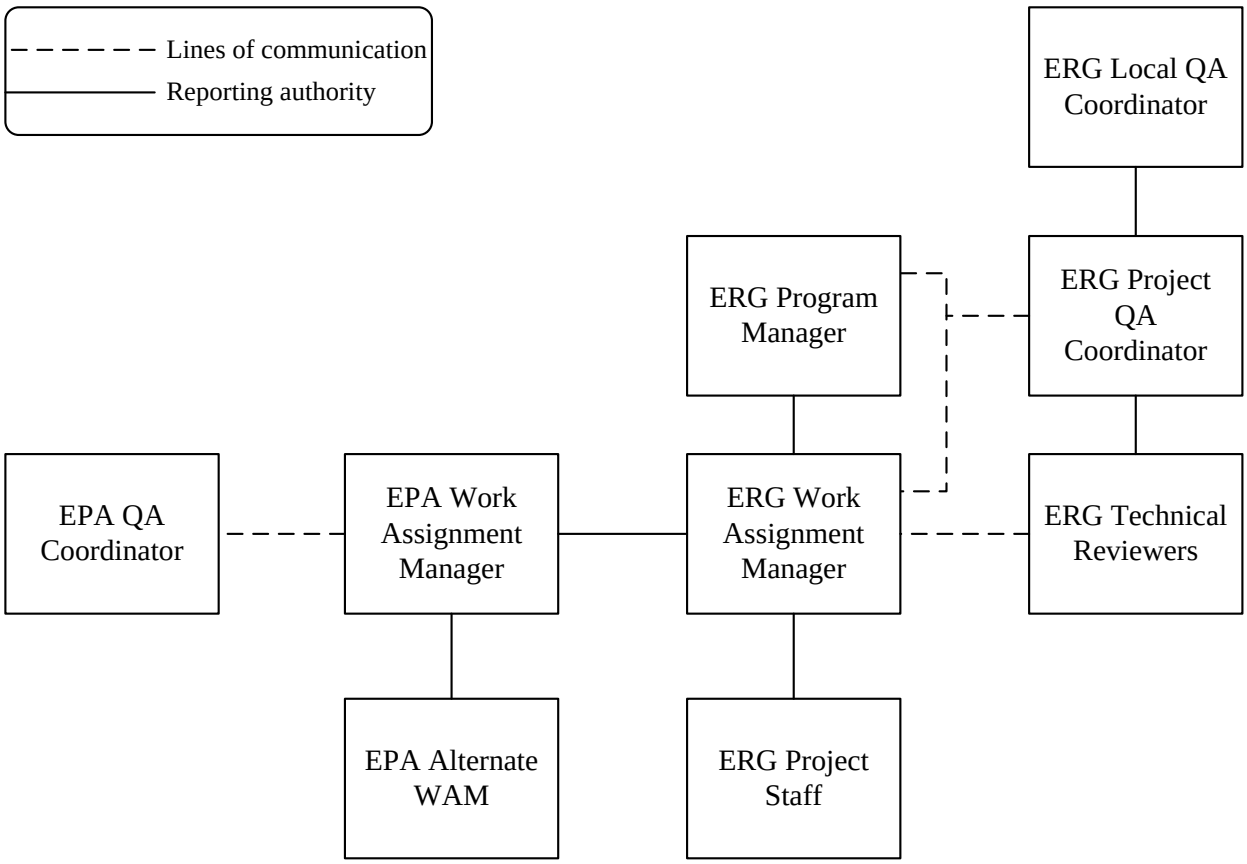

Figure 1. Project Level QA Organization for ERG's Support for the Evaluation of Information on Hydraulic Fracturing

2.2 Element A.5: Problem Definition/Background

This section explains the purpose of the hydraulic fracturing study. It also presents a brief background of hydraulic fracturing.

2.2.1 Background

Hydraulic fracturing is a well stimulation process used to maximize the extraction of underground resources – oil, natural gas, and geothermal energy. Hydraulic fracturing involves the pressurized injection of fluids commonly made up of water and chemical additives into a geologic formation. The pressure exceeds the rock strength and the fluid opens or enlarges fractures in the rock. As the formation is fractured, a "propping agent," such as sand or ceramic beads, is pumped into the fractures to keep them from closing as the pumping pressure is released. The fracturing fluids (water and chemical additives) are then returned to the surface. Natural gas and oil will flow from pores and fractures in the rock into the well for subsequent extraction. Wells used for hydraulic fracturing are drilled vertically, vertically and horizontally, or directionally. Wells may extend to depths greater than 8,000 feet and horizontal sections of a well may extend several thousand of feet away from the production pad on the surface.

Fracturing fluids can be up to 99 percent water. The volume of water needed for hydraulic fracturing varies by site and type of formation. Up to 65,000 gallons of water may be required to fracture one well in a coalbed formation while up to 13 million gallons of water may be necessary to fracture one horizontal well in a shale formation depending on the characteristics of the formation. Water used for fracturing fluids is acquired from surface water or groundwater near the well production area.

Wastewaters from the hydraulic fracturing process may be disposed of in several ways. For example, the flowback water following fracturing may be returned underground using a permitted underground injection well or discharged to surface waters after treatment to remove contaminants. However, not all fracturing fluids injected into the geologic formation during hydraulic fracturing are recovered. Data indicate that between 15 and 80 percent of the volume injected is recovered (7).

Over the past few years, the use of hydraulic fracturing for hydrocarbon extraction has increased and has expanded over a wider diversity of geographic regions and geologic formations. Public concerns have focused on the potential drinking water impacts of the hydraulic fracturing process used during natural gas and oil production from shale and coalbed methane formations. Given this expansion and increasing concerns, EPA announced in March 2010 that it would study the potential impacts that hydraulic fracturing may have on drinking water resources. EPA developed a draft and final study plan using input from EPA's Science Advisory Board to focus on drinking water resources (quality and quantity).

During the summer of 2010, EPA conducted a series of meetings to receive broad, balanced input from stakeholders in key regions affected by hydraulic fracturing to develop its draft study plan. EPA publically released its draft study plan in February 2011 and collected public comments on its draft plan. EPA also decided to collect data from nine hydraulic fracturing service companies using a Microsoft® Excel™ based questionnaire. The objectives of the questionnaire are to:

- Obtain contact information for persons within each company most familiar with hydraulic fracturing operations and for companies that have been contracted for hydraulic fracturing;
- Identify key industry oil and gas operators;
- Gain information on the location and services performed for past and future hydraulic fracturing operations;
- Obtain the names and formulations/mixtures of hydraulic fracturing fluids;
- Attain chemical and proppant constituent information for each formulation/mixture of hydraulic fracturing fluid;
- Gather studies conducted by industry related to human health concerns linked with hydraulic fracturing;
- Define policies, practices, and standard operating procedures for common hydraulic fracturing operations; and
- Identify water specifications for each formulation/mixture.

During the summer of 2011, EPA decided to collect data from nine oil and gas operating companies on 350 wells that had been hydraulically fractured. The objectives of the

data collection effort are to identify driving factors that have the potential for impacts to drinking water resources by obtaining and reviewing well-specific data on:

- Geologic maps and cross sections;
- Water quality sampling;
- Drilling records;
- Mud, open hole, and cased hole logs;
- Casing tallies;
- Cement records;
- Fracturing fluid and stimulation chemicals and volume;
- Fracture stimulation modeling results;
- Micro-seismic monitoring;
- Wellbore diagrams;
- Well completion and rework records;
- Flowback and produced waters; and
- Spill incident reports.

In the fall of 2011 EPA released its final study plan for research on hydraulic fracturing and drinking water resources entitled "*Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources.*"

2.2.2 Statement of Key Questions and Project Objectives

ERG is supporting EPA in its study of the potential impacts of hydraulic fracturing on drinking water resources. Companies that use the hydraulic fracturing process will provide a major source of information through EPA's survey of hydraulic fracturing fluids and hydraulically fractured wells. Other sources of information include existing studies on the potential environmental and human health impacts from hydraulic fracturing.

ERG is supporting EPA in answering the following key questions:

- What is the composition of hydraulic fracturing fluids and what are their degradation products?
- What is the potential to mobilize chemicals from geologic formations?
- How does hydraulic fracturing affect groundwater quality, especially drinking water aquifers?
- What practices are established to control groundwater/drinking water impacts?
- What methods are being used for chemical analyses of the hydraulic fracturing fluid?
- How does hydraulic fracturing differ across the country?
- What are the potential impacts of large volume water withdrawals from ground and surface waters on drinking water resources?
- How much water is used in hydraulic fracturing operations, and what are the sources of this water?

- What are the possible impacts of surface spills on or near well pads of hydraulic fracturing fluids on drinking water resources?
- What role does well integrity have on controlling potential impacts to drinking water resources?

ERG may develop spreadsheets and databases to manage the data submitted by industry to EPA to help address the above questions. ERG will summarize findings in technical reports/memoranda, as directed by the EPA WAM.

2.3 Element A.6: Project/Task Description

This section provides a management level overview of the work ERG will perform in support of this project. ERG will perform this work at the direction of EPA.

2.3.1 Questionnaire for Hydraulic Fracturing Service Companies

ERG assisted EPA by developing a spreadsheet format for the service company questionnaire, based on content developed by EPA. EPA mailed the questionnaires to the nine companies identified by EPA. ERG assisted EPA in managing and analyzing data from the questionnaire. The two major sources of information include companies' responses to questionnaires and existing EPA data. Most of the industry data collected via these surveys are considered confidential business information (CBI) under the Toxic Substances and Control Act (TSCA). ERG, therefore, is managing all CBI questionnaire data obtained from EPA as TSCA CBI. See Section 2.6 (Element A.8 Special Training/Certification) for details on ERG's TSCA CBI management.

ERG populated a Microsoft® Access™ database, *Hydraulic Fracturing Database*, with data from the questionnaire submissions. Data from hard copy submissions were reviewed and manually entered into the database. Data from electronic questionnaire submissions were reviewed and copied and pasted into the database electronically. ERG joined similar tables from all respondents using Microsoft® Access™ queries. For hard copy or PDF data submissions, ERG reviewed 100 percent of the data entered into the database to ensure that the data were transferred correctly. ERG conducted this review by manually verifying that data in the database match the submitted data. For electronic data submissions, ERG reviewed 100 percent of the data entered into the database. ERG conducted this check by electronically comparing the data in the database to the submitted data to ensure they are identical. Any inconsistencies identified during the reviews were fixed to match the original submitted responses.

Other data analysis activities are listed in further detail in Appendix A, "Hydraulic Fracturing Data Analysis Plan." ERG performed other data analysis tasks and database queries as specified by the EPA WAM. All survey submissions were labeled using unique survey identification numbers and uploaded to the c://hydraulic fracturing directory on ERG's TSCA CBI computer. EPA is conducting all follow-up with questionnaire recipients regarding the completeness of the questionnaire and interpretation of the submitted data.

At EPA's direction, ERG will conduct additional analyses of the submitted data. Data collected and managed under this task are used by EPA staff in their study of hydraulic fracturing.

2.3.2 Well File Data from Operators in the Hydraulic Fracturing Industry

EPA requested well data files from nine oil and gas operating companies whose operations include hydraulic fracturing. ERG is assisting EPA in standardizing and managing data from the responses. ERG notifies EPA of any inconsistencies or information missing from the responses. ERG manages responses as TSCA CBI, where necessary. See Section 2.6 (Element A.8 Special Training/Certification) for details on ERG's TSCA CBI management.

EPA requested that all companies return electronic responses when possible, but there were a few instances where hard copy submissions were made. ERG saves all electronic submissions on its TSCA CBI computer and scans hard copy submissions to the same TSCA CBI computer. ERG provides copies of these submissions to the EPA Well File Review team. ERG also manages electronic records received from members of the EPA Well File Review team by creating a database of this extracted well file data entitled *CBI Well File Database from Review Team*. Data from electronic spreadsheet submissions from the Well File Review team members are reviewed and copied and pasted into the database electronically. ERG works with EPA to create a suitable database structure and to create appropriate tables and reports. As specified through technical direction, ERG will also develop spreadsheets of the well file data to share with the EPA Well File Review team. ERG will verify that the database and spreadsheets accurately reflect submittals. Data collected and managed under this task are used by EPA staff in their study of hydraulic fracturing.

2.3.3 Public Comments on Hydraulic Fracturing

ERG will assist EPA in tracking, analyzing data from, and responding to public comments and submittals on its hydraulic fracturing study. As directed by EPA, ERG will review, catalogue, and summarize public comments submitted to EPA. ERG will work with EPA to identify the proper mechanism for tracking the comments, which may include a spreadsheet or ERG's comment response system. Each comment will be logged into the appropriate tracking system and saved to ERG Chantilly's network in Adobe Acrobat™ PDF format. As directed by EPA, ERG may develop and populate a public comment summary database that tracks comments by specific topic and the commenter's position on the topic. Technical data collected and managed under this task will be reviewed by EPA staff for inclusion in the study.

2.3.4 Hydraulic Fracturing Literature Search

As directed by EPA, ERG may perform literature searches and reviews of specified hydraulic fracturing topics including:

- Public waterway impacts;

- Discharge characteristics of POTWs receiving wastewater from hydraulic fracturing operations;
- Chemical composition of flowback and produced waters;
- Reactions between hydraulic fracturing chemicals and gas-bearing formations;
- Information on organic chemicals coming out of wells;
- River low flow requirements by state/basin;
- Volume and chemical composition of hydraulic fracturing fluids; and
- Wastewater treatment and disposal requirements by state.

As directed by EPA, ERG will search available Internet resources for peer-reviewed scientific literature, industry and trade publications and documents, books, gray (unpublished) literature, news articles, reports and conference proceedings, along with any other pertinent data sources. ERG will also review references listed in literature identified through internet searches to evaluate if any of the cited literature is pertinent to the literature review. Data collected and managed under this task will be reviewed by EPA staff for consideration and potential inclusion in the study

2.4 Element A.7: Quality Objectives and Acceptance Criteria

This QAPP is intended to ensure that information collected is of the quality necessary to support EPA's hydraulic fracturing study. ERG will evaluate the quality of information collected by EPA's questionnaires, submitted well file data, and collected in a literature search and reviews. ERG will also ensure that the compilation and analysis of stakeholder and public comment submittals is of the quality necessary to support EPA's hydraulic fracturing study.

All project deliverables will meet EPA's standards of transparency, objectivity, integrity, and utility as specified in *EPA's Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency (Information Quality Guidelines),* EPA/260R-02-008, October 2002 (5). This will be accomplished by preparing documentation supporting the work that identifies the sources of data, assumptions made, and calculations used in their development with sufficient detail so that the work can be reproduced by qualified third parties.

2.4.1 Well File Data from Operations in the Hydraulic Fracturing Industry

This task involves the collection and organization of data regarding the role of well performance during hydraulic fracturing relating to well design, construction, and completion practices. ERG will review and manage these data using the acceptance criteria identified in Table 2. ERG will notify EPA when well data do not meet the acceptance criteria. EPA will make all decisions regarding the acceptability of the submitted data.

Table 2. Well Data Acceptance Criteria

Acceptance Criterion	Description/Definition	Specification
Completeness	Well file submission, by company, is complete.	• Respondent has provided all requested contact information for representatives who provided information. • Well files have been submitted for each requested well. • All topics of the information request contain responses. • Responses can be tracked to individual data requests.
Consistency	Well file submission, by company, is consistent.	• All information throughout the response is consistent (i.e., the same number of wells, maps and cross sections provided, drilling and completion information, water quality, volume, and disposition information, hydraulic fracturing information, and data regarding environmental releases). • Well location in response is consistent with the well location used for statistical selection.

2.4.2 Public Comments on Hydraulic Fracturing

This task will involve the collection and review of publicly submitted comments on hydraulic fracturing. EPA may receive comments through several methods including: transcripts from public meetings (verbal comments), written comments from public meetings and draft reports, e-mailed comments, and comments submitted via Regulations.gov.

As directed by EPA, ERG will extract relevant data submitted with public comments. ERG will use the criteria listed in Table 3 to describe the quality of the data, but EPA will determine if the data are of acceptable quality for use in their study. ERG will prepare a memorandum summarizing the approach used to review and categorize the public comments as well as the overall findings from the comments themselves including the quality of the data.

Table 3. Public Comments Data Acceptance Criteria

Acceptance Criterion	Description/Definition	Specification
Relevancy	The comment provides information relevant to answering the research questions.	• Provides information related to a research question. • Provides information related to one of the five states of the hydraulic fracturing water cycle.
Accuracy/reliability	The information is accurate.	• Government publication (U.S., Canada, state, or province). • Submitter publication (operator standard operating procedures) For academic researcher: • Publication in peer-reviewed journal. • Presentation at professional technical conference. For vendor researcher: • Publication in peer-reviewed journal.

Table 3. Public Comments Data Acceptance Criteria

Acceptance Criterion	Description/Definition	Specification
Representativeness	Do data represent industry or do they focus on one region or type of practice?	• Provides information on current or prospective plays where hydraulic fracturing is or may be used. • Provides information on current or future practices associated with hydraulic fracturing.
Comparability	The data are consistent, and considered accurate.	• Data on quantities (chemical concentrations) includes analytical and/or measurement methods used to collect data

2.4.3 Hydraulic Fracturing Literature Search

This task will involve performing a literature search of topics related to hydraulic fracturing. ERG will use the following available internet sources to identify peer-reviewed scientific literature, industry and trade publications and documents, books, gray literature, news articles, reports and conference proceedings, and any other pertinent data sources:

- USGS publications warehouse: http://pubs.er.usgs.gov/;
- DOE website: www.doe.gov;
- Society of Petroleum Engineers library, OnePetro: http://www.onepetro.org/mslib/app/search.do;
- EPA On-Scene Coordinator Website: http://www.epaosc.org/;
- American Association of Petroleum Geologists Datapages library: http://www.searchanddiscovery.com/subject.shtml;
- Google, Google Scholar;
- State websites and regulations; and
- Conference proceedings.

ERG will use the criteria listed in Table 4 to determine if the literature are of acceptable quality for use in EPA's study.

Table 4. Hydraulic Fracturing Literature Search Acceptance Criteria

Acceptance Criterion	Description/Definition	Specification
Timeliness	The information reflects current conditions.	• Sources were published or presented in the past 5 years. • At the direction of EPA, ERG may use information from sources more than 5 years old if it represents practices currently used in hydraulic fracturing operations.

Table 4. Hydraulic Fracturing Literature Search Acceptance Criteria

Acceptance Criterion	Description/Definition	Specification
Accuracy/reliability	The information is accurate.	• Government publication (i.e., U.S., Canada, state, province). • Publication in peer-reviewed journal. • Presentation at professional technical conference. • Publication from industry experts or organizations. • Publication from other acceptable source, as determined by EPA.
Scope	The information reported is from hydraulic fracturing operations.	• Information pertains specifically to hydraulic fracturing operations. • Source represents a geographic area in which hydraulic fracturing operations are active or emerging.

2.5 Element A.8: Special Training/Certification

During the course of this work assignment, ERG will be accessing and evaluating TSCA CBI data. ERG will, at all times, adhere to CBI procedures when handling confidential information. ERG will manage all reports, documents, and other materials and all draft documents developed under this work assignment in accordance with the procedures set forth in EPA's *TSCA CBI Protection Manual* dated October 20, 2003 (6). ERG staff requiring access to TSCA CBI for this project will maintain active TSCA CBI clearance. The ERG Chantilly office has an approved TSCA CBI storage area, which allows ERG staff to work on TSCA CBI at that location. All work involving TSCA CBI will be completed at ERG's Chantilly, VA, office.

2.6 Element A.9: Documents and Records

ERG has developed and instituted document control mechanisms for the review, revision, and distribution of QAPPs. Each QAPP has a signed approval form, title page, table of contents, and EPA-approved document control format (shown below) that appears in the upper right-hand corner of each page:

Section No.
Revision No.
Date

During the course of the project, any revision to the QAPP will be circulated to all relevant ERG and EPA project staff. ERG will document the circulation of the revised QAPP to project staff with a signature page for the revision.

Standard controls for project-related data, documents, and records are presented in Section 5 of ERG's 2002 QMP (2). ERG's WAM is responsible for designating an individual to maintain all project files. She is also responsible for ensuring that project team members use ERG standard operating procedures (SOPs), including documenting all data sources used (Appendix A). All information collected, generated, and analyzed on the project is handled and

stored in a centralized record. For this project, Carissa Erickson will be responsible for maintaining all project files.

ERG documented these procedures in a draft *Hydraulic Fracturing Project File Management Plan*, which was delivered for EPA WAM review and approval on April 4, 2012. This centralized record will contain all data collected or accessed from other sources and document analyses of data collected. As discussed in the project file management plan, general non-CBI data will be stored on ERG's non-CBI network under the specified directory and CBI data will be stored on ERG's TSCA CBI network. The contents of the record will be indexed using a Microsoft® Access™ database entitled *ERG's Hydraulic Fracturing Study Record*. This will be a separate tracking database developed to identify all data collected and developed under this work. Because many industries identified their data as TSCA CBI, ERG's record database will also be treated as TSCA CBI. ERG will manage the record database in accordance with the procedures set forth in EPA's *TSCA CBI Protection Manual* dated October 20, 2003 (6). Specifically, the record database will be stored in ERG's TSCA CBI room, on the TSCA CBI computer. When not in use, the computer's removable hard drive is kept in a locked TSCA safe. Project information on the TSCA CBI computer is backed up to a CD every time the project information is updated and also stored in the locked TSCA safe. Access to the locked TSCA CBI room is limited to those ERG employees with TSCA CBI clearance.

Management of project data is specifically described in Element B.10, Data Management, of this QAPP.

3.0 DATA GENERATION AND ACQUISITION

This section describes data generation and acquisition via the hydraulic fracturing questionnaires, well file data collection, public comment submittals, and literature search and review. Therefore, this section discusses the following six elements:

- B.1: Sampling Process Design;
- B.2: Sampling Methods;
- B.3: Sample Handling and Custody;
- B.5: Quality Control;
- B.9: Non direct Measurements; and
- B.10: Data Management.

The following elements are not relevant to ERG's support of EPA's hydraulic fracturing study, because ERG will not be supporting field work.

- B.4: Analytical Methods;
- B.6: Instrument/Equipment Testing, Inspection and Maintenance;
- B.7: Instrument/Equipment Calibration and Frequency; and
- B.8: Inspection/Acceptance of Supplies and Consumables.

3.1 Hydraulic Fracturing Questionnaire

This section describes data handling and management activities ERG conducted in support of the questionnaire for hydraulic fracturing service companies, which is referred to as the "questionnaire" throughout the remainder of this section. This questionnaire task included organizing and analyzing data obtained from oil and gas companies that perform hydraulic fracturing. Therefore, this section discusses the following elements:

- B.3: Sample Handling and Custody; and
- B.10: Data Management.

ERG has completed activities associated with this task, but may conduct additional data analysis as directed by EPA. In this case, ERG will follow the procedures described below.

3.1.1 Element B.3: Questionnaire Sample (Data) Handling and Custody

During the Fall and Winter of 2010/2011, EPA mailed the completed questionnaires, electronic and hard copy, to ERG following TSCA CBI procedures, and ERG logged them into the hydraulic fracturing tracking spreadsheet. ERG logged original completed questionnaires into ERG's Hydraulic Fracturing Project File Index and stored them as TSCA CBI in the project file. In order to ensure data quality, ERG did not change original responses of the questionnaire during review and follow-up and created working copies to complete these changes. Examples of data that may have required changes include misspelled chemical names, mistyped CAS numbers, and coding to identify unique wells at a given location. ERG documented all changes to original data in memos to the project file. ERG's standard controls for

project-related data, documents, and records are presented in the *Hydraulic Fracturing Project File Management Plan*.

3.1.2 Element B.10: Questionnaire Data Management

To transfer responses into the *Hydraulic Fracturing Questionnaire Database*, ERG imported tables in electronically submitted questionnaire responses directly into the *Hydraulic Fracturing Questionnaire Database*. ERG manually entered data obtained from hard copy responses. ERG joined similar tables from all respondents using Microsoft® Access™ queries. To ensure that the database accurately reflects responses, ERG reviewed 100 percent of the hard copy and electronic submissions. This check involved manually comparing data in the database to the original data submission to ensure they are the same for hard copy submissions and electronically comparing data in the database to original data submissions to ensure they are the same for electronic submissions. If data transfer errors were detected (e.g., data type mismatch, incorrect file name), ERG documented the error and corrected it. Additional reviews were performed until all data transfer errors were resolved. ERG notified the EPA WAM of the results of the QA reviews. Additional information on ERG's data management procedures are presented in the Appendix B, Hydraulic Fracturing Well File Plan.

Documentation for the questionnaire includes the questionnaire responses on CD and/or hard copy. These documents, except for the original hard copy and/or CD response, are stored in a working file specific to each respondent on ERG Chantilly's TSCA CBI computer. The original hard copy and/or CD response are stored as TSCA CBI in the ERG project archive. ERG's standard controls for project-related data, documents, and records are presented in Section 5 of the 2002 QMP (2).

ERG used standardized practices for database queries and database development while executing the work described in this plan. These practices present requirements for identification and control of different versions of the database and its tables. These requirements include:

- Assigning a unique name and number to the revised version of any database tables where revisions have taken place and maintaining a log of database table revisions.

- Assigning a unique name and number to versions of the database. Also, maintaining a log that identifies database revisions and describes the changes made to the different versions. This log is a table within the database.

ERG used data in the *Hydraulic Fracturing Questionnaire Database* to perform specific analyses. ERG constructed database queries to perform these analyses. The queries are documented in a table in the *Hydraulic Fracturing Questionnaire Database* and reviewed to ensure that all queries used to generate results are designed correctly and that all functions are used appropriately.

Information collected through the questionnaire are managed following the procedures set forth in EPA's *TSCA CBI Protection Manual* dated October 20, 2003 (6). ERG staff requiring access to TSCA CBI for this project maintains active TSCA CBI clearance. The ERG Chantilly office has an approved TSCA CBI storage area, which allows ERG staff to work on TSCA CBI at that location.

3.2 Well File Data

This section describes the acquisition and storage of data collected from well operators regarding well performance during hydraulic fracturing. This task includes collecting and reviewing data obtained from oil and gas companies involved that perform hydraulic fracturing. Therefore, this section discusses the following five elements:

- B.1: Sampling Process Design;
- B.2: Sampling Methods;
- B.3: Sample Handling and Custody;
- B.5: Quality Control; and
- B.10: Data Management.

The data collection work has been completed and ERG is currently working with EPA on the data management and analyses tasks.

3.2.1 Element B.1: Well File Data Sampling (Data Collection) Process Design

For this well file data collection effort, EPA requested data from nine hydraulic fracturing companies for 350 hydraulically fractured wells. EPA selected wells using a stratified random method to reflect the diversity in both geography and size of the oil and gas operator. EPA requested well data as it relates to well design, construction, and operation practices. EPA requested that all companies return well data files electronically, when possible.

3.2.2 Element B.2: Well Data Files (Data Collection) Methods

On August 11, 2011, EPA mailed the data request letter to the nine recipients, requested that the nine recipients complete the data request voluntarily, and that they submit data directly to ERG. All responses must include a certification statement signed by a responsible corporate officer. Responses received without a signed certification statement will be considered incomplete and may not be included in final data analyses. At the direction of the EPA WAM, ERG will follow up with respondents to obtain any missing signed certification statements. EPA will ensure compliance with the information request by using a variety of means, including as necessary, follow-up phone calls and letters.

Companies had the option to identify the information or part of the information submitted as TSCA CBI. See Section 3.2.3 for handling procedures of well data files, including those marked TSCA CBI.

3.2.3 Element B.3: Well Data Files Handling and Custody

EPA requested that all companies return well files information electronically. Well data files were shipped to ERG and were logged into ERG's hydraulic fracturing tracking database and reviewed for completeness and consistency per the specifications listed in Table 2-3. Original well data files were logged into ERG's Hydraulic Fracturing Project File Index and stored as TSCA CBI in the electronic project file. ERG informed EPA of any areas where data are missing or where inconsistencies were noted and ERG conducted follow-up as directed by EPA. In the case where electronic well files were not available, ERG reviewed hard copy submissions for completeness and consistency per the specifications listed in Table 2 and consulted with EPA regarding the creation of corresponding electronic well files and/or duplicate hard copy files. To ensure data integrity ERG did not change original well data responses during review and follow-up. If necessary, ERG created working copies of the files to complete the required analyses. See Section 3.2.4 for further discussion of well data files receipt. Additional information on ERG's procedures for handling and managing well file data is provided in Appendix B, Hydraulic Fracturing Well File Plan.

3.2.4 Element B.5: Well File Data Quality Control

Data Receipt. ERG developed the following procedure to ensure the proper handling and storage of well file data responses. These procedures helped to ensure that all responses were received, tracked, saved, and copied to the appropriate location.

- Upon receipt of well file data, update the hydraulic fracturing tracking spreadsheets with the date ERG received the response.
- Save a copy of each electronic file submitted to EPA on ERG's TSCA CBI computer.
- Store all electronic and paper responses in the ERG project archive as original files. These files will not be altered or changed.

Data Review. ERG reviewed the acceptability of well file data responses using the acceptance criteria described in Table 2. EPA conducted follow-up phone calls or emails to the companies regarding the acceptability of their well data. ERG included all relevant submitted data in the database. ERG identified/flagged data in the database that do not meet the acceptance criteria such as consistency and communicated these findings to EPA to discuss any limitations associated with including these data in the database. EPA determined if there are data that should be removed from the database. ERG documented these discussions in a memo to the project file.

- Completeness Checks:
  - — Check that the respondent has provided all requested contact information for representatives who provided information applicable to the request;
  - — Check that well files have been returned for each requested well; and
  - — Check that all topics of the information request contain responses.
- Consistency Checks:

- Check that all information throughout the response is consistent (i.e., the same number of wells, maps and cross sections provided, drilling and completion information, water quality, volume, and disposition information, hydraulic fracturing information, and data regarding environmental releases); and
- Check that well location in response is consistent with the well location used for statistical selection.

Additional information on the quality control measures performed by ERG on the well file data is available in Appendix C, Well File QA/QC Procedures Report.

3.2.5 Element B.10: Well Data Files Management

Upon receipt of electronic well data files, ERG performs a completeness check to ensure that all requested information has been submitted and that any electronic files can be opened and saved to ERG's TSCA CBI computer without problems. After this review is completed, ERG saves copies of the files to the ERG TSCA CBI computer. ERG then copies files received from the well file team to the *CBI Well File Database from Review Team* located on the ERG TSCA CBI computer.

To ensure that the CBI Well File Database from Review Team accurately reflects responses, ERG reviews 100 percent of the files received from the EPA Well File Review team to ensure data in the database match the original data. This check involves electronically comparing the original data to the data in the database to ensure they are identical. If data transfer errors are detected (e.g., data type mismatch, incorrect file name), ERG will document the error and correct it. Additional files will be reviewed until all data transfer errors are resolved. ERG will notify the EPA WAM of the results of the QA file reviews.

Documentation for well data files is stored in a working file specific to each respondent on ERG Chantilly's TSCA CBI computer. All original well data files are stored as TSCA CBI in the ERG project archive. ERG's standard controls for project-related data, documents, and records are presented in Section 5 of the 2002 QMP (2).

ERG will send copies of all well file data to EPA following TSCA CBI procedures. ERG will place all data received into files organized in order, following the numbering format in EPA's information request letters sent to the nine oil and gas operators.

Information collected in the well data responses are managed following the procedures set forth in EPA's *TSCA CBI Protection Manual* dated October 20, 2003 (6). ERG staff requiring access to TSCA CBI for this project will maintain active TSCA CBI clearance. The ERG Chantilly office has an approved TSCA CBI storage area, which allows ERG staff to work on TSCA CBI at that location.

3.3 Public Comments on Hydraulic Fracturing

This section describes how ERG will ensure that appropriate methods for data collection, generation, and acquisition are employed and documented to support the review of public comments submitted on aspects of EPA's hydraulic fracturing study. Activities may include tracking and reviewing secondary data, such as literature information submitted as part of the public comments. Therefore, this section discusses the following two elements:

- B.9: Nondirect Measurements; and
- B.10: Data Management.

3.3.1 Element B.9: Nondirect Measurements

EPA is conducting many outreach activities associated with its hydraulic fracturing study and may receive public comments from several activities including the release of its December 2012 update of the study. Public comments may be submitted to EPA electronically via email and hard copy through the U.S. mail or other courier and via Regulations.gov.

As directed by EPA, ERG will obtain the comments from EPA and manage stakeholder and public comment input relevant to the *U.S. EPA Study on the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*. ERG will log each comment into the approved comment tracking system, which may be a spreadsheet or ERG's comment response tracking system, and then save the comments to ERG Chantilly's network in Adobe Acrobat ™ PDF format. ERG will review 100 percent of the received comments against the comment logged in the tracking system to ensure that all comments are appropriately tracked. As directed by EPA, ERG will extract data from the public comments for further analysis as described in section 3.3.2.

3.3.2 Element B.10: Data Management

Upon receipt of a public comment, ERG will assign it a unique identifier, referred to as the Commenter ID and place it in a folder titled "to be reviewed." The format of the Commenter ID will include a three-letter prefix, HFS, which identifies the Hydraulic Fracturing Study, and a five-digit numeric code, which represents the sequential numbering of the comments. ERG will convert all stakeholder and public comments to an Adobe Acrobat™ PDF file to facilitate transfer to EPA's public docket. ERG will use the Commenter ID in the electronic file name for efficient organization and identification. As comments are reviewed, ERG will move the electronic PDF comment file from a "to be reviewed" folder to a "reviewed" folder to ensure comments are reviewed only once. ERG will review 100 percent of the submitted comments against the reviewed comments to ensure all comments are addressed.

As directed by EPA, ERG may enter certain comment information into a Microsoft® Access™ database. The database may contain tables linked by the Commenter ID field, the commenter's position on the study and/or topic, and other data contained in the comments or submitted by the commenter. ERG will review 100 percent of the data entered into any such public comment database to ensure they match the submitted comments. ERG will

check that all public comment information meets the data acceptance criteria specified in Table 3. ERG will discuss all quality issues associated with the information with EPA prior to including it in the database.

3.4 Hydraulic Fracturing Literature Search

This section describes how ERG will identify and acquire the literature sources needed to answer the key questions listed in Section 2.2.2, describes how ERG will determine if the sources meet the specifications listed in Table 4, and how this determination will be documented. This task includes collecting and reviewing data obtained from secondary sources. Therefore, this section discusses the following four elements:

- B.1: Sampling Process Design;
- B.3: Sample Handling and Custody;
- B.5: Quality Control; and
- B.10: Data Management.

3.4.1 Element B.1: Data Acquisition Process

ERG project team members will obtain documents identified during the literature search from sources such as government publications, scientific literature, and vendor documents. ERG staff will use the following procedures when collecting published literature:

- ERG will focus internet researching to the key primary and secondary key words approved by EPA.
- ERG will collect full content and bibliographic information on all newly collected publications, including "date accessed" for information collected from the Internet. ERG researchers will save web pages as PDF files, so that the data source can be added to the electronic project file.
- ERG will document any literature for which they are unable to obtain full-text documents. At the direction of EPA, ERG will contact publication authors to request a copy of the document.

3.4.2 Element B.3: Literature Search Results

ERG will provide the results of the literature search to EPA as directed. All materials developed and delivered to EPA will be stored on ERG's hydraulic fracturing project FTP site. ERG's standard controls for project-related data, documents, and records are presented in the *Hydraulic Fracturing Project File Management Plan*.

3.4.3 Element B.5: Data Quality Control

ERG will check that all literature identified meets the data acceptance criteria specified in Table 4. ERG may use references that do not meet the specifications if, for example, there are no other available references. ERG will discuss such quality issues with EPA and obtain written approval before including these references in literature search results.

ERG will perform a 100 percent check of all literature search results in terms of consistency, format and spelling. ERG will perform a 10 percent review of all documents search results by reproducing the search using selected key words.

3.4.4 Element B.10: Data Management

As directed by EPA, ERG will enter data obtained from the literature searches into a literature review spreadsheet. ERG will use standardized practices for spreadsheet development. These practices include requirements for identification and control of different version of the spreadsheets. The requirements include assigning a unique name and number to the revised version of any spreadsheet and maintaining a log of spreadsheet revisions.

4.0 ASSESSMENT AND OVERSIGHT ELEMENTS

This section describes technical review, audits, and corrective actions that will be performed on the hydraulic fracturing information evaluation to ensure the QAPP is implemented as approved.

4.1 Element C.1: Assessments and Response Actions

All work conducted for the hydraulic fracturing project will be subject to technical review. Technical review is a documented in-depth evaluation of work products to assure that established requirements are satisfied. This review will be conducted by the ERG WAM. Review of project deliverables will be documented in a "Deliverable Sign-Off Sheet." All deliverables will be subsequently reviewed by the EPA WAM.

Betsy Bicknell serves as ERG's Local QA Manager. In this role she will perform the following to assess the implementation of QA/QC procedures on this project:

- Review this QAPP for completeness and applicability.

Dan-Tam Nguyen will serve as the Project QA Coordinator for this project. She will perform the following to assess the implementation of QA/QC procedures on this project:

- Audit project files quarterly to ensure project staff have developed appropriate QC procedures and are using these procedures and that the deliverable review process is documented in sign-off sheets. Copies of these audits are submitted to EPA for their review.

At any time or at the end of the project or work assignment, the Local QA Manager, Betsy Bicknell, or her designee, may inspect the project QA files. The Corporate QA Manager, Mary Willett, or her designee will ensure that independent audits are conducted to determine the effectiveness of the ERG QA/QC program. In addition, any quality deficiencies detected by technical reviewers or the Project QA Coordinator will be communicated, in writing, to the ERG WAM. The ERG WAM is responsible for ensuring that appropriate corrective action is taken to fix the deficiency, ensure that similar errors are not made in the future and that these measures are reported to the Project QA Coordinator.

4.2 Element C.2: Reports to Management

ERG will routinely communicate with the EPA WAM through scheduled calls, often biweekly, to discuss the status of work and any issues or questions regarding the integrity or quality of the submitted data and specified deliverables. In addition to the routine calls, ERG will describe QA activities conducted for major deliverables, such as summary memoranda, when such documents are delivered to EPA. These descriptions may be included in the document or in the transmittal email, as directed by EPA. Additionally, ERG will provide the EPA WAM with monthly reports on the status of QA activities. These reports will be incorporated into ERG's monthly technical progress reports, which will be supplemented to include the following:

- Quality assurance activities performed during the reporting period as part of the implementation of the work assignment including the review of submitted data against acceptance criteria;
- Identification of any problems encountered;
- Identification of any deviations from the QAPP; and
- Identification of problem resolution and/or corrective actions taken during the reporting period, if any.

ERG will submit reports to EPA summarizing the quarterly audits of the project files within five business days of completing the audit.

5.0 DATA VALIDATION AND USABILITY ELEMENT

This section describes data review, verification, and validation. It also discusses how validated data will be evaluated to determine if they adequately answer the questions posed in Section 2.2.2 and meet the quality objectives stated in Section 2.4.

5.1 Elements D.1 and D.2: Data Review, Verification, and Validation; and Validation Methods

This section discusses how ERG will check well file, public comment, and literature search information collected during the project to determine how they can be used.

5.1.1 Well File Data

ERG will review the Microsoft® Access™ *CBI Well File Database from Review Team* to ensure that data have been recorded, transferred, and processed correctly. ERG's well file data handling, custody, and review procedures that ensure the quality and completeness of questionnaire responses are described in Section 3.2. Section 3.2.5 describes ERG's data management procedures developed to verify transcription of well file data. ERG uses procedures appropriate to the data source and transfer procedures to verify that data obtained from existing data sources have been transcribed accurately. Specifically, ERG reviews 100 percent of the database entries to ensure they match the original data submissions. For hardcopy submissions, ERG manually compares the database entry and hardcopy submission. For data submitted on electronic media, ERG runs a query to electronically check that the database entry and electronic submissions are identical. If errors are found, ERG corrects the database entry to match the original submission. See Section 2.4.1 for more information regarding checks that ERG will use to determine the completeness and consistency of the well file data. ERG will report these measures of quality to the EPA WAM in the monthly report.

5.1.2 Public Comment Data

For public comment information, ERG will review the selected comment tracking mechanism to ensure that it contains all of the public comments received by EPA. ERG's public comment handling, custody, and review procedures that will ensure the quality and completeness of the public comment tracking activities are described in Section 3.3. Section 3.3.2 describes ERG's data management procedures developed to verify tracking of public comment information. ERG will review 100 percent of the public comment data entered into the tracking system to ensure they match the submitted comments. This will likely include the use of queries to electronically compare database entries with original submissions to ensure they are identical. See Section 2.4.2 for more information regarding checks that ERG will use to determine the relevancy, accuracy/reliability, representativeness, and comparability of the public comment information. ERG will report these measures of quality to the EPA WAM in the monthly report.

5.1.3 Literature Search Data

For data obtained through literature searches, ERG will review the literature search spreadsheets to ensure that they contain all of the relevant literature search data. ERG's literature search data acquisition, handling, and management activities are described in Section

3.4. Section 3.4.4 describes ERG's data management procedures to verify that data in the literature search spreadsheets to ensure they match data obtained through the literature searches. ERG will review conduct a second search of 10 percent of the literature search results using the same keywords and search mechanism to ensure data from the original search match the data obtained during the second search. See Section 2.4.3 for more information regarding checks that ERG will perform to determine the timeliness, accuracy/reliability, and scope of the literature search results. ERG will report these measures of quality to the EPA WAM in the monthly report.

5.2 Element D.3: Reconciliation with User Requirements

Completed questionnaire and well file data are primary data sources that ERG will use to assist EPA in answering, at least in part, each of the key objectives posed in Section 2.2. Questionnaire responses provide information on hydraulic fracturing practices, fracturing fluid constituents, geological factors, and water usage requirements. Well file data provide information on well construction, design, and operating practices. All primary data calculations and analyses are thoroughly documented for the project file in spreadsheets, databases, calculations, database programs and queries, and technical memoranda and documents.

In addition, ERG will describe data quality and limitations in its reports so later data users may determine if the data are of sufficient quality for their use. ERG will work with EPA to determine to what extent data that do not meet the specified data acceptance criteria may be used to support the *U.S. EPA Study on the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources* and how this determination will be documented. All data use determinations will be made by EPA and data determined by EPA to be unacceptable will not be used to support this study.

ERG will include an evaluation of data quality in all project deliverables. ERG will also identify the sources of data, assumptions made, changes or modifications to data based on follow up conversations with EPA, and calculations used in their development in all project deliverables including databases. These identifications will be sufficiently detailed and transparent to ensure the reproducibility of the work by qualified third parties. All project deliverables will meet EPA's standards of transparency, objectivity, integrity, and utility as specified in EPA's *Information Quality Guidelines* (5).

6.0 REFERENCES

1. U.S. Environmental Protection Agency. EPA Requirements for Quality Assurance Project Plans QA/R-5. EPA/240/B-01/003. Office of Environmental Information. March 2001.

2. Eastern Research Group, Inc. Environmental Engineering Support for Clean Water Regulations Quality Management Plan, June 2012.

3. Eastern Research Group, Inc. Quality Management Plan, May 2012.

4. U.S. Environmental Protection Agency, EPA Requirements for Quality Management Plans QA/R-2, EPA/240/B-01/002, Office of Environmental Information, 2001.

5. U.S. Environmental Protection Agency, Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency, EPA/260R-02-008, October 2002.

6. U.S. Environmental Protection Agency, TSCA CBI Protection Manual, EPA Office of Pollution Prevention and Toxics (7407 M), October 20, 2003.

7. U.S. EPA 2010. U.S. Environmental Protection Agency, Science in Action, "Hydraulic Fracturing Research Study," U.S. Office of Research and Development. www.epa.gov/ord. June 2010.

Appendix A

HYDRAULIC FRACTURING DATA ANALYSIS PLAN

MEMORANDUM

TO: Jeanne Briskin, EPA

FROM: Steve Strackbein, ERG
Birute Vanatta, ERG

DATE: October 29, 2010

SUBJECT: **Hydraulic Fracturing Data Analysis Plan**

1.0 Introduction

The hydraulic fracturing survey administered by EPA requests data from companies associated with large scale hydraulic fracturing operations. The survey was sent to nine companies and responses are expected to be received for seven to nine plants/operations. The objectives of the survey are:

- Obtain contact information for persons within each company most familiar with hydraulic fracturing operations and for companies that have been contracted for hydraulic fracturing;
- Gain information on the location and services performed for past and future hydraulic fracturing operations;
- Obtain the names and formulations/mixtures of hydraulic fracturing fluids;
- Attain chemical and proppant constituent information for each formulation/mixture of hydraulic fracturing fluid;
- Gather studies conducted by industry related to human health concerns linked with hydraulic fracturing;
- Define policies, practices, and standard operating procedures for common operations; and
- Identify water specifications for each formulation/mixture.

2.0 Data Management

EPA has requested that all plants return an electronic copy of the questionnaire. Completed questionnaires will be mailed to EPA and transferred from EPA to ERG where they will be logged into the hydraulic fracturing tracking database and reviewed for completeness and consistency. ERG will inform EPA of any areas where data are missing or where inconsistencies were noted and follow up procedures will be discussed. After the data review and any follow up, ERG will electronically extract the data from the questionnaires into the *Hydraulic Fracturing Questionnaire Database.*

Original completed questionnaires will be logged into ERG's Hydraulic Fracturing Project File Index and stored as TSCA CBI in the electronic project file. ERG will manage the

Hydraulic Fracturing Questionnaire Database as TSCA CBI. In order to ensure data quality, ERG will not change original responses of the questionnaire during review and follow-up. ERG will create working copies to complete these changes. Any paper copies received will be stored as TSCA CBI and only used as a reference to the original data.

3.0 Data Analysis

All data will be analyzed for completeness and to identify trends in the industry, common chemical formulations/mixtures, and statistics related to physical/chemical properties of chemical formulations/mixtures. Table 1 presents specific tasks that will be performed within each analysis category.

Table 1. Data Analysis Tasks to be Performed

Analysis Type	Tasks
Completeness Analysis	• Completeness Checks – Check that the respondent has provided all requested contact information and site/formulation; – Check that the number of formulations/mixtures listed in question 1 match the number of formulation/mixture specific questions that have been completed. – Check that response data submitted includes all necessary files and that all parts of the file are present and able to be viewed/accessed; and – Check that all applicable questions are completed on each worksheet of the electronic questionnaire. • Consistency Checks – Check that all information throughout the questionnaire is consistent (i.e., the same number of formulations/mixtures, chemicals are reported throughout); – Check that service areas and types of services are not repeated or have multiple sets of information; and • Assess the accuracy and comparability of 100 percent of the survey data by conducting a question-by-question engineering review of all surveys.
Industry Trend Analysis	• Review Standard Operating Procedures and summarize common practices (including fluid modification techniques, chemical formulation/mixture specifications to meet site requirements, and geological factors related to injection volumes) • Evaluate and summarize typical services provided • Map locations of operations, vendors, and incoming water sources for fluid mixing and compare with other relevant mapping data (e.g., coal seams or other geological factors, drinking water sources, surface waters)
Chemical Formulation/Mixture Analysis	• Review MSDSs provided by industry, summarize common hazards, and categorize chemical hazards based on their known health effects (e.g., known carcinogens, endocrine disrupters, neurological effects) • Evaluate water specifications used in fluids and compare chemical concentrations used in fluid formulations/mixtures to water quality criteria (e.g., MCL) • Review industry studies on human health impacts related to chemicals within fracturing fluid • Review analytical methods used to determine concentrations of chemicals and identify differences that may affect reported concentrations • Categorize chemicals according to purpose in formulation/mixture and types of geology media where certain chemicals are used (e.g., coal bed, shale)

Table 1. Data Analysis Tasks to be Performed

Analysis Type	Tasks
Statistical Analysis	• Provide statistics on properties of chemicals and proppants within fracturing fluid (average, minimum, maximum of chemical/physical properties, and concentrations of chemicals/proppants/water in fluids) • Provided statistics on popularity and quantity of chemical and proppant constituents, SOPs, and services provided (most/least common chemicals and proppants, SOPs and services provided, number of chemicals and proppants used)

Appendix B

HYDRAULIC FRACTURING WELL FILE PLAN

MEMORANDUM

TO: Jeanne Briskin, EPA/ORD

FROM: Steve Strackbein, ERG
Birute Vanatta, ERG

DATE: August 12, 2011

SUBJECT: Hydraulic Fracturing Well File Plan

1.0 INTRODUCTION

The well file data request administered by EPA solicits data from companies responsible for well performance during hydraulic fracturing as it relates to well design, construction, and completion practices. The data request was sent to nine companies and EPA expects to receive responses for up to 350 wells. The objectives of the data request are as follows:

- Obtain contact information for persons within each company most familiar with well performance and operations during hydraulic fracturing;
- Gain detailed geologic maps and cross sections of the field or area where wells are located, including the general field area, the existing production wells within the field showing surface and bottom-hole locations, names of production wells, faults within the area, locations of delineated source water protection areas, geologic structures, and directional orientation;
- Gather drilling and completion information, including daily drilling and completion records and the following logs; mud[1], caliper, density, resistivity, sonic, spontaneous potential, gamma, cement bond[2], cement evaluation, radioactive tracer, and temperature;
- Collect casing tallies[3], cementing records[4] for each casing string, pressure testing results of installed casing, and up-to-date wellbore diagrams;
- Attain detailed information related to water quality, volume, and disposition, including results from any water quality sampling and analyses related to well construction and operation, volume and final disposition of "flowback" and "produced water;"
- Assemble information on practices related to produced water or flowback fluid recycling, including, but not limited to, recycling procedure, volume of fluid recycled, disposition of any recycling waste stream generated, and the uses for recycled fluids;

[1] Mud logs are expected to include the following: shows of gas or oil, losses of circulation, drilling breaks, gas kicks, mud weights, and chemical additives.
[2] Cement bond logs include surface pressure during each logging run.
[3] Casing tallies include number, grade, and weight of casing joints installed.
[4] Cementing records include the type of cement, cement yield, and wait-on-cement times.

- Obtain information on the hydraulic fracturing of requested wells including total volume, source, chemical constituents and quality of base fluids, fracture growth and propagation modeling[5] prior to hydraulic fracturing, and pumping schedule or plans[6];
- Gather post-fracture stimulation reports[7] and micro-seismic monitoring data associated with requested wells or nearby wells; and
- Identify environmental releases through spill incident reports[8] for any fluid spill associated with requested wells including spills by vendors and service companies.

2.0 DATA MANAGEMENT

EPA has requested that all companies return well files electronically when possible. Completed data requests will be mailed to ERG where they will be logged into the hydraulic fracturing tracking database and reviewed for completeness and consistency. ERG will inform EPA of any areas where data are missing or where inconsistencies were noted and follow up procedures will be discussed. In the case where electronic well files are not available, ERG will review hard copy submissions for completeness and consistency and consult with EPA regarding the creation of corresponding electronic well files and/or duplicate hard copy files.

Original well file submissions will be logged into ERG's Hydraulic Fracturing Project File Index and stored in an appropriate manner based on confidential business information (CBI) claims, as applicable, in the electronic project file. ERG will manage data identified as CBI submitted as part of this request as TSCA CBI. To ensure data quality, ERG will not change original well files during review and follow-up. If necessary, ERG will create working copies of the files to complete the required analyses.

3.0 DATA ANALYSIS

All data will be analyzed for completeness and consistency. Table 1 presents the specific tasks that ERG will perform within each analysis category.

[5] Fracture growth and propagation includes modeling inputs (e.g., permeability, Young's modulus, Poisson's ratio) and outputs (e.g., fracture length, height, and width).
[6] Pumping schedule or plan includes the number, length, and location of stages, perforation cluster spacings, and chemical constituents and amounts of stimulation fluid to be used.
[7] Stimulation reports include a chart showing all pressures and rates monitored during the stimulation; depths stimulated; number of stages employed during stimulation; calculated average width, height, and half-length of fractures; and fracture stimulation fluid actually used, including the type and respective amounts of base fluid, chemical additives and proppants used.
[8] Spill reports include the volume spilled, volume recovered, the disposition of recovered volumes, and the identification of any waterways or groundwater that was impacted from the spill and how this is known.

Table 1. Data Analysis Tasks to be Performed

Analysis Type	Tasks
Completeness Analysis	• Completeness Checks -Check that the respondent has provided all requested contact information for representatives who provided information applicable to the request; -Check that well files have been returned for each requested well; and -Check that all topics of the information request contain responses. • Consistency Checks –Check that all information throughout the response is consistent (i.e., the same number of wells, maps and cross sections provided, drilling and completion information, water quality, volume, and disposition information, hydraulic fracturing information, and data regarding environmental releases); and –Check that well location in response is consistent with the well location used for statistical selection. • Assess the accuracy and comparability of 100 percent of the data by conducting a file by file engineering review of all respondent data.
Prepare Well Files for Distribution to EPA-led Team	• Place all data obtained into files organized in identical order, following the numbering format in EPA's letter to nine oil and gas operators.

Appendix C

WELL FILE QA/QC PROCEDURES REPORT

MEMORANDUM

TO: Leigh DeHaven, EPA/ORD
Susan Burden, EPA/ORD

FROM: Steve Strackbein, ERG
Birute Vanatta, ERG

DATE: November 9, 2012

SUBJECT: **Well File QA/QC Procedures Report**

INTRODUCTION

ERG is supporting EPA's data collection efforts regarding the role of well performance during hydraulic fracturing as it relates to well design, construction, and completion practices. ERG has supported EPA's data request to nine oil and gas companies, made in October 2011, by receiving, organizing and distributing data received from industry to the EPA well file review team. Specifically ERG performed the following steps:

1. Received data from industry;
2. Managed and stored data from industry;
3. Distributed industry data to the EPA well file review team;
4. Received reviewed data files (working and final) from the EPA well file review team;
5. Compiled a database of the EPA well file review team data files; and
6. Distributed database and well file review team working files to the EPA well file review team.

This memorandum provides details of the quality control measures performed by ERG to ensure data quality for the well file data during each step in ERG's data management activities.

STEP 1 – RECEIVED DATA FROM INDUSTRY

Data submitted to EPA by industry was delivered to ERG to the attention of the ERG Toxic Substance Control Act (TSCA) Confidential Business Information (CBI) Document Control Officer (DCO). Upon arrival at the ERG office, ERG immediately logged data into the ERG TSCA CBI tracking log spreadsheet. After data were logged into the tracking spreadsheet, ERG copied the data to the ERG removable hard drive for this project. ERG scanned hard copy submissions and saved them electronically to the ERG removable hard drive. When not being

used, the original data submitted by industry and the ERG removable hard drive are stored in a locking filing cabinet as per TSCA CBI procedures.

STEP 2 – MANAGED DATA FROM INDUSTRY

ERG performed a completeness check on all of the data received from industry. ERG used the data copied onto the ERG removable hard drive for the completeness check to ensure the original industry data were not compromised. The completeness check consisted of ensuring that respondents provided contact information; tracking the number of questions each company responded to for each well requested by EPA; and documenting industry's confidential business information claim associated with each response. ERG delivered results of the completeness check to EPA on a regular basis to facilitate EPA's review of the submitted industry data. ERG selected 10 percent of the wells for which data were submitted for QC review. QC of the completeness check spreadsheet consisted of checking the spreadsheet for data input errors by reviewing the data submitted in response to EPAs request and recording the question numbers that received responses. ERG compared the results of the review to the completeness check spreadsheet to identify any discrepancies. ERG evaluated all discrepancies to guarantee the completeness check accurately reflected industry response and made necessary changes to the completeness check spreadsheet. ERG recorded all QC reviews and findings on it QC review spreadsheet developed for this project.

STEP 3 – DISTRIBUTED INDUSTRY DATA TO THE EPA WELL FILE REVIEW TEAM

After conducting the completeness check, ERG copied the submitted industry data to CDs or DVDs and checked each disc to ensure it was operable and contained all of the appropriate files. ERG assigned each disc a document control number (DCN) and prepared a TSCA CBI cover sheet prior to distribution to the specified EPA DCOs. ERG tracked the copies and distribution of all industry data, TSCA CBI and non-CBI, in a copy and distribution tracking spreadsheet. ERG recorded the DCN, the date, disc content and the recipient for each shipment. Additionally, ERG performed all related TSCA CBI checks for TSCA CBI data deliveries including completing a transmittal sheet, double seal packaging, stamping the outer envelope with TSCA CBI stamps, and tracking of package receipt and the return of the signed transmittal sheet. ERG distributed the industry data to the EPA well file review team in batches as they were received by each individual company.

STEP 4 – RECEIVED REVIEWED DATA FILES FROM THE EPA WELL FILE REVIEW TEAM

The EPA well file review team reviewed the industry submitted data and created spreadsheets of extracted data. The well file review team regularly sent the spreadsheets to ERG for collating with other well file review team data. EPA sent spreadsheet to ERG to the attention of the TSCA CBI DCO. Upon arrival at the ERG office, ERG immediately logged data into the ERG TSCA CBI tracking log spreadsheet. After logging data into the tracking spreadsheet, ERG organized the data based on the date of arrival at ERG and copied the data to the removable hard drive for this project.

ERG reviewed each spreadsheet submitted by well file review team members to ensure that column headers were consistent with the data entry format specified by EPA and that data types were valid and could be imported into a Microsoft Access® Database. For data to be considered valid they must be the type of data required for the field type as specified by the data entry format (e.g., dates are in fields that require dates, text is in fields that require text, numbers are in fields that require numbers.) ERG reviewed 100 percent of the data submitted to ERG by the well file review team for column header consistency and data type validation. ERG contacted the EPA well file review team to discuss and correct data inconsistencies. ERG recorded all QC reviews and findings on it QC review spreadsheet developed for this project.

STEP 5 – COMPILED A DATABASE OF THE EPA WELL FILE REVIEW TEAM DATA FILES

ERG created a Microsoft Access database entitled "CBI_ Well File Database from Review Team.accdb" to store and organize the EPA well file review team data files. For each iteration of the database, ERG imported the data from each spreadsheet received from EPA and reviewed the database to ensure the information submitted by the review team was completely and accurately imported into the database. ERG performed this review by ensuring there were no import errors and checking all imported tables for row and column count accuracy. ERG reviewed 100 percent of the data imported into the database for row and column count accuracy. Additionally, ERG spot checked the imported data and compared it to the data as submitted to ERG to guarantee data were imported correctly. ERG performed API number standardizing which identified any inconsistencies in API numbers as submitted by the well file team. ERG recorded all QC reviews and findings on it QC review spreadsheet developed for this project.

STEP 6 – DISTRIBUTED DATABASE AND WELL FILE REVIEW TEAM WORKING FILES TO THE EPA WELL FILE REVIEW TEAM

ERG distributed several iterations of the "CBI_ Well File Database from Review Team.accdb" database to the EPA well file review team for additional review and analyses. After conducting its QC review of the database, ERG copied the database to CDs or DVDs. ERG assigned each disc a DCN and prepared a TSCA CBI cover sheet prior to distribution to the specified EPA DCOs. ERG checked each disc to ensure it was operable and contained all of the appropriate files. ERG tracked the copies and distribution of all industry data, including the database, TSCA CBI and non-CBI, in a copy and distribution tracking spreadsheet. ERG recorded the DCN, the date, disc content, and the recipient for each shipment. Additionally, ERG performed all related TSCA CBI checks for TSCA CBI data deliveries including completing a transmittal sheet, double seal packaging, stamping the outer envelope with TSCA CBI stamps, and tracking of package receipt and the return of the signed transmittal sheet.