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Supplemental
Programmatic Quality Assurance Project Plan
For Work Assignment 5-58, Including Amendment 1
Well File Review in Support of Study of Potential Impacts of Hydraulic Fracturing on Drinking Water Resources, Part 3

Issued Under
Contract No. EP-C-08-015

Organization Implementing the Project:
The Cadmus Group, Inc.
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To support the
Office of Science Policy (OSP)
Office of Research and Development (ORD)
U.S. Environmental Protection Agency (EPA)

July 24, 2013

GROUP A: PROJECT MANAGEMENT

A1. Title and Approval Sheet

Programmatic Quality Assurance Project Plan Supplement
For Work Assignment 5-58, Including Amendment 1
Well File Review in Support of Study of Potential Impacts of Hydraulic Fracturing on Drinking Water Resources, Part 3

Organization Implementing the Project:
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Approving Officials:	Approval Dates:
/s/ Jill Dean Contracting Officer's Representative, ORD, EPA	8/6/2012 Date
/s/ Stephen Watkins Quality Assurance Officer, ORD, EPA	8/6/2013 Date
/s/ Chi Ho Sham Program Manager, The Cadmus Group, Inc.	8/6/2013 Date
/s/ Glen Boyd Project Manager, The Cadmus Group, Inc.	8/6/2013 Date
/s/ Patricia Hertzler QA Lead Reviewer, The Cadmus Group, Inc.	8/6/2013 Date

Effective Date: July 24, 2013

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 Hydraulic Fracturing 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 Quality Assurance (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 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 dated November 2011[1]). The results of the research projects will provide the foundation for EPA's 2014 study report.

This QAPP provides information concerning the Water Acquisition, Chemical Mixing, Well Injection, Flowback and Produced Water, and Wastewater Treatment and Waste Disposal Stages of 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.

[1] http://www.epa.gov/hfstudy/HF_Study__Plan_110211_FINAL_508.pdf

A2. Table of Contents

List of Acronyms

CASRN	Chemical Abstracts Service Registry Number
CBI	Confidential Business Information
COR	Contracting Officer's Representative
EPA	Environmental Protection Agency
GIS	Geologic Information System
GWPC	Ground Water Protection Council
HF	Hydraulic Fracturing
NCCT	National Center for Computational Toxicology
NHD	National Hydrologic Dataset
OGWDW	Office of Ground Water and Drinking Water
ORD	Office of Research and Development
OSP	Office of Science Policy
PQAPP	Programmatic Quality Assurance Project Plan
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAO	Quality Assurance Officer
QC	Quality Control
QMP	Quality Management Plan
SDWIS	Safe Drinking Water Information System
TSCA	Toxic Substance Control Act
USGS	United States Geological Survey
WA	Work Assignment

A3. Distribution List

U.S. Environmental Protection Agency

Cathy Basu, Contract Officer
Jill Dean, Contracting Officer's Representative
Jeanne Briskin, Alternate Contracting Officer's Representative
Nancy Parrotta, Project Officer
Stephen Watkins, ORD Quality Assurance Officer

The Cadmus Group, Inc.

Dr. Chi Ho Sham, Program Manager
Dr. Glen Boyd, Project Manager
Gene Fax, Quality Assurance Manager
Patricia Hertzler, Quality Assurance Lead Reviewer

A4. Project/Task Organization

Amendment 1 for Work Assignment (WA) 5-58 issued under Contract No. EP-C-08-015 requires Cadmus to prepare a revised supplement to the Programmatic Quality Assurance Project Plan (PQAPP) for this contract to ensure the quality of secondary data collected and used under this work assignment. This supplement describes how Cadmus will collect, compile, and analyze data to assess whether there may be impacts on drinking water resources due to hydraulic fracturing activities. Cadmus will also obtain and analyze well records from the FracFocus system to compile basic statistics and information on the use of chemicals in hydraulic fracturing fluids. This work assignment follows work that began under Cadmus WA 3-58 and 4-58. Cadmus submitted a supplemental Programmatic Quality Assurance Project Plan (PQAPP) to EPA under the original work assignment and received approval of the PQAPP on April 2, 2013.This revised supplemental PQAPP updates the previous supplemental PQAPP to include quality assurance procedures and project tasks based on modifications made by Amendment 1.

Exhibit 1 identifies the quality assurance (QA) elements that are addressed in the PQAPP for this contract, the elements that are addressed in this supplemental PQAPP, the elements that are addressed in the work plan for this work assignment, and the elements that are not addressed because they are not relevant to this work assignment.

The Environmental Protection Agency (EPA) Office of Research and Development (ORD) has developed a Quality Assurance Project Plan (QAPP) dated January 4, 2012, that covers all activities as a whole pertaining to the evaluation of existing production well file contents. EPA ORD has also developed a QAPP (dated August 2, 2012) for the analysis of FracFocus data downloaded in August 2012 under WA 4-58. Cadmus will follow the same quality assurance procedures for the FracFocus data to be obtained under WA 5-58 as described below in Section A6, Task 4. From Cadmus' perspective, the EPA QAPPs, *National Hydraulic Fracturing Study Evaluation of Existing Production Well File Contents: Quality Assurance Project Plan* (Well File Review QAPP) and the *Quality Assurance Project Plan for Analysis of Data Extracted from FracFocus* (FracFocus QAPP)[2] are incorporated into the Cadmus supplemental PQAPP. In addition to following the QA provisions in this supplemental PQAPP, Cadmus will follow applicable quality assurance provisions in the Well File Review QAPP and the FracFocus QAPP. In the event that the Well File Review QAPP or FracFocus QAPP are revised, Cadmus will modify QA activities accordingly. If there are any conflicts among the documents, Cadmus will work with EPA ORD to resolve the conflicts.

Some of the information shared with Cadmus by EPA may be designated as confidential business information (CBI). EPA is using the Toxic Substance Control Act (TSCA) CBI rules for handling the data. Cadmus obtained the appropriate CBI clearance under WA 3-58 and reauthorization under WA 4-58. Cadmus assumes reauthorization will be required again under WA 5-58. Cadmus will handle all CBI designated materials under the TSCA CBI rules for handling the data.

[2] http://www.epa.gov/hfstudy/qapps.html

A4.1 Roles and Responsibilities

Dr. Glen Boyd will serve as the Project Manager for WA 5-58. Dr. Boyd is responsible for the day-to-day management of the work assignment and for the technical quality of the products to be provided. He will provide administrative and technical leadership throughout the duration of the work assignment, and will direct all activities of the project team, including the development of techniques and methods to meet the work assignment's objectives. Dr. Boyd will be responsible for maintaining the official, approved supplemental PQAPP and ensuring Cadmus personnel working on the work assignment receive the most updated version of the supplemental PQAPP.

As described in the PQAPP for this contract, the QA Officer (QAO) may assign a senior technical reviewer based on that person's field of expertise, education, and experience as they relate to the objective of the project. For Work Assignment 5-58, **Patricia Hertzler** will serve in this capacity as the QA Lead Reviewer. Ms. Hertzler is the QA Manager for Dr. Boyd's Operating Group. She has no direct operational function on the project, which preserves her independence in performing reviews of the products of this work assignment or for ensuring the that QA activities are carried out.

Dr. Jonathan Koplos, a Cadmus Senior Associate, will direct some project activities and provide senior technical support under this work assignment. Dr. Koplos will direct activities pertaining to the analysis of FracFocus data and related GIS analysis. He will also direct activities and provide senior technical support for the analysis and technical support of miscellaneous data and information.

A5. Problem Definition/Background

In the 2010 Congressional Appropriations report, Congress asked EPA to prepare a study of the potential impacts of hydraulic fracturing (HF) on water resources. EPA researched and prepared the draft study plan; the EPA Science Advisory Board completed its review of the draft study plan in July 2011. EPA reported initial study results in December 2012 (http://www.epa.gov/hfstudy/pdfs/hf-report20121214.pdf), with follow-up results to be reported in 2014. Under this work assignment, Cadmus will conduct analyses that will be used by EPA in their development of the 2014 report.

EPA's Office of Research and Development is leading a study to assess whether drinking water resources are impacted by HF. EPA contacted nine companies that conduct HF and obtained information from them regarding their practices. This information included the location of all wells for which the companies provided HF services during a one-year period. Under this work assignment, Cadmus will review and evaluate the well files obtained from the owners/operators of the wells that were hydraulically fractured in order to assess the key drinking water resources risk factors potentially related to well design, construction, operation, and maintenance.

A6. Project/Task Description

WA 5-58 includes four tasks (Tasks 3, 4, 5 and 7) that involve the collection and use of secondary data; Amendment 1 removed Task 6 from the work assignment. Cadmus will follow the QA procedures in the Well File Review QAPP and the FracFocus QAPP, which are incorporated by reference.

Task 3: Review and Evaluate Oil and Gas Well Files

Task 3 is a continuation of work from WA 3-58 and 4-58. Cadmus will participate on a team comprised of EPA personnel and other contractors to review oil and gas well files aimed at evaluating how well design, construction and operation may impact drinking water resources, particularly with respect to hydraulic fracturing. Cadmus will meet with EPA to establish procedures for reviewing well files and standards for evaluating and reporting information. In addition, Cadmus will collaborate with the team of well file reviewers to develop an overall assessment of all well files evaluated by the team, including written summaries of findings. Team members have been selected based on the individuals' background and associated level of expertise and fluency interpreting certain well file contents. Relevant data extracted from the well files will be determined based on procedures outlined in the Well File Review QAPP and the reviewer's professional judgment.

Under Task 3, Cadmus will continue summarizing information from the oil and gas well files including information on fluid constituents, flowback management, hydraulic pressure testing, and miscellaneous data and information in order to meet the objectives of the well file review as discussed in the Well File Review QAPP and as requested by the EPA COR. Cadmus will record the results in the database according to Well File Review QAPP with detailed references as to the location and source of the data being summarized to enable the EPA COR to easily follow the process Cadmus used to collect and summarize the data.

In addition, upon request from the EPA COR, Cadmus will provide quality assurance (QA) on information from selected operators and/or wells. Cadmus will plan to provide QA review for up to 40 well files for each subtask under Task 3. The EPA COR will provide Cadmus with a list of wells that require QA review upon completion of the subtasks.

The QA effort will focus on confirming whether data and information are present or missing from specific well files as described in the Well File Review QAPP. If the data and information are present in the well files, Cadmus will extract the data and information independently from the extraction performed by other well file reviewers under Task 3. Replication of this effort will help identify differing data extractions, if any. If the data are missing from the well file, Cadmus will note this in the data extraction records.

This QA effort will help the project team by assuming that data and information are being consistently and accurately extracted from the well files. Cadmus will record the results in the database (according to Well File Review QAPP) with detailed references as to the location and

source of the data being summarized and will clearly identify the results as QA.

Task 4: Analysis of FracFocus Data

Amendment 1 modifies the activities associated with the FracFocus data, expands the analysis of the data, and includes the preparation of a final report for peer-review.

Under WA 4-58, Cadmus received technical direction to assist well file evaluations by analyzing publicly available inventory and operational data for all hydraulic fracturing well records posted by well operators to the FracFocus website (www.fracfocus.org). Cadmus completed the initial download of FracFocus well records on February 27, 2012, and a second download on August 29, 2012. The August 29, 2012 download was of all well records submitted to and maintained in the FracFocus database as of August 29, 2012. (The August 29, 2012 download was conducted under a separate work assignment with EPA OGWDW, WA 4-72.)

Under this Task 4 of WA 5-58, Cadmus will analyze a third dataset of all well records contained in the FracFocus website as of February 28, 2013. Cadmus will perform QA/QC checks and use these well records to develop an updated FracFocus well record database for submission to EPA. All FracFocus parameters will be included in the database. (Please refer to the WA 5-58 Work Plan Task 4.a. for a complete list of the FracFocus parameters.) This database will be of the same structure and quality as the FracFocus databases previously submitted by Cadmus to EPA. An interim working version of the third database (containing all well records from the February 28, 2013 FracFocus download) was sent to EPA in April 2013. Submission to EPA of the final version of the third database (based on the February 28, 2013 download) is anticipated for July or August 2013. This final database will be clearly identified and documented, and will reflect several small additional quality checks as well as a comprehensive quality check for structure, function, and embedded queries. These additional quality checks were developed through communications between Cadmus and EPA staff. As analyses using the database proceed, Cadmus and EPA staff will continue to discuss database quality and any issues that may arise. Cadmus will respond to information and other data quality requests from the EPA COR on any aspect of the final database development, data QA/QC checks, and analyses of FracFocus data stored in the database.

Through recent discussions with staff from the Ground Water Protection Council (GWPC), the organization that maintains the FracFocus website, EPA learned that it is possible that the FracFocus well record files may be provided directly to EPA thereby eliminating the need for Cadmus to download all well record files from the website. Cadmus will perform QA/QC checks and analyses of the data in all the well record files contained in the FracFocus website as of February 28, 2013 whether those files are obtained through a download or received directly from GWPC. Cadmus will conduct the QA/QC and analyses using the procedures provided by the EPA COR that directed similar Cadmus work on the data previously downloaded from FracFocus. The data management, QA/QC checks, and analysis procedures used for the previous FracFocus download and database development efforts were described in a

Cadmus report ("*FracFocus Well Records Data Management and Quality Assessment Report*") submitted to EPA on June 22, 2012.

The extraction process consists of copying data from the downloaded or directly obtained FracFocus PDF files and copying that data to XML or Excel file formats that enable QA checks and analysis. QA checks include standardizing reported names for certain FracFocus parameters such as Operator, Supplier, Purpose, etc. Based on experience with the first data downloads, many data entries for these parameters in the original FracFocus data have different spelling, misspellings, different use of acronyms, etc., and require standardization to enable analyses. Standardized names of Operators, Supplier, Purpose, and other parameters were established through work on the February 27, 2012 and August 29, 2012 data. Specific well record parameter values will be identified and flagged when reported values are outside of the technically reasonable range of values established for each parameter in a manner consistent with the QA work conducted on the FracFocus data downloaded on February 27, 2012 and August 29, 2012.

The work for the February 28, 2013 data includes conversion of different name spellings, abbreviations, etc., to the existing standardized names list and identification and flagging of parameters with values outside the range of values previously established. The February 2013 dataset (for a potential total of 36,000-38,000 well records) may result in the need to expand the standardized name lists and re-evaluate the range of reasonable values established for each parameter. For example, the current range of reasonable parameter variables is for an aggregate of all well types and EPA may want to refine those values to reflect specific subsets of wells (such as oil versus gas wells or wells operating in specific geographic areas). Cadmus will consult with the EPA COR and staff regarding any modifications to existing QA/QC checks (such as the revision of standardized names or range of reasonable parameter values). Additional discussions and consultations with EPA may also be necessary regarding water source data (e.g., fresh, brine, recycled, etc.) which is provided in some well files but is not a formal, specific FracFocus parameter. In addition, discussions with EPA regarding other QA/QC checks on the data may be warranted given the new FracFocus dataset with a much large number of well records.

Also under Task 4, Cadmus will prepare database queries and conduct analyses of the FracFocus well information contained in the database. Cadmus will develop database queries that will serve to characterize HF well operations regarding location, depth, water and chemical use, and other aspects of well operations. Examples of well-related information to be generated by the database queries included the minimum, mean, and maximum values for a particular parameter or lists of the top ten chemicals used for a specific 'purpose.' For each query, Cadmus will develop a report that describes the query structure; provides a written description of the quantitative query; describes the data and/or computational assumptions made in the development of the query; provides a descriptive summary of the query results; and provides a description of the QA/QC methodology conducted to verify the dependability and accuracy of the queries. The QA/QC description will include any problems encountered and the resolution to those problems.

Cadmus will also analyze the FracFocus data and identify and describe trends in the variables requested by EPA. The general variables are: ingredients, products, water volumes, and proppants. (More details regarding the variables are presented in the Work Plan, Task 4.b.) The analyses can be stratified by basin, county, and state (or other appropriate geographical distribution), production type (oil vs. gas), depth (in cases where production is occurring in multiple formations in an area), operator, time, and any combination of these variables as specified by EPA staff. Cadmus will note any data management steps taken to enable and facilitate analyses (e.g. identifying and managing duplicate records, standardizing names of operators, chemicals), types of QA issues, exact number of records with unresolved QA issues for each field, and the number of records associated with each type of QA issue.

The findings of the analyses will be presented in tables, annotated maps/GIS-supported presentations, whisker plots, simple summary statistics, etc. Any statistical methodology used to assess correlations between variables will be described and will include descriptions of the data used, assumptions made, and discussions, as warranted, of the correlation coefficients to identify the degree of correlation.

Upon completion of the work with the February 28, 2013, well data, Cadmus will prepare reports describing: a) the data management and QA checks involved in downloading the FracFocus data (as applicable) and developing the database, b) the development, findings, and QA of the queries, and c) the analyses conducted on that well data and the findings of those analyses.

In addition to the analyses discussed above, Cadmus will assess the FracFocus data focusing on up to four (4) basins and six (6) counties. Prior to conducting the assessments, Cadmus will work with EPA to develop criteria for selecting the location of the focused assessments. For each identified basin and county, the FracFocus data assessment will include chemical use/concentrations; water use; information on oil and gas exploration and production; and potential impacts to drinking water sources utilizing the information obtained from the literature search discussed below. Additional analyses may be conducted based on discussions with EPA.

In addition to the focused assessments, Cadmus will prepare a fact sheet for each of the twenty (20) states that have data submitted by operators in the data extracted in February 2013. Cadmus will include, for each state fact sheet, a state map with wells categorized by depth, a summary of QA/QC problems with the state's data, water volumes used for hydraulic fracturing in the state, a figure with state well counts over time and markers for significant dates such as effective date for regulatory requirements, and a list of chemicals most frequently reported and with highest concentrations/volumes for each state.

Cadmus will support the identification of areas where hydraulically fractured wells may be relatively near drinking water well depths by reviewing available information on the depths of private and public drinking water wells in the identified focused assessment basins and counties. Cadmus will conduct a literature review to identify publically-available information from state

and federal agencies, trade associations, and peer-reviewed journals. Cadmus will submit a memo to EPA describing the obtained information and include a discussion of any benefits or limitations to its use by EPA. Upon receipt of technical direction from the EPA COR, Cadmus will review in more detail the data sources selected by EPA for a comparison of drinking water well depths and FracFocus well depths. Cadmus will include a summary of the well depth comparison analysis in the summary report.

Cadmus will develop a report that summarizes the tasks conducted under Task 4, including the background on FracFocus, a description of the differences between the August 29, 2012 data and the February 28, 2013 data; a summary of the methodology for extracting the data from FracFocus and development of queries and analyses; a description of the existing data and including context for state regulatory requirements; a summary of the QA/QC issues and impacts of any errors, bias, etc. on the results of the analyses; a general analysis of the data with regards to national product and chemical use, chemical concentrations/volumes, water volumes, hydraulically fractured well depths and depth placement of public and private drinking water wells (more detail follows); a summary of the focused assessments on specific basins and counties; and the state fact sheets. Cadmus understands the report will be peer-reviewed and published to the EPA website. Consequently, Cadmus will write the summary report for an audience of the general public with a scientific background but not necessarily in hydraulic fracturing. For budgeting purposes, Cadmus will assume the preparation of one outline populated with figures, tables, maps, and bulleted information, a first draft of the summary report and four (4) subsequent drafts of the report.

Task 5: GIS Analysis

Based on technical direction form EPA in Amendment 1, Cadmus will develop one (1) map of FracFocus wells with a depth near that of the documented drinking water well depths (as determined in Task 4 above) for each focused assessment area (as identified in Task 4 above), up to four (4) basins and six (6) counties.

In addition, upon technical direction from the EPA COR, Cadmus will prepare GIS-compatible datasets (e.g. shapefiles) with ArcGIS version 10.1 using the quality-assured data extracted from well file reviews in Task 3 and the FracFocus well records in Task 4. The exact specifications of the GIS data will be determined more explicitly once the full array of data has been extracted. Cadmus will provide metadata for all GIS datasets delivered to the EPA COR including full references (appropriate for a bibliography) for all data sources used to create maps.

The GIS data layers will be used to create maps illustrating the spatial distribution of the data extracted during Tasks 3 and 4. Examples of possible maps include:

- Hydraulic fracturing depth
- Chemical additives and proppants used during hydraulic fracturing
- Water use volumes
- Water sources used for hydraulic fracturing

- Drinking water resources (oil and gas well files only)
- Well construction features, such as depth, well orientation (vertical/horizontal), degree of cementing, use of different casing strings (oil and gas well files only)
- Analysis of sampled waters (oil and gas well files only)
- Disposition of flowback / produced water (oil and gas well files only)

Additionally, Cadmus will conduct rigorous quality analysis and quality control checks to ensure that the download and extraction steps reproduce the data and information as contained in the original oil and gas well files and FracFocus PDF files. Cadmus will provide a description of the QA/QC methodology, problems encountered, and resolutions to problems in a memo accompanying the GIS files transmitted to the EPA COR.

Task 7: Miscellaneous Data and Information

The EPA COR will provide technical direction for all work to be performed under Task 7. Under Task 7, Cadmus will analyze data provided by the COR as requested by the COR and conduct QA/QC checks on the data and analysis results. In addition, Cadmus will assist in the technical editing of EPA reports summarizing the results of the well file review. Technical editing will include, but is not limited to, document organization, creation of a bibliography using Endnote software, placing citations in the report, developing definitions for glossary terms, ensuring consistent terminology and acronym use, and suggesting modifications to the report to improve clarity of message.

A7. Quality Objectives and Criteria

All of the analysis Cadmus will perform for the production company well file analyses will be based on data and information pertaining to well design, construction, completion (including hydraulic fracturing), and other limited information regarding its operation and maintenance, which are compiled by the production companies. These data will be provided by the EPA COR. In some cases, Cadmus may supplement these data with data from EPA, the U.S. Geological Survey (USGS), or other sources of data. For the analysis of the FracFocus well record data, Cadmus will obtain the well record files that are publicly available online from the FracFocus website, which reflects information voluntarily supplied by well operators to the GWPC-maintained website. In addition, for the GIS overlay exercise, Cadmus will use data from the Safe Drinking Water Information System (SDWIS), available state databases, and USGS databases such as the National Hydrological Dataset (NHD).

Cadmus will consider the elements listed below when assessing the quality of any data reviewed under this task. In addition, Cadmus will consider the elements listed in the Well File Review QAPP and the FracFocus QAPP. The Well File Review QAPP describes the procedures used to select the well files subject to review under this work assignment and describes how these selection procedures help ensure that the projects meets EPA's data quality objectives. The FracFocus QAPP describes the procedures used to assess the adequacy of secondary data and the uncertainty in the results derived from the use of the FracFocus data sources.

- ***Accuracy.*** Statistically, accuracy is a measure of the overall agreement of a measurement to a known value. It includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. The well file reviews will be based primarily on data generated by production companies and provided by EPA. Cadmus will review these files and extract as much relevant information as possible and record the data on standard reporting forms. To help ensure accuracy, the standard reporting form will be a spreadsheet that contains data elements that will clearly identify important well inventory information (unique well ID, etc.), as well as all construction, operational, logging, remediation, and other factors that might relate to potential risks to water resources due to the HF well, HF activities, and well operations.

  During our analysis of the data, Cadmus will make note of any apparent errors in the accuracy of the data. In some cases, we may help ensure the accuracy of data by using other publicly available data (e.g., determining the distance of a well to a nearby surface water body by using locational information provided by the company and topographic maps from USGS).

  An EPA well file review team member will review a random subset of ten percent of the well files from a different first reviewer, in order to ensure that the correct well file was reviewed and to compare data recorded by the two different reviewers. In the event of discrepancies in data interpretation between the reviewers, the well file review team will meet to discuss the issues and agree to a common approach. These reviews will be documented using the form shown in the Well File Review QAPP. The goal is to have 100 percent accuracy of data transcription from the industry submitted files to the well file reviewer's spreadsheets to the well file database.

  For all work regarding FracFocus data, the sole source of well record data will be the data, and associated information, available online from the FracFocus website. To assist in the name standardization effort (standardizing the submissions for the parameters of operator, chemical, purpose, etc.) additional information may be collected through internet research. Standardized chemical names and Chemical Abstracts Service Registry Numbers (CASRNs) will be provided by EPA's National Center for Computational Toxicology (NCCT).

  The FracFocus work consists of two separate areas of data quality concerns: the download and extraction of information from the FracFocus website; and the analyses of the data obtained. As mentioned above, if the FracFocus well files are provided directly to EPA, the automated download will not be necessary but all the quality checks described below are still relevant. The first area of accuracy refers to how well the well record data obtained through an automated download and extraction process of well record PDF files data compares to the original well record data (contained in the original PDF files as submitted by the operators to the FracFocus website)

available on the FracFocus website. Cadmus will conduct a quality assurance review to verify the accuracy of the download and extraction process by randomly selecting 100 to 200 well records (based on the unique well record number), manually downloading the corresponding PDF files from FracFocus for those well records, and comparing parameter values in those files to the parameter values in the well records obtained through the automated download and extraction process. Quantitative assessments (measures such as confidence intervals and margins of error) for the data download and extraction process will be calculated to characterize how well the automated data download and extraction process reproduces the original data contained in the well record PDF files in the FracFocus database. One important caveat regarding measures of the reproduction of the original data is the quality and format of the original FracFocus files and data. FracFocus requires no third party checks nor imposes any quality requirements for data entered into FracFocus. Experience with previous download and data management indicates that the original data quality, and in some cases the format of the original data tables, can be highly variable. The second area of accuracy relates to the analysis of the data. To check the accuracy of the data analyses (simple non-parametric frequency counts nationally and by state), portions of the analyses will be conducted by two separate individuals; the same findings by both analysts indicate accurate analyses. In addition, portions of the analyses conducted will be spot-checked for accuracy. For parameters with text entries, Cadmus will make note of any apparent errors (e.g., different spellings or misspellings of chemical names).

For the GIS overlay exercises, Cadmus will use existing datasets such as SDWIS, comparable state datasets, and the NHD. These datasets are known to have been compiled using quality assurance steps to help ensure their accuracy. Nonetheless, Cadmus will make note of any apparent errors in the accuracy of the data. If necessary, Cadmus will establish methods for correcting any persistent errors (e.g., inaccurate source locations in SDWIS).

Cadmus will conduct QA reviews by randomly selecting 10 percent of the mapped production well locations to ensure the accuracy of the analyses performed. As applicable, this spot check will include:

- Visual examination of well locations overlain with aerial imagery to identify any questionable data points (e.g., a well inside of a lake).

- Measurement of any buffer distance shown around well locations to ensure that the buffer was delineated correctly.

- If features such as aquifers, surface waters, drinking water wells, or surface water intakes are overlain with well buffers, visual examination to ensure that appropriate features were represented in the findings.

- Recalculation of any summary statistics (e.g., min, max, mean, median) to ensure logical values.

Cadmus will report any data anomalies identified during this process to EPA and will contact the entity responsible for generating the data source to identify reasons for any inconsistencies, resolve problems with changes to the data source, and to answer any outstanding questions as necessary.

While reviewing miscellaneous data provided by EPA for analysis, Cadmus will make note of any apparent errors in the accuracy of the data.

- ***Precision.*** Precision is the measure of agreement among repeated measurements of the same property under identical or substantially similar conditions, and is calculated as either a range or standard deviation. Cadmus will primarily be using data generated by production companies and provided by EPA for the file review task. An EPA well file review team member will review a random subset of ten percent of the well files from a different first reviewer, in order to ensure that the correct well file was reviewed and to compare data recorded by the two different reviewers.

  For the analysis of FracFocus data, the sole source of well record data will be the data, and associated information, available from the FracFocus website. The records in the FracFocus system are individual records and not repeated measurements. Thus, evaluations of precision of the original dataset do not apply. Cadmus will, however, note any issues that emerge that could indicate a problem with precision as analyses proceed. Quality checks will be conducted as described under *Accuracy*.

  For the GIS overlay exercises, Cadmus will use existing datasets such as SDWIS, comparable state datasets, and the NHD. These datasets are known to have been compiled using quality assurance steps to help ensure their precision. Nonetheless, Cadmus will make note of any analytical limitations related to the precision of the data. If necessary, Cadmus will attempt to remedy any shortcomings of the data and will document the steps it takes.

  While reviewing miscellaneous data provided by EPA for analysis, Cadmus will make note of any issues that emerge that could indicate a problem with precision of the data.

- ***Bias.*** Bias is the systematic or persistent distortion of a measurement process that tends to yield an erroneous outcome or incorrect representation of the system being described. As noted above, Cadmus will primarily be using data generated by production companies and provided by EPA for the file review task. However, in order to help mitigate any bias in the data, Cadmus may in some cases supplement the data with other publicly available data. An EPA well file review team member will review a random subset of ten percent of the well files from a different first reviewer,

in order to determine whether any significant bias was introduced by the review team.

For the analysis of FracFocus data, the sole source of well record data will be the data, and associated information, available online from the FracFocus website. Cadmus will attempt to use all records available from the FracFocus website. Because Cadmus will use established procedures for summary statistics and other analyses using all available data, Cadmus does not foresee the data analysis introducing bias. Cadmus will, however, note any apparent bias in the dataset itself (e.g., geographical bias) and report such issues as appropriate. If it becomes necessary to exclude certain records from analysis due to technical difficulties, Cadmus will evaluate whether such exclusion introduces geographic or other bias in the analysis. Any data excluded from analyses will be clearly identified through a data 'flagging' system in the database.

For the GIS overlay exercises, Cadmus will use existing datasets such as SDWIS, comparable state datasets, and the NHD. These datasets are known to have been compiled using quality assurance steps to help prevent bias. Nonetheless, Cadmus will make note of any apparent bias in the data.

While reviewing miscellaneous data provided by EPA for analysis, Cadmus will make note of any apparent bias in the data.

- ***Completeness.*** Statistically, completeness is a measure of the amount of valid data needed to be obtained from a system that enables a true representation of that system. As noted above, Cadmus will primarily be using data generated by production companies and provided by EPA for the file review task. Data will not be rejected unless they obviously are inconsistent with the well file being reviewed. However, if data in these files are incomplete, Cadmus may in some cases supplement the data with other publicly available data. For the work using the FracFocus data, the sole source of well record data will be the data, and associated information, available online from the FracFocus website and data will not be rejected unless they obviously are inconsistent with the well file being reviewed. Any such exclusion will be documented. The quality checks for the download and extraction process, as described above under *Accuracy*, will also enable assessments of completeness in the sense of downloading and extracting the complete well record data sets that are contained in the original well record PDF files in the FracFocus database. For the GIS overlay exercises, Cadmus will use existing datasets such as SDWIS, comparable state datasets, and the NHD. Use of multiple data sets will help ensure completeness (i.e., help ensure that all water sources are located). Miscellaneous data will be provided by the EPA COR; Cadmus assumes this data to be complete.

- ***Representativeness***. Representativeness is in most cases a qualitative term to express the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. As noted above, Cadmus will primarily be using data

generated by production companies and provided by EPA for the file review task. Data will not be rejected unless they obviously are inconsistent with the well file being reviewed. However, Cadmus will inform the EPA COR if the data (e.g., the sampling data) do not appear representative. Cadmus may in some cases supplement the data with other publicly available data.

For the FracFocus work, the issue of representativeness is addressed above under *Completeness.* Completeness (not representativeness) is the key data quality measure for analysis of the FracFocus records. All FracFocus well record files will be downloaded, so the data used for the analysis are expected to duplicate the information available in FracFocus (i.e., the original FracFocus data will be fully represented in the FracFocus database developed with the downloaded data). Nonetheless, Cadmus will assess possible approaches for evaluating general representativeness or possible bias of the well records reported to FracFocus.

For the GIS overlay exercises, the issue of representative is addressed above under *Completeness.* Completeness (not representativeness) is the key data quality measure for analysis of the GIS overlay exercises.

Miscellaneous data will be provided by the EPA COR; Cadmus assumes the data to be representative.

- ***Comparability.*** Comparability is a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made. Comparability will be assured by using standardized units in the reduced data. Conversion of original data from one set of units to another will be documented.

- ***Sensitivity.*** Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. Cadmus does not anticipate any problems with sensitivity in its sources of data.

A8. Special Training and Certification

Cadmus will ensure staff working on this work assignment exhibit competency to understand all well file contents in general and meet the requirements outlined in the performance work statement for this work assignment.

In addition, EPA is using the TSCA CBI rules for handling the data. Cadmus has obtained appropriate CBI clearance and will handle all CBI-designated materials under TSCA CBI rules for handling the data. To maintain TSCA CBI access approval, a briefing on the *TSCA*

CBI Protection Manual[3] or completion of the TSCA CBI On-Line Training must be completed annually.

A9. Documentation and Records

All personnel working on this project will receive this supplemental PQAPP. If there are revisions to the supplemental PQAPP, personnel will receive updates by electronic mail to ensure that they have the most recent version. Personnel working on this project will also receive copies of the Well File Review QAPP and the FracFocus QAPP, which are incorporated by reference.

Throughout this work assignment, Cadmus will provide draft and final reports to EPA in electronic and hard copy formats. Cadmus will discuss the computer file formats to be used for statistical analyses, word processing, spreadsheet development, database management, and graphics with the EPA COR prior to file preparation.

Cadmus will ensure that paper records adhere to EPA PPM 13.2, "Paper Laboratory Records." The majority of records will require permanent retention under EPA Records Schedule 501, "Applied and Directed Scientific Research." Cadmus will maintain written documentation indicating the data sources to be used in the study (including the source name, data, table or exhibit numbers, page numbers, column headings, Web sites, and dates of Web site access). If Cadmus identifies any potential problems with data sources, Cadmus will develop and send to EPA a written summary of the problem encountered, the impact of the problem on the analysis, and possible options for addressing the problem. Cadmus will follow CBI data-handling procedures as applicable.

Cadmus will retain files and documents considered to contain any CBI information on the CBI laptop computer only and backed up on CD. Other files and documents containing non-CBI information may be retained on Cadmus' file servers and backed up through the company-wide process. After the contract's expiration date, Cadmus will handle all CBI in accordance with the TSCA CBI Protection Manual. Cadmus will retain all other project files for three years after the contract's expiration date.

[3] U.S. Environmental Protection Agency. 2003. *TSCA CBI Protection Manual*, Office of Pollution Prevention and Toxics, Washington DC (7407 M), October 20 (7700A1).

GROUP B: DATA GENERATION AND ACQUISITION

B1. Sampling

Statistical sampling is the responsibility of another contractor, and sampling procedures are described in the Well File Review QAPP. No physical or statistical sampling is anticipated under this work assignment. Sampling is not relevant to the FracFocus work as it consists of compilation and analysis of *all* well records maintained in FracFocus. Therefore, a sampling design process is unnecessary for this supplemental PQAPP.

B2. Sampling Methods

Statistical sampling is the responsibility of another contractor, and sampling procedures are described in the Well File Review QAPP. This section does not apply because no direct measurement/experiments are anticipated for this work assignment. Therefore, a sampling design process is unnecessary for this supplemental PQAPP.

B3. Sample Handling and Custody

"Samples" within this research project refer to data submitted by the nine oil and gas operators sent letters on August 11, 2011, requesting well file information expected to be in their possession. "Sample handling procedures" are the responsibility of another contractor and are described in the Well File Review QAPP. This section does not apply to this supplemental PQAPP because no direct measurement/experiments are anticipated for this work assignment.

B4. Analytical Methods

No direct measurements will be taken. Therefore, this section is not applicable.

B5. Quality Control

No direct measurements will be taken. Therefore, these sections are not applicable.

B6. Instrument/ Equipment Testing, Inspection, and Maintenance

Laptop computers used to review CBI data have been scanned for viruses. From time to time, as new data may be transmitted to the well file review team, virus scans will be updated through consultation with local information technology support. Back up versions of spreadsheets containing the recorded data will be made by burning the file to a disk.

B7. Instrument/ Equipment Calibration and Frequency

This section is not applicable because no direct measurements are being taken. Therefore, no instruments will be used or calibrated.

B8. Inspection/ Acceptance of Supplies and Consumables

The Well File Review QAPP describes procedures to ensure that computers used to record well file data claimed as confidential are configured to ensure they meet protocols in the *TSCA CBI Protection Manual*, including removing the machine's ability to connect to servers and the internet. Information will be provided to Cadmus in hard copy or using supplied disks. The Well File Review QAPP explains that each incoming submission from the nine oil and gas companies will be visually examined to determine whether a claim of confidentiality is made.

B9. Non-direct Measurement Data

Cadmus will use the following secondary data sources:

- Production company files analyses that include initial baseline and follow-up water quality monitoring data as well as data related to well design, construction, completion (including hydraulic fracturing), and other limited information regarding its operation and maintenance. These files will be compiled by the production companies and supplied by the EPA COR.
- Water quality data from EPA or USGS.
- Data on the sources of drinking water from SDWIS, available state databases, and USGS databases such as the NHD.
- Chemical data and information from FracFocus.
- Oil and natural gas production information and GIS data from state agencies, the US Department of Energy (DOE), and US Department of the Interior (DOI).

During our analysis of the data, Cadmus will make note of any apparent errors in the accuracy of the data. In some cases, we may supplement the data with other publicly available data (e.g., determining the distance of a well to a nearby surface water body by using locational information provided by the company and topographic maps from USGS). Data will generally be accepted for inclusion in the review unless an obvious error precludes its use, such as the data is from the wrong well file.

For the analysis of FracFocus data, the sole source of well record data will be the data, and associated information, available online from the FracFocus website. Cadmus will note any apparent errors in the accuracy of the data.

Cadmus will identify and review available information from state and federal agencies, trade associations, and peer-reviewed journals regarding the depths of private and public drinking water wells located in the sedimentary basins and counties included in the focused assessments where production wells depths (as reported to FracFocus) are relatively near drinking water well depths. Cadmus will prepare and submit to EPA a list of the drinking water well information that will also include information on the benefits and limitations of the information as used in support of the summary report discussion of FracFocus well locations and

depths. Data collected by Cadmus will be evaluated for acceptability based on the five assessment factors (soundness, applicability and utility, clarity and completeness, uncertainty and variability, and evaluation and review) as described in the contract PQAPP.

For the GIS overlay exercises, Cadmus will use existing datasets such as SDWIS, comparable state datasets, and the NHD. These datasets are known to have been compiled using quality assurance steps to help ensure their accuracy, precision, and lack of bias. Nonetheless, Cadmus will make note of any apparent errors in the accuracy of the data. If necessary, Cadmus will establish methods for mitigating any persistent errors (e.g., inaccurate source locations in SDWIS).

B10. Data Management

This section of the supplemental PQAPP describes how secondary data not designated as CBI will be managed. Cadmus will maintain, handle, and transmit CBI in accordance with applicable requirements for contractors, as specified in the *TSCA CBI Protection Manual*.

B10.1 Data Retrieval

Cadmus recognizes the importance of ensuring, before conducting analyses, that the applicable data are reliable and directly applicable to the technical tasks in this work assignment. For tasks that involve retrieving data from databases, Cadmus will ensure that the data are not corrupted or damaged.

B10.2 Data Transmittal

This work assignment will involve the transfer of data from various data sets. All data transmittals include potential threats to data quality. Cadmus will minimize the steps necessary to transfer data for each task and will document all data transfers, from raw data through final interpretation. When Cadmus receives data sets from EPA, a summary text document will be prepared and placed in the same network folder on the file server that describes when the data set was received, what that data set contains, and any relevant information concerning the contents of the file. Cadmus will retain an original, unchanged (read-only) version of the data set received from EPA and will perform all analyses, including any modifications to the data set (e.g., adding fields or modifying contents of existing fields) on a duplicate version of the data set. Cadmus will prepare a separate summary text describing all changes made to that data set relative to the original data set received from EPA.

B10.3 Data Analysis

For tasks under WA 5-58 that involve data analysis, Cadmus will, in final reports submitted to EPA, describe analyses conducted on the datasets and address the reliability of computations. Cadmus will address potential problems in data analysis and how the potential problems might be solved.

B10.4 Data Tracking

It is essential to track data from generation to end use or storage to establish the quality of all data collected and used in this work assignment. For databases and documents developed under WA 5-58, Cadmus will follow the data tracking procedures outlined in the PQAPP for this contract including version control, file backups, and records of comments from the EPA COR.

GROUP C: ASSESSMENT AND OVERSIGHT

C1. Assessment and Response Actions

Assessing the quality management system itself is important to maintaining the system's effectiveness and integrity. The Cadmus QAO oversees quality assurance activities throughout the company, identifies weaknesses, and recommends and implements improvements. As the Cadmus QA Officer, Mr. Gene Fax, is also the QA Officer for this contract. When deemed necessary, the Cadmus QAO will conduct an internal assessment of the work assignment activities and/or deliverables.

All deliverables generated under this work assignment that do not involve CBI will be reviewed by Ms. Patricia Hertzler, the QA Technical Lead Reviewer for this work assignment, or her designee. Deliverables containing CBI will be reviewed by an EPA review team member.

C2. Reports to Management

Cadmus will include QA activities in its monthly technical progress report to EPA and will provide verbal updates to the EPA COR, as necessary. QA reports will discuss limitations and constraints in the data sources, identify assumptions made about the information, and describe any information gaps and uncertainties.

GROUP D: DATA VALIDATION AND USABILITY

D1. Data Review, Verification, and Validation

EPA requirements for QAPPs specify that there be two types of analysis for each data item:

1. **Process of *verification***. Verification confirms that the required QC acceptance criteria have been met.
2. **Process of *validation.*** Validation confirms that the requirements for a specific intended use have been fulfilled and determines whether specific user needs have been met.

These analyses typically apply to data such as field or laboratory measurements. Data verification and validation for this work assignment requires the review team to:

- Conduct senior internal review of all work products that do not involve CBI, and
- Revise work products based on the EPA COR's technical direction.

Methods for verification and validation to be used during reviews of work products are described below.

D2. Verification and Validation Methods

The procedures for verification consist primarily of examination to ensure that the requirements of specific QC acceptance criteria are met. The goal of data verification is to ensure that the data are complete, correct, and conform to the pre-determined collection, transmission, and analysis methods or procedures. Data verification evaluates, through a set of criteria, how closely the project's data quality procedures were followed.

Cadmus will not perform any mathematical or statistical procedures that would determine whether data should be rejected or transformed before statistical analysis. Instead, the QA team will perform independent review of the non-CBI deliverables to ensure compliance with criteria set forth in Sections A7 of the supplemental PQAPP.

The Cadmus QAO or QA Technical Lead Reviewer assigned by the QAO is responsible for the verification and validation processes and will serve as an independent examiner. QA Technical Lead Reviewers are chosen by the QAO based on the individual's field of expertise, education, and experience as they relate to the objective of the project. A QA Technical Lead Reviewer performing verification or validation of data for a project has no direct operational function on the project. If independence and objectivity cannot be preserved by assigning an in-house reviewer, Cadmus will use an outside expert consultant. For this work assignment, Cadmus will rely on EPA QA reviewers for the review of data involving CBI.

D3. Reconciliation with User Requirements

Cadmus understands that the work products resulting from this work assignment will be used by EPA. To that end, Cadmus will strive to develop and prepare products of high quality that represent the issues facing EPA, which are developed in a manner and style appropriate to the target audience(s). The Agency will determine which information and reports generated under this work assignment are of adequate quality for decision making and may seek peer review or public comment.

Exhibit 1. QA Project Plan Elements for Work Assignment 5-58

QA Project Plan Element	Addressed in PQAPP	Addressed in this Project-Specific Supplement	Addressed in Work Plan	Not Relevant to this Work Assignment
Group A: Project Management Elements				
A1 Title and Approval Sheet	✓	✓		
A2 Table of Contents	✓	✓		
A3 Distribution List	✓	✓		
A4 Project/Task Organization	✓	✓	✓	
A5 Problem Definition/Background	✓	✓	✓	
A6 Project Task/Description		✓	✓	
A7 Quality Objectives and Criteria	✓	✓		
A8 Special Training/Certification		✓	✓	
A9 Documents and Records	✓	✓		
Group B: Data Generation and Acquisition				
B1 Sampling Process Design (Experimental Design)				✓
B2 Sampling Methods				✓
B3 Sample Handling and Custody				✓
B4 Analytical Methods				✓
B5 Quality Control				✓
B6 Instrument/Equipment Testing, Inspection, and Maintenance				✓
B7 Instrument/Equipment Calibration and Frequency				✓
B8 Inspection/Acceptance of Supplies and Consumables				✓
B9 Non-direct Measurements	✓	✓	✓	
B10 Data Management	✓	✓	✓	
Group C: Assessment and Oversight Elements				
C1 Assessments and Response Actions	✓	✓		
C2 Reports to Management	✓	✓		
Group D: Data Validation and Usability Elements				
D1 Data Review, Verification, and Validation	✓	✓		
D2 Verification and Validation Methods	✓	✓		
D3 Reconciliation with User Requirements	✓	✓		