Version 2.0

Alliance for Aquatic Resource Monitoring

Shale Gas Extraction: A study design and protocol for volunteer monitoring

June 2012

Visit ALLARM's Marcellus Shale Toolkit: http://blogs.dickinson.edu/marcellusmonitoring

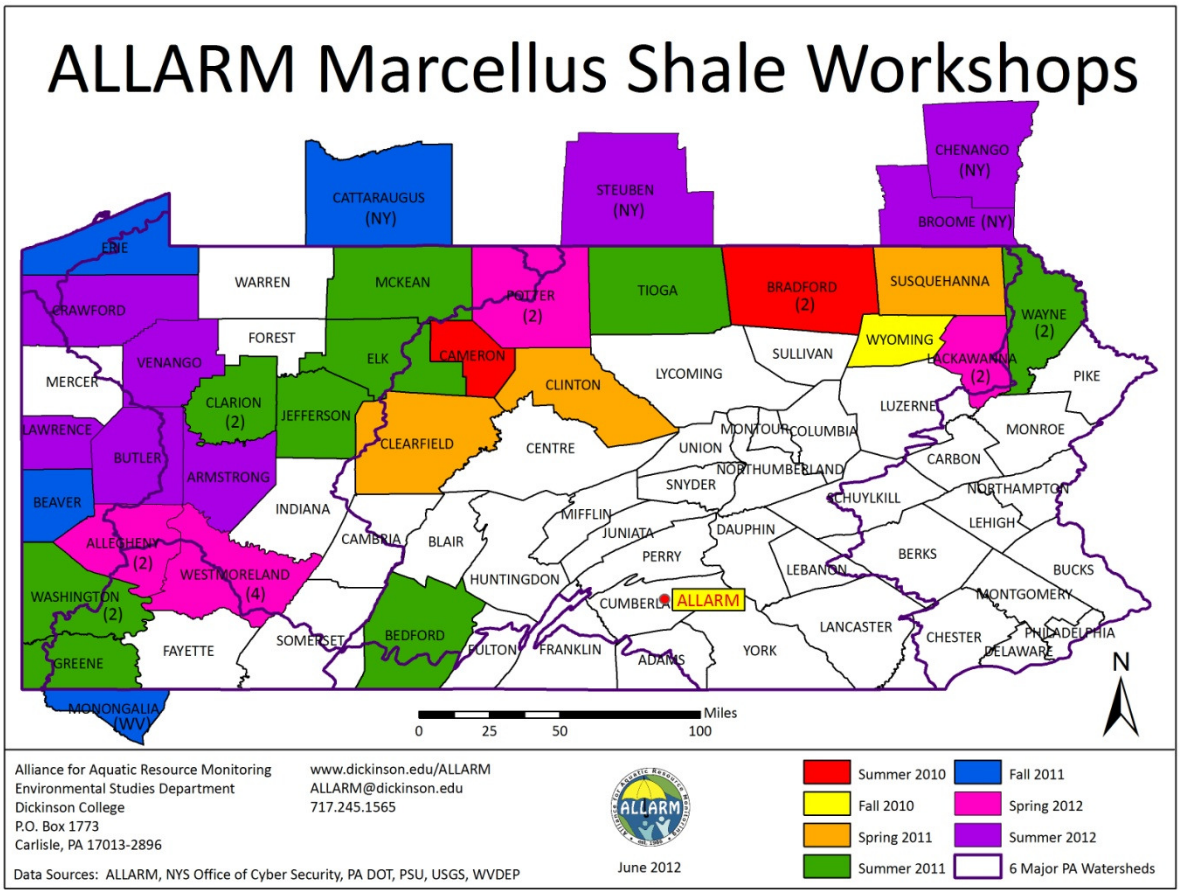
Authors:

- Candie C. Wilderman (wilderma@dickinson.edu), professor of Environmental Science at Dickinson College and ALLARM Founder and Science Director.
- Jinnieth J. Monismith (monismij@dickinson.edu) ALLARM Assistant Director of Technical Assistance.

Contacts for workshops:

- Julie Vastine (vastine@dickinson.edu), ALLARM Director.
- Kathryn Tomsho (tomshok@dickinson.edu), ALLARM Assistant Director of Outreach.

Note: This manual is designed to be a dynamic document. We expect changes as we conduct training workshops across the region and continue to learn from our interactions with professionals in the field and with volunteers. Please feel free to send us your comments, corrections, and suggestions!



Between June 2010 and July 2012, ALLARM conducted 42 workshops, some of which were in collaboration with the following organizations: Trout Unlimited, Delaware Riverkeeper Network, PA Association for Sustainable Agriculture, Sierra Club, Mountain Watershed Association, West Virginia University Water Resources Institute, and Creek Connections. Approximately 800 volunteers have been trained. The map above shows the counties in PA, NY, and WV where ALLARM has conducted workshops during the past two years.

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Background on ALLARM:

The Alliance for Aquatic Resource Monitoring (ALLARM) is a project of the Environmental Studies Department at Dickinson College. Since its founding in 1986, ALLARM has become a nationally recognized technical and programmatic support center for community organizations interested in watershed assessment, protection, and restoration. ALLARM's program goals are to:

1) Enhance local action for the protection and restoration of Pennsylvania watersheds by empowering communities with scientific knowledge and tools to implement watershed assessments;
2) Provide Dickinson College students with opportunities to participate in community-based participatory research thereby enhancing the quality of undergraduate science education; and
3) Be the leader in volunteer monitoring in Pennsylvania and a national model for college-community partnerships.

Through the work of student and professional staff, ALLARM offers comprehensive services to enable groups to use critical scientific tools to enhance environmental quality and fully participate in community decision-making. The program staff includes a Director, two Assistant Directors, a faculty Science Director, and 12-14 undergraduate student staff. For more information on ALLARM please visit: www.dickinson.edu/ALLARM or email: ALLARM@dickinson.edu

Dickinson College/ALLARM
P.O. Box 1773
Carlisle, PA 17013
717.245.1565

ALLARM has recently focused its efforts on developing a protocol and training workshops for volunteer monitoring of small streams for the effects of gas shale extraction activities. This manual is a reference for that protocol and training. In addition, ALLARM has developed a toolkit (http://blogs.dickinson.edu/marcellusmonitoring/) which contains information and manuals, narrated PowerPoint presentations and demonstration videos on the following topics (links):

- Science of the Marcellus Shale
- Safety Considerations
- Determining Where the Wells Are
- Visual Observations
- Water Quality Monitoring
- Data Management
- Dickinson College
- Additional Resources
- Marcellus On The Go

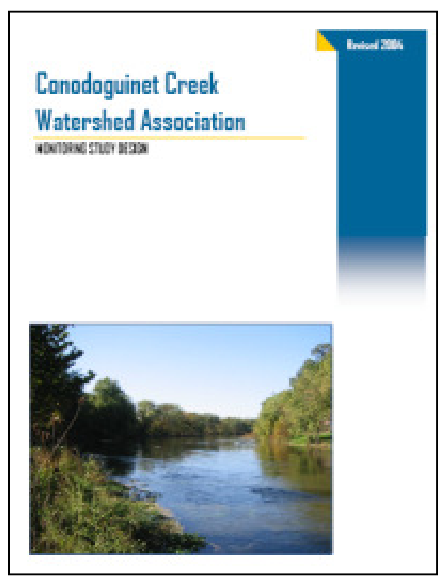
Why Develop a Study Design?

The study design process[1] facilitates the essential decisions that need to be made in a monitoring study. Developing a study design serves several purposes:

- It helps you focus on what you are trying to achieve with your monitoring program;
- It prevents waste of time and money on equipment/procedures that are inappropriate for your group or goals;
- It helps you match your monitoring program to your watershed goals;
- It clearly documents your sampling and analysis methods;
- It clearly outlines your quality assurance and quality control procedures; and
- It minimizes the impact of changing personnel on the continuity of your monitoring activities.

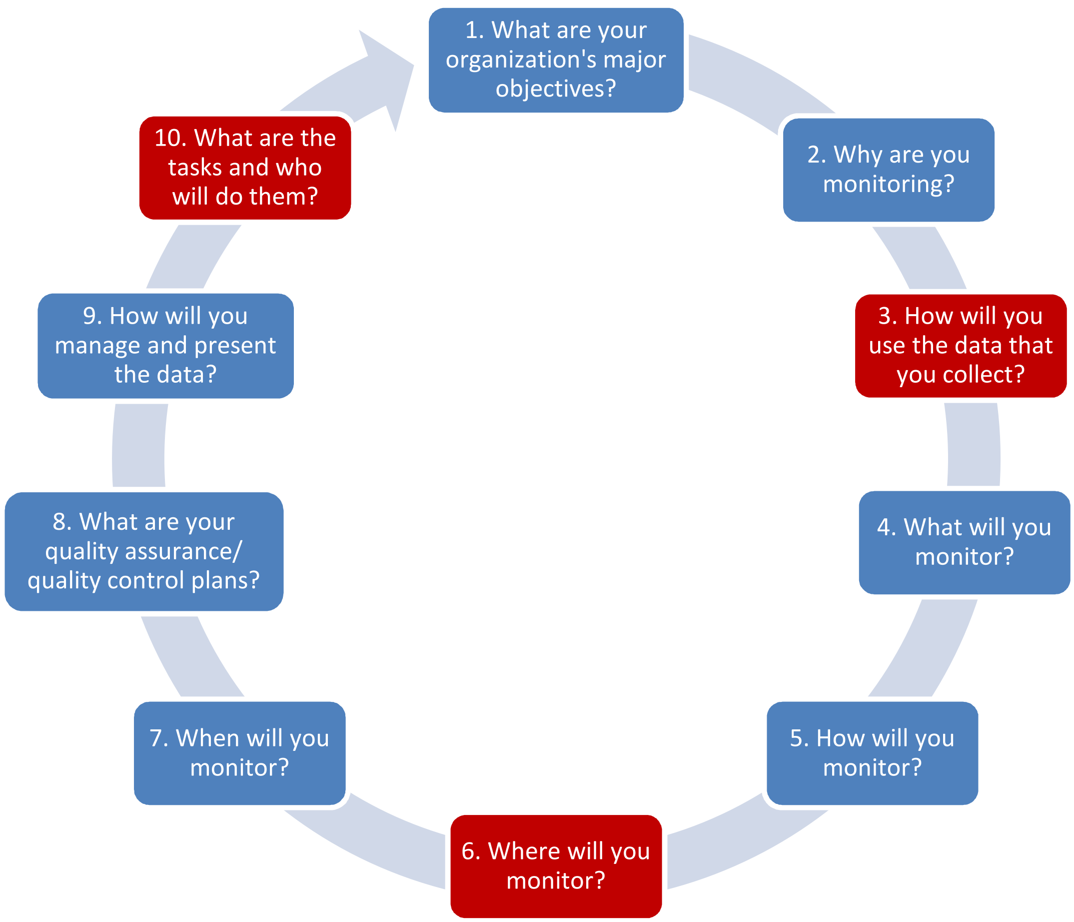
Study designs are dynamic plans that should be revisited as needed to determine if the data you are collecting are answering the questions that prompted you to monitor and to determine if your methods are appropriate.

This study design has been developed for projects with the goal of monitoring small streams and their watersheds for early detection of the impacts from Marcellus Shale gas extraction in PA. For most of the steps in this study design, there are suggested standard protocols and prescriptive measures. For a few steps, there are instructions on how the group needs to customize the plan to fit their own needs. It is our hope that groups throughout the state will follow these protocols so that the results will be directly comparable and so that a statewide database can be easily established. On the other hand, groups who have other goals and who desire to meet their goals using different protocols are encouraged to use this design as a template and customize it to meet their needs.



[1] ALLARM has developed a Study Design Manual which explains in detail how to develop a study design; this can be accessed at: http://www.dickinson.edu/about/sustainability/allarm/content/Toolkit/.

Study Design Steps:

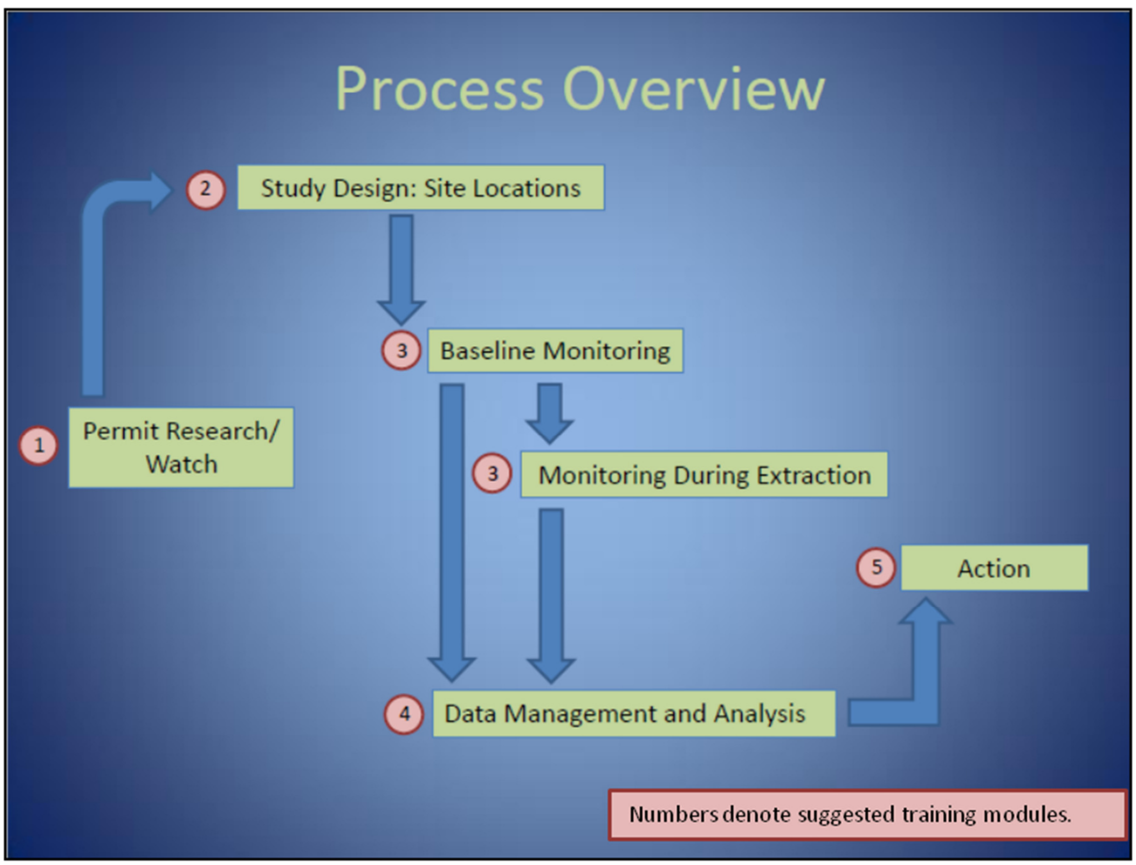


The study design wheel that is pictured above takes you through all of the questions that should be answered in a study design plan. In the case of monitoring for Marcellus Shale gas extraction impacts, the answers to all of the questions except for 3, 6 and 10 will be given to you so that standard protocols can be followed by volunteer monitoring groups throughout the state. Your group should complete the study design by addressing these three questions (noted in red in the study design wheel above) before monitoring begins.

Overview of the Monitoring Plan:

The monitoring process can be broken down into six main categories:

(1) Permit research: The process for monitoring the impacts of Marcellus Shale gas extraction starts with the identification of active, inactive and proposed drilling and infrastructure sites. Volunteers are trained to access this information from a number of online sources.
(2) Site locations: Documentation of extraction activities allow volunteer monitors to locate sites for monitoring and will provide information on any impacts that might occur due to these activities. The number and location of sites depends on the resources of the group.
(3a) Baseline monitoring: Volunteers are trained to collect field data on water chemistry, flow, and visual impacts (observational monitoring) at their monitoring sites. Ideally, sites will be monitored for 3 months to a year before the extraction activities begin. This will provide baseline data to compare to data after the activities have begun and will establish a baseline relationship between flow and water chemistry as well as establish natural background levels of chemicals and normal landscape conditions.
(3b) Monitoring during extraction: When drilling begins, volunteers continue to monitor the same parameters, keeping careful watch for deviations from baseline conditions.
(4) Data management and analysis: Throughout the monitoring process, data are entered into a data management program and carefully scrutinized for indications of impact.
(5) Action: If significant deviations from baseline conditions are documented, volunteers will take action as they see fit.



The Study Design Plan

The following study design plan is organized by the steps in the study design wheel (page 3). For most steps, the appropriate information has been entered to be consistent with the standardized protocol that we are encouraging volunteer monitoring groups to use. For three of the steps, there are questions that prompt you to fill out the appropriate information which will be customized for your watershed.

Step 1: What are the major objectives of this project?

The objectives of this project can be summarized as two major goals:

1) Early detection of contamination of small streams and of disturbance in the surrounding watersheds of gas extraction activities.

2) Prevention of future environmental impact through the continuing presence of watchful residents.

Does your group have other goals? Are they realistic within the constraints of the group resources? If so, be sure to list them here and consider them in each step of the study design.

Step 2: Why are you monitoring?

Marcellus Shale gas extraction activities may be a significant threat to our water resources. A summary of water-related impacts of Marcellus shale operations include:

- Potential for surface and ground water contamination from poor casing of well bores, accidental spills, flooding of well pads in floodplains, and the poor handling, treatment and disposal of fracking and flowback fluids;
- Runoff from well pads, pipelines, increased trucking activity and access roads;
- Air pollution from transport vehicles, compression stations, pipelines and well pad activities, much of which translates into water pollution; and
- Fragmentation of sensitive lands adjacent to water bodies.

Experience in the state has demonstrated that spills and accidents are common[2].

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[2] For example, to see DEP non-compliance reports, go to
http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/OG_Compliance
You can also access a map of all of the violations at:
http://data.fractracker.org/cbi/dataset/datasetPreviewPage?uuid=~016ee9eba2a60811e1812fca19b5340658#

Step 3: How will you use the data you collect?

Your group needs to discuss this question before completing your study design. Now that we have determined the objectives, you need to look ahead and think about how you are going to use your data. In doing so, it is important to keep in mind what your resources are.

Determine what action you expect to take with your data and who will use the data. Remember to align your data use objectives with your monitoring objectives.

Common data audiences include:

- Volunteer monitoring groups
- University and research scientists
- Gas companies
- Community
- Local government
- State and Federal Government

Examples of data use include:

- Reporting incidents to state and local officials;
    - Possible implementation of a certification or memorandum of understanding process
- Calling companies to report findings and to seek mitigation;
- Publicizing monitoring activities in newspaper articles, op ed pieces, letters to the editor, etc.;
- Testifying at permit application hearings;
- Discussing findings with landowners; and
- Archiving data for future use by researchers

Envision data outputs. For example perhaps your primary concern is developing a strong baseline database and simply informing the gas companies that you have these data and are watching for any changes (to help promote better management practices). Perhaps you are interested in documenting the impact from increased trucking activities and you are photographing road damage. How can these data best be used to achieve your goals?

It is a common default for groups to identify the State/Federal Government as the audience for the data. Often people will determine that the group will collect data and then assumes the state will use it. Unless a relationship is established with a governmental entity upfront that they will use the data or be an audience for the data, ALLARM recommends that the group think along other lines as well. How can the group best analyze the data and use the data to communicate to others?

Record your intended data uses in the space below:

____

____

Step 4: What will you monitor?

There are three groups of stream and landscape evaluation measures that you will use:

1) chemical analysis,
2) flow measurement, and
3) observational or visual monitoring.

Detailed information and directions for each evaluation measure can be found in Step 5 and in the appendices of this manual. This section is devoted to an overview and background information.

1) Chemical analysis

Background [3]

Frack Water
In the hydrofracking process, a large amount of water is injected into the well under pressure to fracture the rock and release the gas. The water used is called the frack water. It contains a large number of additives, the exact concentrations of which are considered proprietary information. Additives include a proppant (such as sand), scale inhibitors (such as ethylene glycol), surfactants (such isopropanol), antibacterial agents (biocides), corrosion inhibitors, and friction reducers.

Flowback Water
The frack water mixes with a natural brine which is found in the shale and between 20-80% returns to the surface. That water, known as flowback water often contains high concentrations of chlorides, sodium and sulfates, metals (such as barium, iron, manganese, arsenic, strontium, lead, cadmium, chromium, and aluminum), naturally occurring radioactive materials (such as uranium, radium, and radon), methane, and bacteria.

These waters can reach the environment and contaminate water resources through well casing leaks, surface spills and leaks, incomplete treatment of flowback water in wastewater treatment plants, and migration through bedrock. Water quantity problems can also occur since withdrawal of water for fracking may decrease the flow in a stream, whereas discharge of flowback water may increase the flow. Both conditions

[3] For more information on the Science of Marcellus Shale, watch the narrated PowerPoint presentation in the ALLARM toolkit at: http://blogs.dickinson.edu/marcellusmonitoring/science-of-the-marcellus-shale/

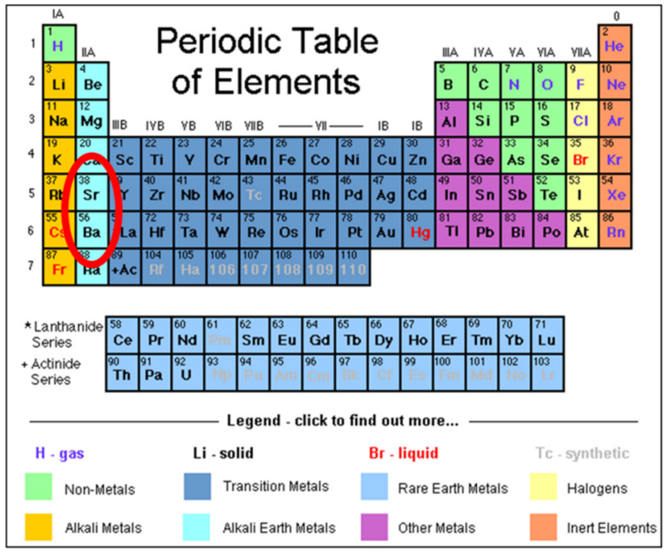
can cause harm to the stream's habitat and/or biota.

Indicator Chemicals: Conductivity and Total Dissolved Solids

Since there are hundreds of different chemicals found in the waters associated with gas extraction, it is not possible to test for each possible constituent. For our testing we are using two indicator chemicals: conductivity and total dissolved solids (TDS). A large increase in conductivity/TDS is an indicator that the water may be impacted by spills or leaks from gas extraction and other activities.

Signature chemicals: Barium and Strontium

In addition to using conductivity/TDS as indicator parameters, we will also use signature parameters, that is, those chemicals that point to gas extraction activities as the cause for the increase in conductivity. Although the composition of flowback water varies quite a bit, two parameters are almost always found: Barium (Ba) and Strontium (Sr).[4] These two analytes will serve as our signature chemicals. Simply put, if conductivity/TDS is high, we then test for Ba and Sr, and if they are high also, we assume that the source of impact is Marcellus Shale flowback water.



The following table is adapted from the New York Department of Conservation Supplemental Generic Environmental Impact Statement On the Oil, Gas and Solution Mining Regulatory Program, and is based on flowback water samples from PA and WV. Notice the very high concentrations of the indicator and signature chemicals in flowback water in comparison to water quality criteria in PA.

Parameter	Median concentrations in flowback samples (mg/L)	PA water quality criteria (mg/L)	PA drinking water criteria (mg/L)	Potential health & environmental effects
Total Dissolved Solids	93,200	500	500	Variable; includes many chemicals
Barium	661	10	2	Increase in blood pressure
Strontium	821	0.050	none	Musculoskeletal toxicant

[4] The New York Department of Environmental Conservation completed a draft Environmental Impact Statement on the gas regulatory program in September, 2009. They reported typical concentrations of flowback constituents based on limited samples from PA and WV. There were more than 75 different chemicals listed.

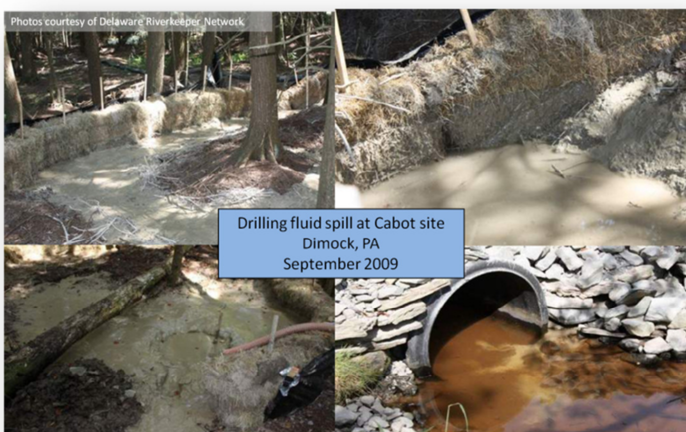
2) Flow Measurement

The volume of water that flows past a given point during a given time period is called flow or discharge. Simply put, this is the amount of water in the stream. Knowledge of the flow is critical in evaluating:

1) Water quantity changes that may be due to either excessive withdrawals or spills, and

2) The normal relationship between the concentration of conductivity/TDS and the amount of flow in the stream. Understanding this relationship helps to decide whether increases or decreases in conductivity/TDS are simply due to changes in flow, or to a contamination event.

3) Observational Monitoring (Visual Assessment)



Visual Assessment is a powerful tool which allows volunteers to evaluate management practices and their impact on the physical conditions of the ecosystem. Impacts can be documented through photography.

Volunteers systematically make and record observations on land disturbances, spills and discharges, gas migration or leakage, and compliance with sedimentation and erosion plans.

Step 5: How will you monitor?

In this section, we provide an overview of the methods that are used to monitor the parameters that were identified in the last step. The actual step-by-step protocols for all of the methods are explained in the appendices.

1) Chemical Analysis

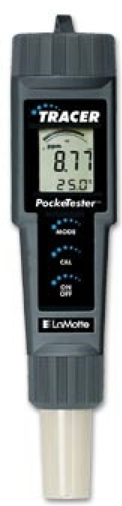
Indicator Chemicals: Conductivity and TDS (Total Dissolved Solids)

Conductivity and TDS are typically measured in the field using an electronic meter. ALLARM tested a variety of popular conductivity/TDS meters and determined (through trial tests with untrained volunteers) that the LaMotte Tracer PockeTester exceeds all other meters tested in terms of accuracy, precision, and ease of use.

TDS meters are, in reality, conductivity meters. That is, they work by applying a voltage between two or more electrodes. Positively charged ions (e.g. sodium, calcium, and magnesium) will move toward the negatively charged electrode, and negatively charged ions (e.g. chloride, sulfate and bicarbonate) will move toward the positively charged electrode. Because these ions are charged and moving, they constitute an electrical current, which is then measured by the meter. The meters actually measure charged particles, and then use an equation to convert that measure to total dissolved solids in mg/L. That conversion is approximate and the conversion equation varies with water chemistry. For that reason, we have chosen meters that will report both the conductivity measurement and the TDS result. As with all electronic meters, the LaMotte Tracer PockeTesters need to be calibrated twice a month. Standard solutions and training are provided for volunteers to learn how to successfully calibrate and use the LaMotte Tracer PockeTester.

The LaMotte Tracer PockeTester offers direct reading on conductivity, total dissolved solids, salinity and temperature. Its memory can store up to 15 readings. Further specifications are in the table to the right. The cost is $95.00. The life expectancy of the electrode is 5 years with reasonable care. Electrodes can be replaced for $49.00.

Appendix A1 gives detailed directions on sample collection, meter calibration and use of the LaMotte Tracer PockeTester.

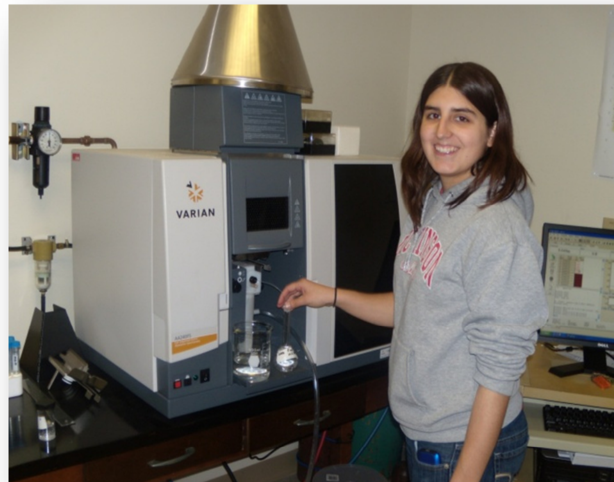


Specifications	
Conductivity Range	0 to 199.9 µS
	200 to 1999 µS
	2.00 to 19.99 mS
TDS Range	0 to 99.9 mg/L
	100 to 999 mg/L
	1.00 to 9.99 g/L
Salinity Range	0 to 99.9 mg/L S
	100 to 999 mg/L S
	1.00 to 9.99 g/L S
Accuracy	EC, TDS, Salt: ± 2% FS
Temperature	±1°C (1.8°F)

Signature Chemicals: Barium and Strontium

Although the components found in flowback water vary quite a bit, barium and strontium are almost always present in rather high concentrations, and therefore are used as our signature chemicals – chemicals whose presence points to flowback water as the source of contamination.

Barium and strontium are metals that are associated with minerals naturally found in the shale rock formation and that are therefore dissolved into the brine that is also found within the shale. Although natural in origin, barium and strontium are toxic elements when found in high concentrations.



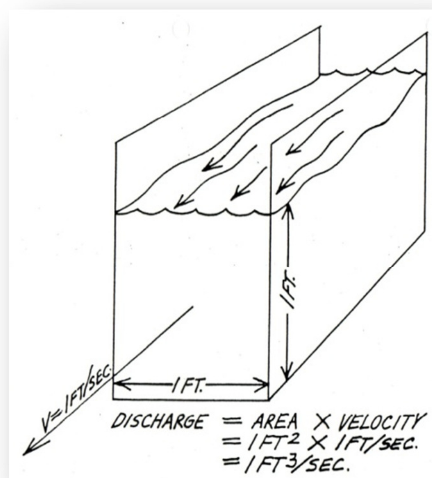
Since there are no accurate field kits for measuring concentrations of barium and strontium, these components will be measured by a PA certified laboratory using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Volunteers will use bottles supplied by ALLARM to collect water samples for ba/sr analysis (Appendix A3).

2) Flow Measurement

Measuring discharge in a stream is a complex and time-consuming task. It requires measuring the cross sectional area (width x average depth) and the average velocity of the stream. The standard formula is:

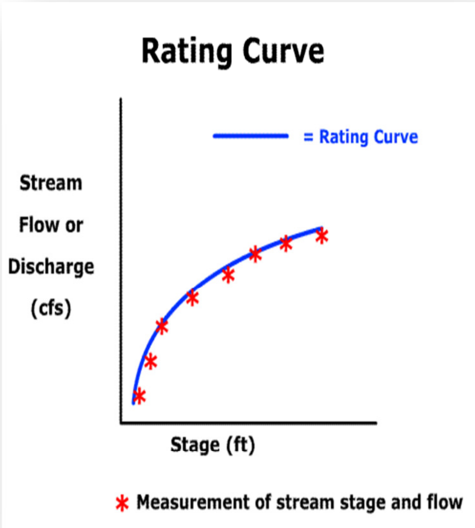
Q = (0.8)* w* d *v

Where:
- Q = discharge in cubic feet/sec (cfs)
- w = width of the stream across a given transect (ft)
- d = average depth of the stream at the transect location (ft)
- v = average velocity of the stream in the transect vicinity (ft/sec)
- 0.8 = an empirically-derived correction factor



A wide, deep stream will have a greater discharge than a shallow, narrow stream, assuming their flow velocity is the same. Conversely, two streams of similar size may have quite different discharges if the flow velocity differs.

For our purposes, it is sufficient to produce a surrogate measure of flow that will indicate relative increases and decreases of flow at any given site location. **This surrogate will simply be the stage of the stream, that is, the level of the water, relative to some reference point.** This measure can only be used to compare relative flows at a given site and cannot be used to compare flows between sites. However, it should be sufficient to detect unusually high or low flows that are not related to recent precipitation patterns (and could therefore indicate water withdrawal or discharges) and/or to determine if unusually



high TDS measurements are simply due to flow conditions or might suggest a water contamination event[5].

Stage is commonly used as a surrogate measure for discharge, understanding that the relation between them is not linear. If discharge is to be inferred from stage, then the relationship needs to be calibrated at several points throughout the range of flows. The diagram to the left shows a typical calibrated stage/discharge curve. For our purposes, stage measurements are sufficient.
A detailed protocol for measuring the stage of small streams is found in Appendix B1, a blueprint for building a gage stick is found in Appendix B1A, and directions for building a staff gage are found in Appendix B1B.

If you were trained prior to June 2012, you should continue to use cross-sectional area as your surrogate flow measure; the protocol for this is found in Appendix B2.

3) Visual Assessment (Observational Monitoring)[6]

Visual documentation of drilling activities is a powerful way for volunteers to help provide needed oversight of drilling activities. This visual assessment method consists of a checklist of possible observations that indicate impact from gas extraction activities. It is divided into four sections: land disturbances, spills and discharges, water withdrawals, and gas migration and leakages. For each section there is a list of observations that, if found, likely indicate impact. The checklist data form is found in Appendix C.

Checklist for Gas Related Earth Disturbance

Land disturbance for drilling pads, access roadways, and connecting pipelines can cause accelerated runoff and soil erosion. This adds to the sediment loading of nearby streams and can increase stream bank erosion. Deposition of sediments into the stream adversely affects stream biota. An erosion and sedimentation control plan incorporating best management practices must be prepared and followed for all land disturbances associated with oil and gas development. In general, these measures do a good job of holding soil erosion in check. However, sometimes improperly installed or maintained erosion and sediment control measures can lead to accelerated erosion. Most often access roadways are the problem, as they frequently are built on steep slopes, and routine maintenance is not a priority once a well is installed and producing.

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[5] Upon request, ALLARM will provide protocols and training for those groups who would like to do more sophisticated measurements of discharge, including measurements of velocity and cross-sectional area.

[6] For a narrated PowerPoint presentation on the protocol for visual assessment, visit the ALLARM Marcellus Shale monitoring tooklit at: http://www.authorstream.com/Presentation/Marcellusmonitoring-1392386-visual-assessment/

If you find any of the features in this checklist, there is a high probability that the company is violating its sedimentation and erosion plan.

Checklist for Spills and Discharges

Discharges of polluted water to streams, whether intentional or not, can have a significant impact on water quality and stream biota. In extreme cases, fish kills can occur. Every producing gas well also produces some water, which is stored in a tank at the well site and periodically trucked to a treatment facility as required by Pennsylvania law. But spills do occur; and regrettably, “midnight dumping” occasionally does take place. These events can occur and important evidence can disappear before anyone takes notice, especially on more remote streams. Early detection and prompt reporting are crucial.

Checklist for Gas Migration or Leakage

Leakage of natural gas into soil, springs, and waterways results from a pipeline break or a breech in the gas well casing. This is not so much an environmental problem as a concern for human health and welfare. As it is colorless and odorless, it may not be detected if migrating directly out of the ground. Natural gas mixes with atmospheric oxygen, and any spark or flame can ignite the mixture. This situation is particularly dangerous when someone’s potable water supply is contaminated. When gas is routed to a pipeline, mercaptan compounds are added to provide an odor for detection.

Cost of equipment needed for monitoring

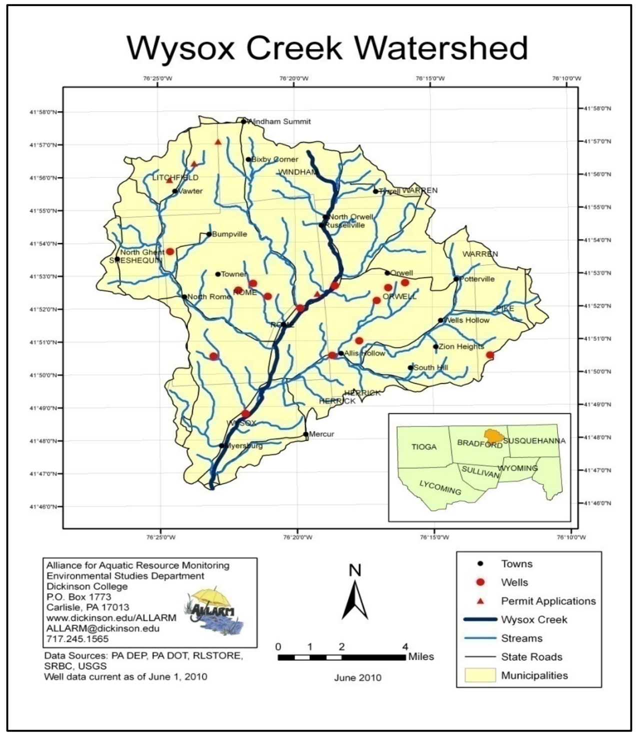
The following table summarizes the costs for all equipment needed to complete monitoring. You may purchase items directly from ALLARM (at cost) or purchase items directly from the suppliers. Each supplier (and their web address) is listed below. Supplier prices do not include tax or shipping and handling charges. Depending on your budget, you may want to share equipment among volunteers or have a complete set of equipment for each volunteer monitor. Once purchased, most equipment will last indefinitely. The PockeTester’s electrode has a life expectancy of ~5 years. Replacement electrodes can be purchased for $49. Calibration solution prices are based on monitoring one site for one year on a weekly basis.

Item	Cost	Source
Marcellus Shale Monitoring Kit · 1 LaMotte Tracer PockeTester · 1 Calibration solution (1,413 µS/cm, 1 L) · 1 Distilled water bottle (500 mL) · 3 Sample collection bottles (250 mL)	$125	ALLARM
Gage Stick	$5	ALLARM
LaMotte Tracer PockeTester	$95	LaMotte Company: www.lamotte.com
Calibration solution	$15	AquaPhoenix Scientific: www.aquaphoenixsci.com
Distilled water wash bottle	$10	AquaPhoenix Scientific: www.aquaphoenixsci.com
Sample bottle	$6	AquaPhoenix Scientific: www.aquaphoenixsci.com
Waders	Optional	

Step 6: Where will you monitor?

In this step you will determine your monitoring site locations. Site locations can be a balancing act; however you must always keep in mind the overall goals of your monitoring program and make sure your sites produce data that can address these goals.

Part I. How do we find out where the drilling sites are?



For Marcellus Shale gas extraction impact monitoring, the first consideration in most cases will be the location of the gas extraction activities. Permit applications for drilling are made public in a timely fashion by the PA Department of Environmental Protection (DEP), and can be accessed by signing up for eNotices: http://www.ahs2.dep.state.pa.us/eNOTICEWeb/. DEP also produces compiled reports on permits issued, drilling commence dates (SPUD dates), county data, operator specific data, as well as inspections, violations and enforcement actions http://www.portal.state.pa.us/portal/server.pt/community/marcellus_shale/20296. Permit applications and site locations for water withdrawal or discharges within the Susquehanna River Basin can be found on the Susquehanna River Basin Commission (SRBC) website: http://www.srbc.net/wrp/. And finally, a privately-managed website called rlstore compiles all eNotices and updates compilation tables every day: http://www.rlstore.com.

During the workshop, ALLARM demonstrates how to use the available tools to access information in your watershed about drilling activities and well locations, so that you can use this information in choosing your monitoring sites. This information is also available as tutorials and videos on the ALLARM Marcellus Shale Monitoring Toolkit at: http://blogs.dickinson.edu/marcellusmonitoring/determining-where-the-wells-are/

Part II. How do we choose our sites?

Before you make any decisions about site location, you should use the base maps that are provided to enter any information that is important to you and that will help determine priority site locations. For example, use your knowledge of the watershed to denote areas of special interest such as high quality stream reaches, swimming holes and fishing areas, forested or pristine sections, areas with endangered or high value species, stream reaches with other potential impacts such as agricultural or industrial activities, and so on. Ultimately your site selection will be prioritized on the basis of the juxtaposition of areas of interest with areas of extraction activities.

Other site location considerations include:

- *Accessibility*: Can you easily access the site? Are there public lands you can use? Bridges? Friendly neighbors? If you need to access the stream from someone's property, you will need to get the landowner's permission.
- *Resources and number of sites*: How many sites can you support given your resources? Look at the cost chart on p. 13 to help answer this question. Can you share equipment between volunteers? How many volunteers do you have? What are your time constraints?
- *Safety*: Can you wade in your streams? In order to collect representative water samples, ALLARM recommends that samples be taken from the center of the stream. If you cannot safely wade in your streams, you will want to consider bridges as sampling locations. Or you will need to explore purchasing or building a sampling pole.

You will want to make note of the site locations you choose as well as why you chose those sites and a brief description of each site.

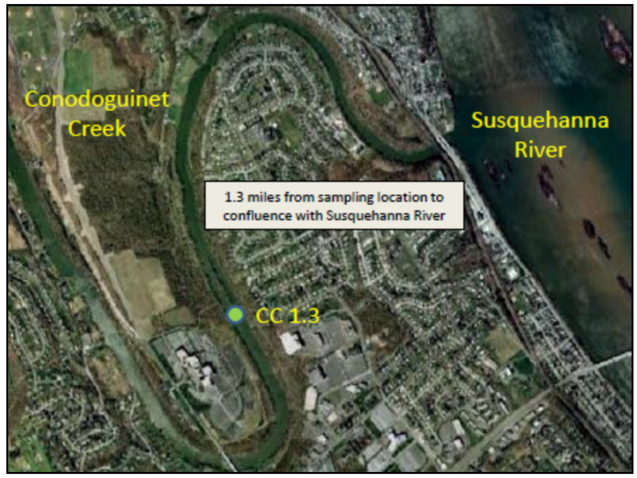
Site Number	Brief Description of Location	Latitude	Longitude

Once you have determined your sites, you will want visit those sites to document the exact locations and give them site numbers. You can use Global Positional System (GPS) devises to obtain longitude and latitude coordinates. If GPS is not available, you can also use Google maps and get latitude and longitude by locating your site on the map and following the directions in the ALLARM Marcellus Shale Monitoring Toolkit at: http://blogs.dickinson.edu/marcellusmonitoring/files/2012/02/Site-Location_Google-Maps.pdf.

Once site locations are determined, ALLARM recommends giving the site a name with the initials of the waterway and the stream mileage (stream miles from the site to the mouth of the waterway; if a tributary it is the mileage from the site to the confluence). ALLARM can help groups calculate stream mileage using a Geographic Information System. For example:

Name of stream: Conodoguinet Creek
Mileage from site to confluence with Susquehanna River: 1.3 miles
Site name: CC 1.3

Remember: Monitoring is an ongoing project where decisions are revisited based on results. That is, study design is a process of constant revision and site locations may be added or removed as the situation changes in terms of the groups' resources, goals, results of the monitoring, and the status of drilling activities. Consider the sites that you have just located as a first pass on site locations and be open to revision as the circumstances change.



Step 7: When will you monitor?

The ideal study would measure everything everywhere all the time. Unfortunately, this is never possible, and so scientists settle for sampling the environment. The more samples you take, the more secure you can be that your results match the "true" results. But the number of samples will depend once again on the resources available – time, personnel, equipment, and of course, money.

The fact that we are looking for leaks and spills, which are transient events, makes the sampling frequency even more challenging. A spill or leak may impact the chemistry of a stream at any one spot for a very short period of time, as it moves downstream and becomes diluted. Water chemistry is a snapshot in time of conditions; often it does not tell us too much about what happened yesterday or even several hours ago. However, there are other more long-lasting clues to recent contamination events – the kinds of clues that we may discover when we do observational monitoring – for example, impacts on instream habitat, erosion rills on the land or even gases bubbling from the ground.

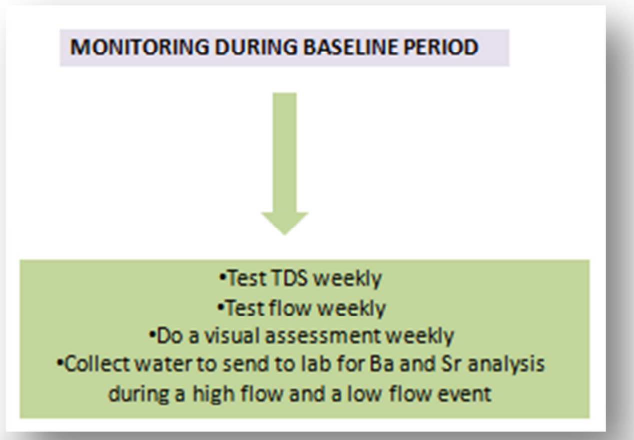
We are recommending that volunteers monitor their sites once per week as a compromise between the ideal and the practical. You need to determine a clear monitoring schedule up front so that monitors are consistent and understand the time commitment and expectations from the beginning.

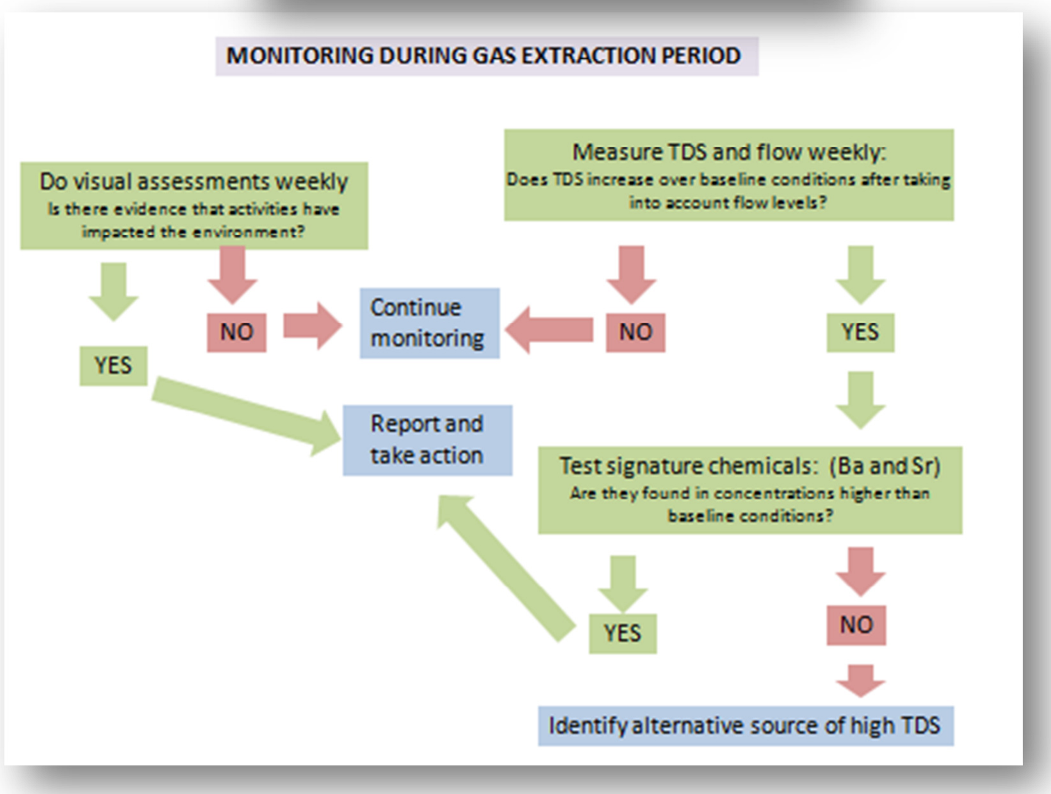
During the baseline data collection period (prior to the onset of drilling activities), we recommend:

- weekly monitoring of conductivity/TDS
- weekly monitoring of stream level
- weekly visual assessment

In addition, volunteer monitors should send water samples to the ALLARM laboratory for analysis of Ba and Sr during one high flow event and one low flow event during the baseline data collection period. Ideally this baseline collection period will last a full year, but this ideal condition will not always be met.

After drilling begins, volunteers should continue the weekly protocol. Samples for analysis of Ba and Sr should only be collected if conductivity concentrations are found to be higher than expected based on baseline conditions. This protocol is diagrammed below:





HELPFUL HINT: Since you will be monitoring once per week, choose a day of the week and get into a routine of monitoring at some point during that day. Building your monitoring activities into your routine helps you maintain your commitment. If you miss a week, just skip it and continue to monitor the following week.

Step 8: What are your quality assurance/quality control measures?

Quality assurance refers to the measures you take to ensure that your data meet the standards of quality that you define (the plan); quality control refers to the actions you implement to achieve your quality assurance objectives (the steps). Essentially in this step you are determining the actions you will take to assure that your data meet your data quality objectives.

In most cases, we anticipate that the data quality objectives include that the data must be credible and of sufficient value to solicit a timely response for mitigation. Explaining our quality assurance plan to regulators and companies is one way to assure that the data are viewed as credible and sufficient to warrant a timely response.

The actions you implement to achieve these quality assurance objectives are:

- *Training requirements*: All volunteers receive training from service providers in the state of PA, such as ALLARM. This training will consist of close examination of the monitoring manuals, laboratory training on equipment, and field training including chemical monitoring, flow measurement, and visual assessment.

- *Care and calibration of equipment*: The conductivity/TDS meters are calibrated using standard solutions and are stored according to manufacturer specifications between uses.

- *External QA/QC measures*: All volunteers are required to pass a split sample quality control test. Monitors will use the conductivity/TDS meters to test the stream water and then collect an extra set of water samples to send with their data to the ALLARM lab[7]. At the lab, the water will be tested using the monitors' equipment as well as more sophisticated equipment and results will be compared to the data collected by the volunteers. If the precision is within acceptable limits, the volunteers will have passed the quality control test and can continue monitoring. If the precision is outside the acceptable limits, ALLARM will make suggestions to the volunteers and they will try again.

- *Documentation of procedures*: It is essential that all of your methods are clearly documented so that anyone can see your quality control plan and action. This manual, along with other manuals with more detailed instructions on methods, provide the necessary records to insure credibility.

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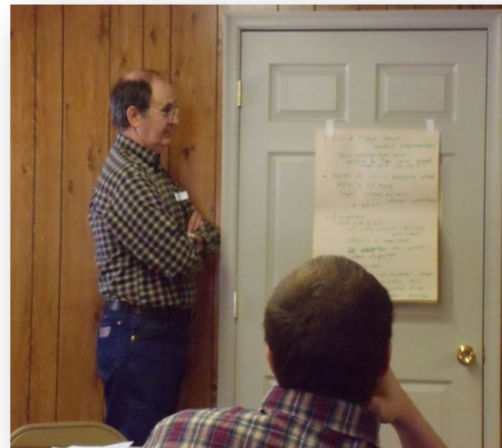
[7] Please see Appendix A2 for details and directions for quality assurance/quality control split sample analysis. Also see the ALLARM Marcellus Shale Monitoring Toolkit at: http://blogs.dickinson.edu/marcellusmonitoring/water-quality-monitoring/

Step 9: How will you manage your data?

Since we are attempting to detect impacts of gas extraction activities and then to act in a timely manner, it is essential that all data are compiled and examined carefully as they are collected. That is, in this particular project, data cannot be archived and examined at a later date for patterns, but need to be compiled and examined on a weekly basis.



For these reasons, we suggest that a data manager who is willing to compile and examine the data be identified. All volunteers will submit data on a weekly basis to this person, who will compile the numbers and observations and work with data collectors to determine if the data reveal a problem that needs to be addressed. Turning the data into information and the information into quick action will require establishing a strong communication network among the participants.

Appendix A1 contains a data sheet that can be used in the field to record the raw data. It can also be found at: http://blogs.dickinson.edu/marcellusmonitoring/files/2012/02/Chemical-and-Flow-Monitoring-Data-Sheet.pdf

To compile data from multiple sampling dates and/or multiple volunteers, we suggest the data manager use the following Excel spreadsheet: http://blogs.dickinson.edu/marcellusmonitoring/data-management/2012-chemical-and-flow-database-3/

For data interpretation and action, Appendix D1 contains a decision tree to help guide your decisions about reportable events, and Appendix D2 contains a table with the names and numbers of offices to contact with your findings.

During the workshop, there are a series of exercises to familiarize you with data entry, management, and interpretation, including identification of reportable events.

After the data are compiled and examined, ALLARM will act as a temporary repository for the data. Currently we are working with a variety of partners to develop a public access database for Marcellus Shale volunteer-collected data. During the workshop, ALLARM will detail the current state of this effort and describe the steps you need to take to provide data to us for archiving until the larger public database is ready to go.

Step 10: What are the tasks and who will do them?

This final step is a task that must be completed before the monitoring can begin. There are many responsibilities and roles that come with maintaining a successful volunteer monitoring program. It is important that responsibilities are shared so that volunteers are not overburdened.

Think through your monitoring plan and develop a timeline with the different tasks that need to be accomplished to achieve your goals. Look at the list of tasks and see if any can be grouped together. Afterwards develop titles for different roles and job descriptions.

Possible monitoring positions:

- *Program Coordinator*: Checks in with monitors, keeps track of training schedule, maintains QA/QC results and needs, and reminds volunteers of monitoring dates.
- *Permit Watch Coordinator*: The group expert on following permit applications and helping the group update watershed maps with the latest information.
- *Volunteer Trainer*: Someone who understands the monitoring methodology and procedures, has accreditation, or has gone through a train-the-trainer program.
- *Data Management Coordinator*: Collects data sheets, enters data into database, conducts data analysis and sends data to ALLARM central database.
- *Data Entry Volunteer*: A volunteer that double checks that the data have been entered into the database correctly.
- *Equipment Manager*: Keeps a schedule with reagent expiration dates, responsible for ordering and distributing supplies.
- *Volunteer Monitors*: Carry out monitoring.

Use the table below to develop a list your tasks, assign roles to participants, and develop a timeline for participation.

Task	Task Description	Assigned to Whom	Targeted Action Time

References:

New York State Department of Environmental Conservation, Division of Mineral Resources. 2009. *DRAFT Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program*, available on line at: http://www.dec.ny.gov/energy/58440.html

River Network and PA DEP Citizen Volunteer Monitoring Program. 2001. *Designing Your Monitoring Program: A Technical Handbook for Community-Based Monitoring In Pennsylvania*.

Zerbe, F. and C. Wilderman, 2010. Monitoring Impacts of New Gas-drilling Technologies, *The Volunteer Monitor*, 21(1), Spring 2010.

Acknowledgements:

Throughout the process of developing this manual, the authors have worked with numerous people and organizations across the Marcellus Shale play area gathering information from them, asking their opinions, and getting permission to use their materials. ALLARM would especially like to acknowledge the following people and organizations for their invaluable contributions to this manual:

Debra Nardone and Robert Volkmar of PA Trout Unlimited;
Mike Lovegreen and Scott Mollnar of Bradford County Conservation District;
Julie Vastine, Director of ALLARM;
Benson Ansell, Vallie Edenbo, Anna Farb, Vinca Krajewski, Kerri Oddenino, Simona Perry, Katie Tomsho, and Maunette Watson of Dickinson College;
Jim Weaver of Waterdogs;
Steve Penningroth of Community Science Institute; and
Faith Zerbe of Delaware Riverkeeper.

Appendix A1: Detailed directions for chemical monitoring of conductivity and TDS[8]

You may measure the conductivity and TDS of the water by inserting the meter directly into the stream, but it may be difficult to read the display. Therefore, if you would prefer, you can collect a water sample in a bottle and do the measurement when you return to streamside.

Sample Bottle Preparation

To prepare your bottle, you should thoroughly wash and rinse a container. The container must be large enough so that the meter electrodes can be fully immersed in the water. Note: be sure to use the bottles supplied by ALLARM if you are collecting your sample for split sample analysis (Appendix A2) or Ba and Sr analysis (Appendix A3).

Sample Collection

This sample collection protocol applies to collecting water samples for all of the analyses you do. This method is designed to collect a water sample that is small enough in volume to be conveniently collected, transported, and handled, while accurately representing the quality of the entire stream segment at the point in time when the sample was taken.

1) **Sampling location:** You should collect your sample away from the stream bank in the current, ideally in the middle of the stream. Do not sample stagnant water.

2) **Entering the stream:** Enter the stream downstream of your sampling location to avoid introducing any disturbed sediment into the sample. Move to the center of the stream, if possible, and collect a water sample facing upstream from where you are standing (the water will be flowing towards you).

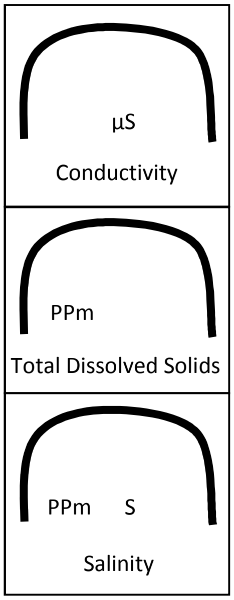
3) **Rinsing the sample bottle:** Rinse the bottle and cap of your sampling bottle with stream water, being careful not to touch the insides of the bottle or cap with your hands. Totally fill the bottle and cap with water. Pour out the rinse water downstream from where you are sampling (behind you) to avoid reintroducing the rinse water back to the collected sample. **Repeat 3 times.**

4) **Collecting a sample:** Prepare to fill the bottle by slightly tilting the mouth towards you. This will position the bottle opening away from the direct flow of the stream current. Lower the bottle into the stream current, attempting to smoothly and evenly sample the entire depth of the stream. Try to get the same volume of sample at each depth. Keeping the sample bottle slightly tilted will prevent the bottle from totally filling, which will allow for thermal expansion during shipping/transportation (if necessary). Cap the filled bottled.

[8] There are two narrated videos that explain this protocol: 1) Meter training video and 2) Weekly monitoring steps video. You can access these videos at: http://blogs.dickinson.edu/marcellusmonitoring/water-quality-monitoring/

Conductivity/Total Dissolved Solids Measurement: LaMotte Tracer PockeTester

Step 1: Calibrate the meter (home)



1. Turn the meter on by pressing the **ON/OFF** button.
2. Take off the bottom cap covering the electrodes.
3. The meter must be in conductivity mode (*"µS" will be displayed above the reading; to change modes, press the **MODE** button for 3 seconds).*
4. Place the meter in 20 mL of 1413 µS/cm standard calibration solution. Press and hold the **CAL** button for ~2 seconds. "CAL" will appear on the bottom of the screen and 1413 will flash on the screen.
5. The device will automatically recognize and calibrate to the conductivity standard. 1413 will stop flashing and the display will briefly read "SA" and "End". (*"SA" will not appear if the calibration fails.*)
6. Rinse the meter with distilled water, shake dry, and turn the meter off.

Note: If sampling weekly, meters should be calibrated every other week.

Step 2: Measure the conductivity and TDS of a water sample (field)

1. Turn on the meter by pressing the **ON/OFF** button.
2. Take off the bottom cap covering the electrodes.
3. "SELF CAL" will flash and then disappear on the display.
4. Make sure the meter is in conductivity mode (*"µS" will be displayed above the reading; to change modes, press the **MODE** button for 3 seconds).*
5. Place the meter directly into the stream, making sure the electrodes are completely immersed in the water.
    a. If you prefer, you may take a water sample from the middle of the stream and place the meter in the clean sample container.
        i. Enter the stream downstream from your monitoring point to avoid introducing disturbed stream sediment to the sample.
        ii. Move to the center of the stream, if possible.
        iii. Collect the water sample using a clean sample bottle facing upstream from where you are standing (water is flowing towards you).
6. Allow the reading to stabilize.
7. Record the conductivity measurement on your data sheet.
8. Hold the **MODE** button for approximately 3 seconds (*TDS will flash on the bottom of the display and "ppm" will be in the top left corner of the display. There should not be an "S" above the reading – that is the salinity mode*).
9. Allow the reading to stabilize.
10. Record the TDS measurement on your data sheet.
11. When finished, rinse the meter with distilled water and turn the meter off.

VOLUNTEER MONITORING FOR MARCELLUS SHALE IMPACTS
Chemical and Stage Monitoring Data Sheet[9]

Sample Site: ________________________________ **Date:** ____________________ **Time:** ____________

Sample Site Location: ______________________**Latitude**:_____________**Longitude:**________________

Monitor's Name: ____

****

Circle the description that best matches your observation:

Weather & Precipitation: Clear Cloudy Partly Cloudy Fog/Haze

Rain Drizzle Intermittent Rain Snow

Precipitation last 48 hours: None Trace Light Moderate Heavy

****

Parameter	Units	Replicate 1	Replicate 2	Average
Conductivity	µS/cm			
Total Dissolved Solids	mg/L			
Stage	ft			

<u>Inches to feet conversion</u>

1 inch = 0.08 ft	5 inches = 0.42 ft	9 inches = 0.75 ft
2 inches = 0.17 ft	6 inches = 0.50 ft	10 inches = 0.83 ft
3 inches = 0.25 ft	7 inches = 0.58 ft	11 inches = 0.92 ft
4 inches = 0.33 ft	8 inches = 0.67 ft	

Did you calibrate your meter this week? Yes No

How much time did you spend monitoring? __________ hours

[9] A printable version of this data sheet can be found at: http://blogs.dickinson.edu/marcellusmonitoring/files/2011/09/Chemical-and-Stage-Monitoring-Data-Sheet.pdf

Appendix A2:
Detailed directions for quality assurance/quality control (QA/QC)

Printable version can be found at:
http://blogs.dickinson.edu/marcellusmonitoring/files/2012/06/QAQC-Instructions_ALLARM_2012_2.pdf

Directions for collecting water samples for QA/QC:

1) **Label the sample collection bottle** with your name, stream name, and date of collection.
2) Enter the stream and **stand downstream of your sampling site**. Fill the bottle with water and empty the water behind you. Rinse the bottle a total of **3 times.**
3) Lower the bottle into the water with the opening facing upstream. Fill the bottle completely with stream water and close tightly with the cap.
4) Record the conductivity, stage, and TDS results in the table below.
5) Pack a small box with your water sample and this sheet. Be sure that the sample bottle is secure within the box and cannot move around.
6) Mail the box containing your water sample and this sheet to ALLARM for processing.

ALLARM
Dickinson College
5 N. Orange Street
Carlisle, PA 17013

Monitor Information		**Sample Information**	
Name		Stream Name	
Mailing Address		County Monitored	
		Sample Collection Date	
Email Address		Meter Used (i.e. LaMotte Tracer PockeTester)	
Affiliation (if applicable)		GPS Coordinates (Latitude, Longitude)	

Parameter	Units	Result
Conductivity	µS/cm	
Stage	ft	

TDS	mg/L	

Appendix A3:
Detailed directions for sampling for Ba and Sr lab analysis

Sample Collection

To collect a water sample for barium and strontium analysis, follow the Sample Collection procedure outlined in Appendix A1 on page 22. Be sure to collect the water sample using the sample bottles included in your monitoring kit.

Baseline Analysis

For baseline monitoring, you will want to test for barium and strontium levels at your monitoring site twice a year, preferably once during a low flow event and once during a high flow event. This is important for understanding the background levels of these two parameters at your site prior to any drilling activity taking place. These data will also serve as a reference when determining if a drilling-related chemical pollution event has occurred. It is ideal to sample twice a year under different flow conditions to document the variability in barium and strontium at your site.

Once you have collected your water sample, you will send it to a certified lab for barium and strontium analysis. The cost of analysis is approximately $15 - $30 per sample. You can find a list of PA certified labs at: http://blogs.dickinson.edu/marcellusmonitoring/files/2012/06/Pennsylvania-Accredited-Labs-for-Barium-and-Strontium.pdf. ALLARM has grant money available for certain groups to have this testing done for free. If you group qualifies for free analysis, ALLARM will send the water sample you submit for QA/QC to a PA certified lab for barium and strontium analysis. Once ALLARM receives the results, they will be forwarded to monitors. For more information about this or to see if you group is eligible for free analysis, contact ALLARM.

Incident Analysis

If you believe a chemical pollution incident has occurred (see chemical decision tree on page 37), you should collect a water sample and send the sample directly to a local certified lab for analysis. It's a good idea to find a local lab when you begin your monitoring program and explain what you are doing. They may offer you a discount on services (community program) or give you priority in running your sample, should a pollution event occur.

Appendix B1: Detailed directions for flow monitoring using stage

You will be taking a surrogate flow measurement every week when you go to your site to measure conductivity/TDS and to do a visual assessment. Be sure to enter the stream stage on the data sheet used for chemical monitoring (Appendix A1).

Choosing a stream reach

Choose an area around your site that has easy access and is wadable under most flow conditions. It is also best to choose a reach that is uniform in depth across the width of the stream; this is usually the case with reaches that are straight, rather than curved. If there is a bridge that crosses the stream in a convenient location, you can use OPTION A below.

Measuring stage

Choose from the three options for measuring stage below. To collect a useful set of data, you need to choose an option and stick with it for the duration of the collection period.

OPTION A. MEASURING THE DISTANCE TO THE WATER FROM A REFERENCE POINT ON A BRIDGE

If you are fortunate enough to have a bridge cross the stream reach of interest to you, then we strongly recommend this method, due to its ease of execution and accuracy. Choose a spot on the bridge (as close to mid-stream as possible) that you can identify and return to every week. If possible, you will want to mark that spot. Attach a weight to a tape measure and lower it over the side of the bridge until it just hits the top of the water. Record that distance, being sure to measure from your marked spot on the bridge to the water height.

This measurement will increase as the depth (and flow) of the stream decreases. Therefore, it will have the opposite relationship to conductivity/TDS than a stream stage or stream depth measurement. This will make no difference in terms of our intended use of these data for identifying patterns and outliers.   This method has the advantages of not having to wade into the stream and therefore being able to obtain accurate measures regardless of weather or flow conditions.

OPTION B. DIRECTLY MEASURING THE DEPTH OF THE STREAM

Choose a spot in the stream that you can identify and return to every week. Be sure that this location is covered by water, even during low flow conditions. Find some reference points (i.e. rocks, trees, etc.) that will help you locate the spot, even under different flow conditions. Return to that spot every week and measure depth. You should use a yard stick, or if you wish, you may purchase a gage stick (depth measuring rod) from ALLARM or even make your own! Appendix B1A describes how to make a gage stick.

If there is a significant change in the shape of the stream channel, perhaps due to a high flow event, then please note such on the datasheet. For example, if the spot where you are sampling undergoes some scouring, your depth measurements will not be directly comparable to the ones you took prior to the scouring event. However, it you note such on the data sheet, there are ways we can help you to adjust your data.

OPTION C. USING A MORE PERMANENT STAFF GAGE

There are several ways to install a more permanent gage stick or staff gage that will withstand varying flows and that you can use to read the depth of the creek every week.   You can pound a calibrated gage stick into the stream bed.   You can embed the staff in a heavy object, such as a tire filled with cement. If your site is near a bridge, you can attach a staff to one of the bridge piers, or even calibrate the pier directly.

This method has the advantage that you do not have to enter the creek each week. It does however require more work in construction, and staff gages are prone to be washed away in high flows, unless very securely affixed.

Appendix B1B is a blueprint for building your own staff gage, along with some advice on how to place it so it will remain stable in the creek.

Appendix B1A: Building a Gage Stick

Creating a gage stick is relatively simple and requires few tools. Items needed include:

- 4 ft. stick
- Tape measure, yard stick, etc.
- Sharpie permanent marker

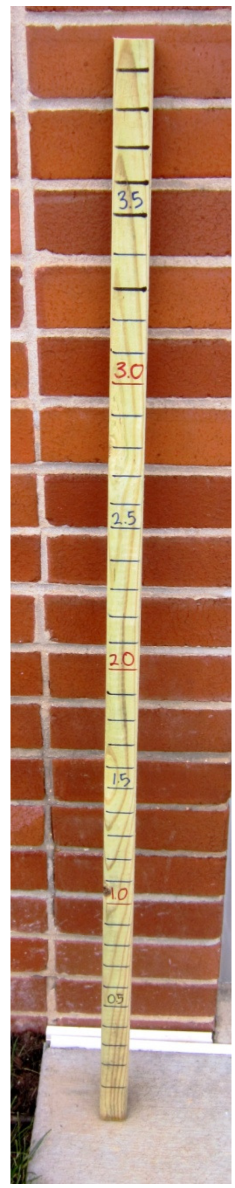
Step 1: Purchase the sticks

- ALLARM purchases the sticks directly from Lowe's. The sticks are found in the lumber department and the dimensions are labeled as 2" x 2" x 8'.

Item: 2 x 2 x 8 Treated #1 Pine

Item #: 204231

Model #: 228T125N



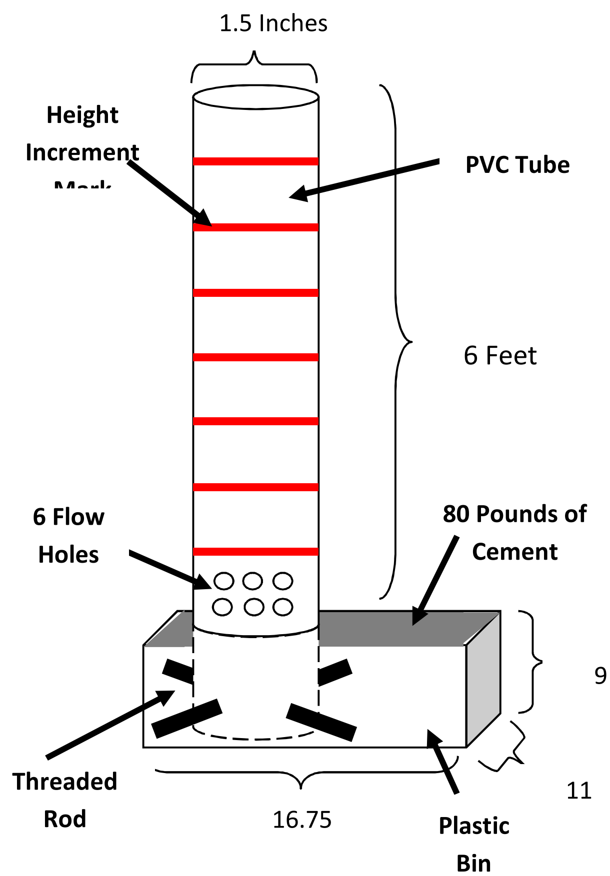
- You can make 2 gage sticks from each stick by having the people at Lowe's cut them in half. If you need 10 gage sticks for your group, grab a lumber cart, load five sticks on it, and meet an attendant at the cutting station in the lumber department. They will cut the rods in half for you.
- When you pay for the sticks, make sure you pay for the number of 8 ft. long sticks you purchased, NOT the number of gage sticks you will make.

Step 2: Create the gage sticks

- The easiest way to create the gage sticks is to make a template and use it to create the remaining ones.
- Using a tape measure, yard stick, etc. mark off the stick with tick marks and label the following measurements: 0.5 feet, 1.0 feet, 1.5 feet, 2.0 feet, 2.5 feet, 3.0 feet, 3.5 feet. ALLARM uses a Sharpie permanent marker so the writing does not come off or bleed in the water (*you may want to make your first gage stick using a pencil until you are sure the graduations are made correctly*).
- ALLARM makes tick marks at every 0.1 ft. This is very easy to do if you have a tape measure that is divided into 0.1 ft. measurements, but most tape measures do not have this feature. This can also be done by making a tick mark approximately every 1 $^{1/4}$ inches between the main measurements (i.e. 1.0 feet and 1.5 feet). *Making the graduations in 0.1 ft. intervals helps when multiplying the width and depth measurements.*
- Once you have one gage stick made, it is easy to line up multiple sticks to create the remaining gage sticks.

Appendix B1B: Building a Staff Gage

The following diagram shows a completed staff gage. This design was one of three designs developed by two students (Dylan Brown and Sam Parker, 2011[10]) at Dickinson College and tested during high flow conditions in a local stream. They consider it the best design.



1. Cut the 1.5-in PVC tube to a suitable length. Choose a length that is appropriate for the selected stream; making the pipe too long or too short could prove problematic. This can be done either by hand with a hacksaw or with an electric chop saw.

2. Cut two lengths of threaded rod. These rods will give the tube additional support and keep it in the cement. Again, choose appropriate lengths for the rods; they need to fit within the cement base while providing adequate support. This can be done with either a hacksaw or a band saw.

3. Drill four, evenly spaced holes around the bottom of the 3-in PVC tube. These holes should be drilled in pairs; the holes across from each other should be slightly higher than the other set. The holes should be large enough for the threaded rod to fit in but not so large that the nuts will fit through. A 9/16-in drill bit works well.

4. Slide the cut threaded rod into the holes and screw the bolts on. Center the threaded rod as best as possible. This is best done with a set of channel lock or adjustable wrenches.

5. Mix the cement. Read the directions on the bag of cement mix. Be sure to mix enough cement to fill the container; for the 11-in x 16.75-in plastic boxes, about 60-lb (3/4 of an 80-lb bag of mix) is required. This is best done in a wheel barrow or a large bucket with a shovel. If you can find a larger base container, the heavier, the better.

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[10] Brown, D and Parker, P. 2011. *Measuring stream stage with a permanent staff gage: study design for volunteers assessing Marcellus Shale impacts*, paper completed in fulfillment of requirements for ENST 310, Freshwater Ecology, Dickinson College, Carlisle, PA, April 17, 2011.

6. Place the 3-in PVC tube with the threaded rod into the container and add the cement mix. Allow the cement to set over night.

7. Drill a series of holes at the base of the pipe, both in the front and back. These holes allow water to flow through and around the gage. Six holes in the front and back works well.

8. Make marks every 2-in with a marker, starting from the top of the cement. Use an enamel paint to go over the lines; using a bright color such as red increases visibility. Allow to dry for a few hours.

9. Place the staff gage in the stream. Be sure to find a place to put the gage before carrying it out. The site should be a flat, level surface, preferably close to the deepest point of the stream. Move all rocks in the area prior to placement.

10. Once the gage is in place, use rocks or other large objects to ground the gage.

Item	Cost
Plastic container (11" x 16.75")	$4
80 lb. bag concrete	$3
PVC tube (3" x 10')	$10
Hex nut (3/8"), 4 needed	$2
Exterior paint/primer	$7
Stainless steel threaded rod (3/8" x 16")	$4
Total	$30

HELPFUL HINTS FROM DYLAN AND SAM:

- ✓ Install the prototype during the summer so the water is warmer and affords you more time to place the gage in the stream.
- ✓ Be sure to place the gage on a flat and level surface; clear out all of the rocks that are in your way and dig into the ground a little for added stability.
- ✓ If possible, increase the size of the base to increase stability and increase weight of the base by at least 20 pounds; our base weighed 60 pounds and we feel that an 80 pound base would offer the best combination of stability and portability.
- ✓ Stagger the lengths of the painted lines to better discern them; be sure to label all of the lines with measurements.
- ✓ Anchor the gage to multiple secure structures along either shore of the stream – e.g. trees, boulders, etc. – to further increase stability.

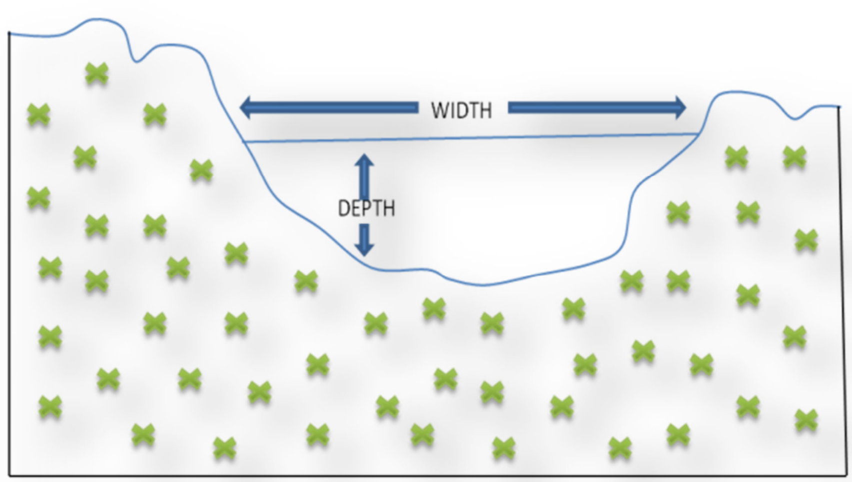
Appendix B2:

Detailed directions for flow monitoring using cross-sectional area[11]

You will be taking a surrogate flow measurement every week when you go to your site to measure conductivity/TDS and to do a visual assessment. You can purchase the materials needed to measure flow from ALLARM or you can construct your own. Be sure to enter the depth and the width on the data sheet used for chemical monitoring (Appendix A1).

1) **Choosing a stream reach:** Choose an area around your site that has easy access and is wadable under most flow conditions. It is also best to choose a reach that is uniform in depth across the width of the stream; this is usually the case with reaches that are straight, rather than curved.

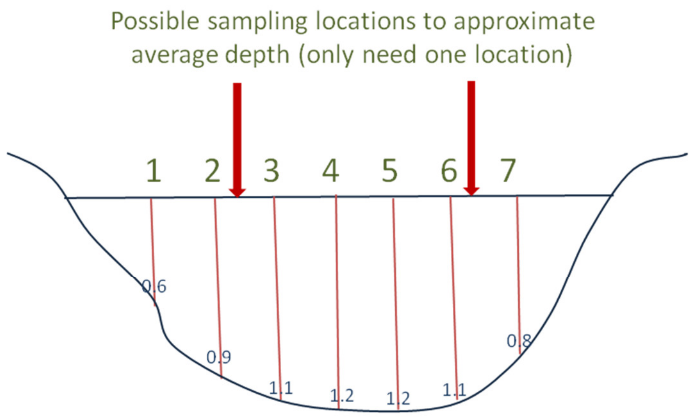
2) **Measuring width:** Stretch a measuring tape or string across the stream and measure the distance from one bank to the other, starting at the edge of the water and extending perpendicular to the direction of the stream channel to the edge of the water on the opposite bank. Read the measurement in feet. If the tape reads in feet and inches, convert the final number to the nearest tenth of a foot.



3) **Measuring depth:** The first time you go to your site, measure the depth at several locations across the transect that you have defined in your width measurement using your gage stick. You should space

[11] This protocol was used for training volunteers prior to June, 2012, and has since been replaced with the protocol for stage measurement (Appendices B, B1, B2). If you were trained prior to June 2012, please continue to use this protocol – it is scientifically sound, but just a bit more complicated and time-consuming than the stage protocol which we are now using. A training video which includes this protocol can be found at: http://www.youtube.com/watch?v=m0u3bmZoH8s&context=C48f715bADvjVQa1PpcFMpvzQEqgLtyQ-N65go2-uJ4D7rGrhRr54=

your measurements so that you end up with 5-10 separate depth measurements. Average these depths. See the diagrams below.



Location of depth measurement	Depth (ft)
1	0.6
2	0.9
3	1.1
4	1.2
5	1.2
6	1.1
7	0.8
Average	1.0

Now identify a spot in the stream along the same transect that is close to the average depth and that you can return to every week . From now on, all you need to do is take a single depth measurement at this location, as illustrated in the diagram above. To be sure you can return to the same spot each week, find some reference points (i.e. rocks, trees, etc.) that will help you locate the spot, even under different flow conditions. If you would prefer to continue to take multiple depths across the transect each week and average them, that would also be fine.

Appendix C: Visual Assessment Checklist[12]

Monitor Name: ____________________ Date: ______________________

Stream Name: _____________________ Site Coordinates: _________________

Observations for Gas Related Earth Disturbances

Streams:	Observed	N/A	Pipeline?	Photo Taken
Visual evidence of sediment entering stream, pond, or other body of water • Sediment plume • Discolored water • Increased sediment deposition on the stream bottom				
Access Roads:	**Observed**	**N/A**	**Pipeline?**	**Photo Taken**
Mud/sediment/drainage from access road travels to main road				
Mud/sediment/drainage from access road enters road ditch				
Access road not stabilized with clean substrate material (i.e. gravel)				
Access road crosses stream and drainage from road empties directly into stream				
Access road banks are not stabilized (no mulch, seeding, vegetation, etc.)				
Drill Pad, Storage Pond, Staging Areas:	**Observed**	**N/A**	**Pipeline?**	**Photo Taken**
Earth has been disturbed to edge of water body; there are no controls to stop or filter runoff				
Clean water enters the site from uphill with no diversion ditch				
Outlets of sediment control structures go directly into a water body without filtering or cleaning runoff				
Outlets of sediment control structures are not stabilized (no mulch, seeding, vegetation, etc.)				

Observations for Spills and Discharges

Streams:	Observed	N/A	Pipeline?	Photo Taken
Unusual odor in the water				
Discolored water (such as an oily film on the water surface)				
Persistent foam and/or bubbles (where there isn't normal agitation)				
Dead fish and/or other organisms in the water or along the bank				
Evidence of illegal dumping				

Observations for Gas Migration or Leakage

Streams:	Observed	N/A	Pipeline?	Photo Taken
Gas bubbling to surface				
Unusual odor (due to mercaptan compounds)				

Observation description: ____

____

____

Alliance for Aquatic Resource Monitoring 2012

[12] For a printable, electronic version of the checklist, go to the ALLARM Marcellus Shale Monitoring Toolkit: http://blogs.dickinson.edu/marcellusmonitoring/files/2012/02/Visual-Assessment-Checklist1.pdf . For a narrated PowerPoint presentation on the protocol for visual assessment, visit the ALLARM Marcellus Shale Monitoring Toolkit at: http://www.authorstream.com/Presentation/Marcellusmonitoring-1392386-visual-assessment/

Appendix D1: Decision Trees

TURNING DATA INTO ACTION

Making decisions on whether data are "actionable" is a complex process. The decision trees in this section are designed to help guide you through that process. There is a tree for chemical monitoring, visual assessment, and pipelines.

Below is a brief summary of the steps in our protocol for data collection, interpretation, and action. The decision trees are then found on the next pages.

STEP 1. COLLECTING BASELINE DATA. Collect baseline data for as long as possible. Each week, fill out the data sheets, examine them for any outliers or unusual values, and then send the data to your data manager for archiving and graphing.

The purpose of our baseline data is to determine the relationship between conductivity and flow and the natural seasonal fluctuations in conductivity and flow. Once these background relationships are established, it will be easier to determine if there is an impact from gas extraction activities.

STEP 2. COLLECTING WATCHDOG DATA. Once gas extraction activities begin, continue to collect weekly data as before. At this stage, the important thing is to examine each week's results very closely to ascertain whether or not there are any values that differ from what we would expect based on the baseline data.

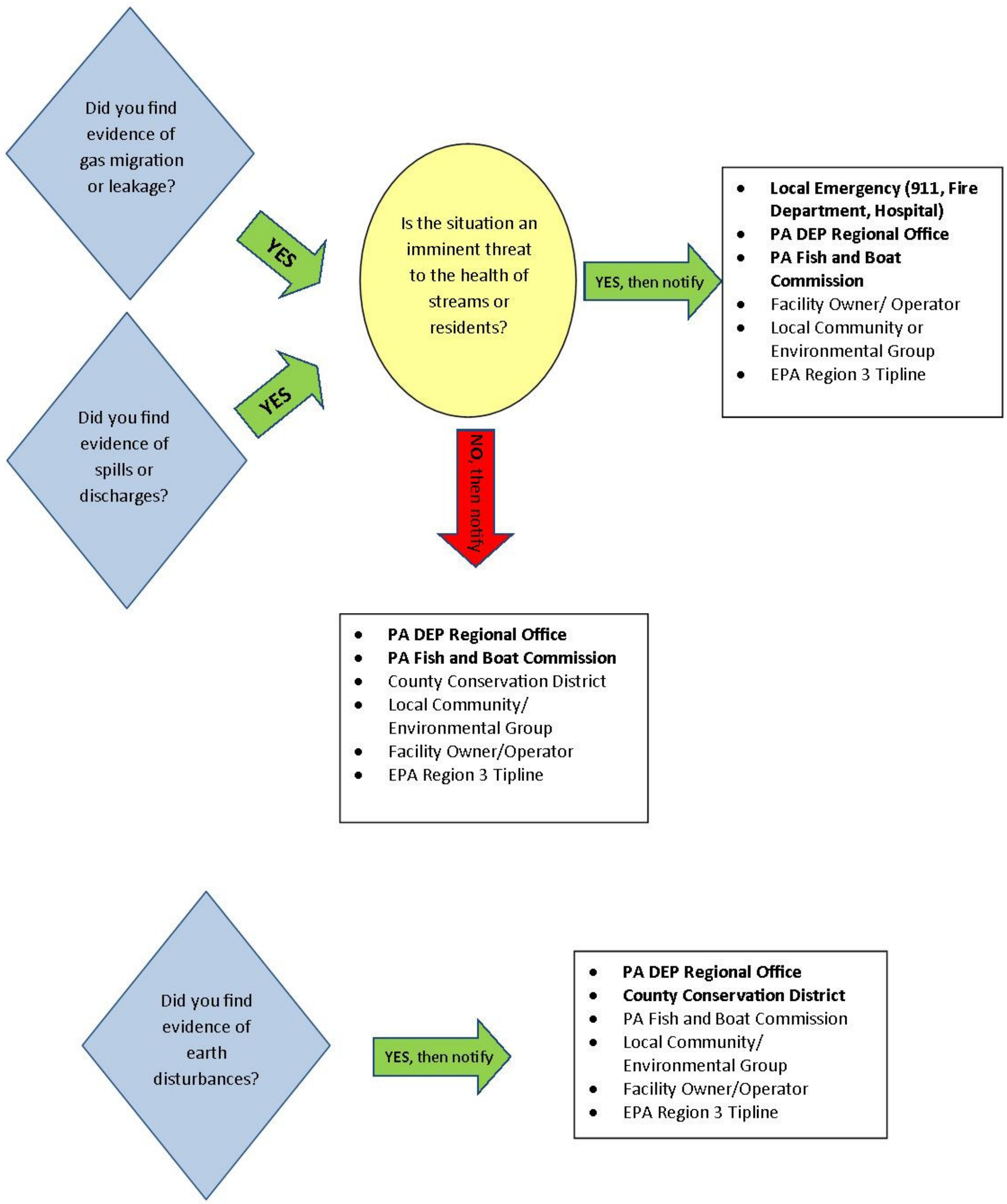
STEP 3. TAKING ACTION. If you find data that indicate there may be an impact, you need to determine if this event is reportable, and if so, to whom to report. Use the decision tree to help in this process.

Ultimately, you need to use your judgment on whether to report your findings or not. It is better to err on the side of caution but it is also important not to repeatedly "cry wolf." One of the advantages in working with groups and in partnership with local agencies is that you can consult them for advice on whether or not an event that you have observed is actionable.

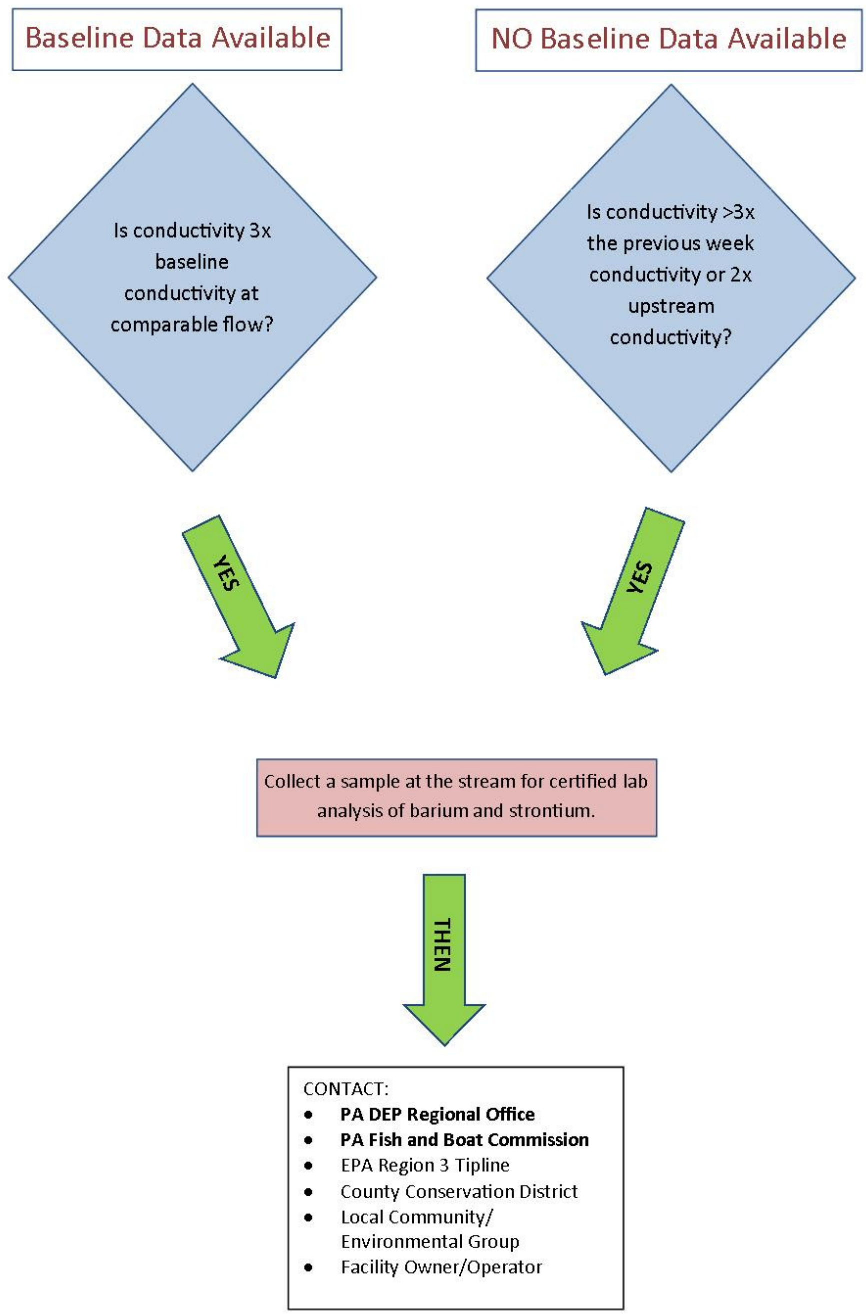
When you report an event, be sure to identify yourself as someone who has been monitoring the stream for gas extraction impacts and has been trained to do so by ALLARM at Dickinson College. Explain that ALLARM is providing quality control services to assure that your data are credible. Also explain that you have been collecting baseline data and are aware of what constitutes healthy conditions of the stream system. Do not be shy about your credentials or training.

STEP 4. ARCHIVING DATA. These data should also be sent to your data manager for archiving. Even if no actionable events occur (hopefully), the data can be graphed and utilized to increase our knowledge of stream conductivity/TDS and flow patterns – knowledge that ultimately should lead to better management practices.

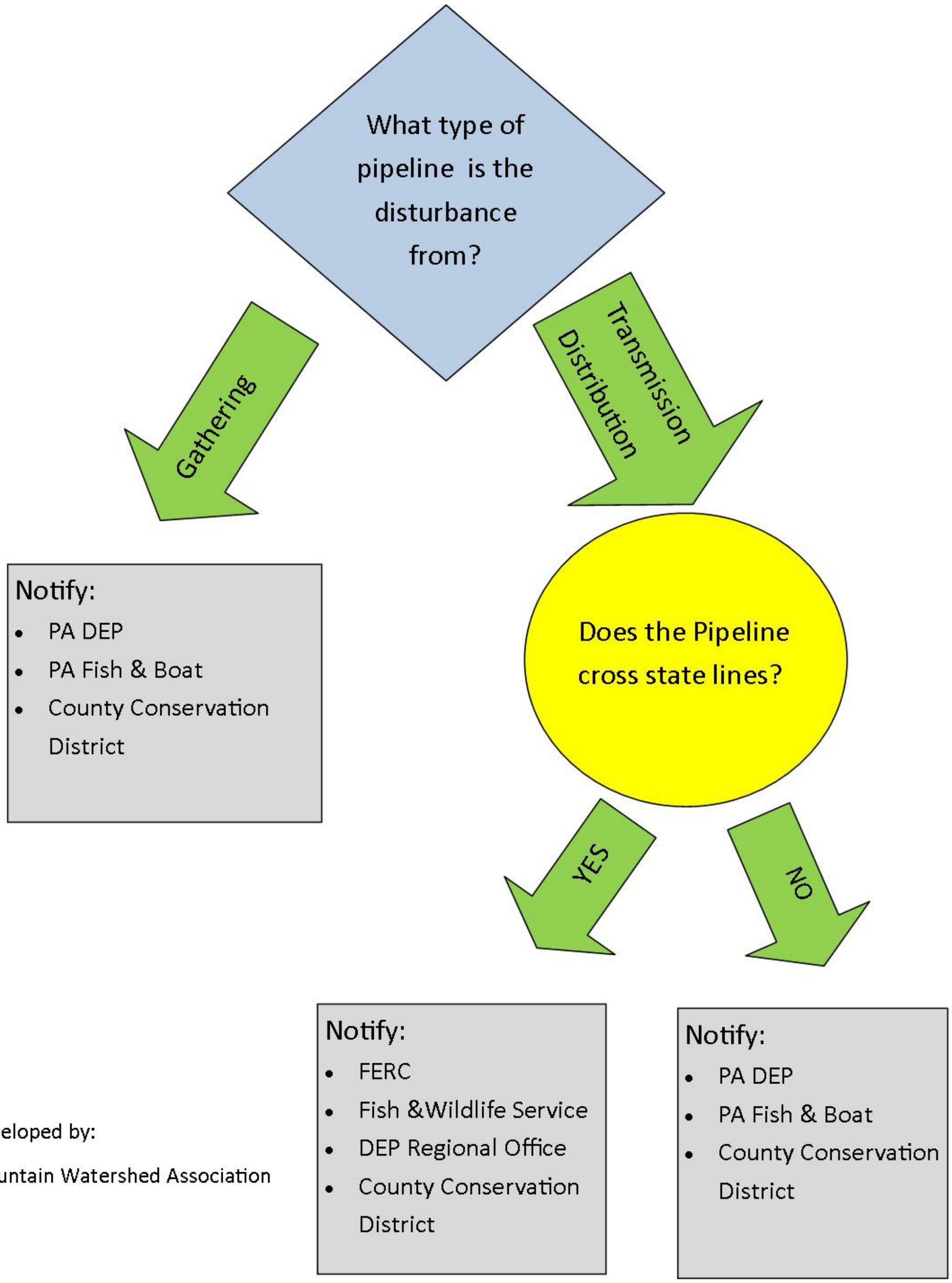
VISUAL ASSESSMENT DECISION TREE



CHEMICAL MONITORING DECISION TREE



PIPELINE DECISION TREE



Developed by:

Mountain Watershed Association

Appendix D2: Agency Contact Information

County	PA DEP Regional Office	PA Fish & Boat Regional Office	County Conservation District Office	PA Game Commission Regional Office
Adams	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Gettysburg, PA 717.334.0636	Southcentral Regional Office Huntingdon, PA 814.643.1831
Allegheny	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Pittsburgh, PA 412.241.7645	Southwest Regional Office Bolivar, PA 724.238.9523
Armstrong	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Kittanning, PA 724.548.3425	Southwest Regional Office Bolivar, PA 724.238.9523
Beaver	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Aliquippa, PA 724.378.1701	Southwest Regional Office Bolivar, PA 724.238.9523
Bedford	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Bedford, PA 814.623.8099	Southcentral Regional Office Huntingdon, PA 814.643.1831
Berks	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southeast Regional Office Lititz, PA 717.626.0228	Leesport, PA 610.372.4657	Southeast Regional Office Reading, PA 610.926.3136
Blair	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Hollidaysburg, PA 814.696.0877	Southcentral Regional Office Huntingdon, PA 814.643.1831
Bradford	Northcentral Regional Office Williamsport, PA 570.327.3636	Northeast Regional Office Sweet Valley, PA 570.477.5717	Towanda, PA 570.265.5539	Northeast Regional Office Dallas, PA 570.675.1143
Bucks	Southeast Regional Office Norristown, PA 484.250.5900	Southeast Regional Office Lititz, PA 717.626.0228	Doylestown, PA 215.345.7577	Southeast Regional Office Reading, PA 610.926.3136
Butler	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Butler, PA 724.285.5515	Northwest Regional Office Franklin, PA 814.432.3188
Cambria	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Ebensburg, PA 814.472.2120	Southwest Regional Office Bolivar, PA 724.238.9523

County	PA DEP Regional Office	PA Fish & Boat Regional Office	County Conservation District Office	PA Game Commission Regional Office
Cameron	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Emporium, PA 814.486.2244 x 5	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Carbon	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Lehighton, PA 610.377.4894 x 4	Northeast Regional Office Dallas, PA 570.675.1143
Centre	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Bellefonte, PA 814.355.6817	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Chester	Southeast Regional Office Norristown, PA 484.250.5900	Southeast Regional Office Lititz, PA 717.626.0228	Kennett Square, PA 610.925.4920	Southeast Regional Office Reading, PA 610.926.3136
Clarion	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Clarion, PA 814.226.4070	Northwest Regional Office Franklin, PA 814.432.3188
Clearfield	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Clearfield, PA 814.765.2629	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Clinton	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Mill Hall, PA 570.726.3798	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Columbia	Northcentral Regional Office Williamsport, PA 570.327.3636	Northeast Regional Office Sweet Valley, PA 570.477.5717	Bloomsburg, PA 570.784.1310	Northeast Regional Office Dallas, PA 570.675.1143
Crawford	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Meadville, PA 814.763.5269	Northwest Regional Office Franklin, PA 814.432.3188
Cumberland	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Carlisle, PA 717.240.7812	Southcentral Regional Office Huntingdon, PA 814.643.1831
Dauphin	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Dauphin, PA 717.921.8100	Southeast Regional Office Reading, PA 610.926.3136
Delaware	Southeast Regional Office Norristown, PA 484.250.5900	Southeast Regional Office Lititz, PA 717.626.0228	Media, PA 610.892.9484	Southeast Regional Office Reading, PA 610.926.3136

County	PA DEP Regional Office	PA Fish & Boat Regional Office	County Conservation District Office	PA Game Commission Regional Office
Elk	Northwest Regional Office Meadville, PA 814.332.6945	Northcentral Regional Office Bellefonte, PA 814.359.5250	Ridgway, PA 814.776.5373	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Erie	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Erie, PA 814.825.6403	Northwest Regional Office Franklin, PA 814.432.3188
Fayette	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Lemont Furnace, PA 724.438.4497	Southwest Regional Office Bolivar, PA 724.238.9523
Forest	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Tionesta, PA 814.755.3450	Northwest Regional Office Franklin, PA 814.432.3188
Franklin	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Chambersburg, PA 717.264.5499	Southcentral Regional Office Huntingdon, PA 814.643.1831
Fulton	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	McConnellsburg, PA 717.485.3547	Southcentral Regional Office Huntingdon, PA 814.643.1831
Greene	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Waynesburg, PA 724.852.5278	Southwest Regional Office Bolivar, PA 724.238.9523
Huntingdon	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Huntingdon, PA 814.627.1627	Southcentral Regional Office Huntingdon, PA 814.643.1831
Indiana	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Indiana, PA 724.471.4751	Southwest Regional Office Bolivar, PA 724.238.9523
Jefferson	Northwest Regional Office Meadville, PA 814.332.6945	Northcentral Regional Office Bellefonte, PA 814.359.5250	Brookville, PA 814.849.7463	Northwest Regional Office Franklin, PA 814.432.3188
Juniata	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Mifflintown, PA 717.436.8953	Southcentral Regional Office Huntingdon, PA 814.643.1831
Lackawanna	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Mayfield, PA 570.281.9495	Northeast Regional Office Dallas, PA 570.675.1143

County	PA DEP Regional Office	PA Fish & Boat Regional Office	County Conservation District Office	PA Game Commission Regional Office
Lancaster	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southeast Regional Office Lititz, PA 717.626.0228	Lancaster, PA 717.299.5361	Southeast Regional Office Reading, PA 610.926.3136
Lawrence	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	New Castle, PA 724.652.4512	Northwest Regional Office Franklin, PA 814.432.3188
Lebanon	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Lebanon, PA 717.272.3908 x 4	Southeast Regional Office Reading, PA 610.926.3136
Lehigh	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Southeast Regional Office Lititz, PA 717.626.0228	Allentown, PA 610.391.9583	Southeast Regional Office Reading, PA 610.926.3136
Luzerne	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Shavertown, PA 570.674.7991	Northeast Regional Office Dallas, PA 570.675.1143
Lycoming	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Montoursville, PA 570.433.3003	Northcentral Regional Office Jersey Shore, PA 570.398.4744
McKean	Northwest Regional Office Meadville, PA 814.332.6945	Northcentral Regional Office Bellefonte, PA 814.359.5250	Smethport, PA 814.887.4001	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Mercer	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Mercer, PA 724.662.2242	Northwest Regional Office Franklin, PA 814.432.3188
Mifflin	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	Burnham, PA 717.248.4695	Southcentral Regional Office Huntingdon, PA 814.643.1831
Monroe	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Stroudsburg, PA 570.629.3060	Northeast Regional Office Dallas, PA 570.675.1143
Montgomery	Southeast Regional Office Norristown, PA 484.250.5900	Southeast Regional Office Lititz, PA 717.626.0228	Collegeville, PA 610.489.4506	Southeast Regional Office Reading, PA 610.926.3136
Montour	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Danville, PA 570.271.1140	Northeast Regional Office Dallas, PA 570.675.1143

County	PA DEP Regional Office	PA Fish & Boat Regional Office	County Conservation District Office	PA Game Commission Regional Office
Northampton	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Southeast Regional Office Lititz, PA 717.626.0228	Nazareth, PA 610.746.1971	Southeast Regional Office Reading, PA 610.926.3136
Northumberland	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Sunbury, PA 571.286.7114 x 4	Northeast Regional Office Dallas, PA 570.675.1143
Perry	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	New Bloomfield, PA 717.582.8988 x 4	Southcentral Regional Office Huntingdon, PA 814.643.1831
Philadelphia	Southeast Regional Office Norristown, PA 484.250.5900	Southeast Regional Office Lititz, PA 717.626.0228	Philadelphia County does not have a County Conservation District	Southeast Regional Office Reading, PA 610.926.3136
Pike	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Hawley, PA 570.226.8220	Northeast Regional Office Dallas, PA 570.675.1143
Potter	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Coudersport, PA 814.274.8411 x 4	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Schuylkill	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Southeast Regional Office Lititz, PA 717.626.0228	Pottsville, PA 570.622.3742 x 5	Southeast Regional Office Reading, PA 610.926.3136
Snyder	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Middleburg, PA 570.837.3000	Southcentral Regional Office Huntingdon, PA 814.643.1831
Somerset	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Somerset, PA 814.445.4652 x 5	Southwest Regional Office Bolivar, PA 724.238.9523
Sullivan	Northcentral Regional Office Williamsport, PA 570.327.3636	Northeast Regional Office Sweet Valley, PA 570.477.5717	Dushore, PA 570.928.7057	Northeast Regional Office Dallas, PA 570.675.1143
Susquehanna	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Montrose, PA 570.278.4600 x 280	Northeast Regional Office Dallas, PA 570.675.1143
Tioga	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Wellsboro, PA 570.724.1801 x 5	Northcentral Regional Office Jersey Shore, PA 570.398.4744

County	PA DEP Regional Office	PA Fish & Boat Regional Office	County Conservation District Office	PA Game Commission Regional Office
Union	Northcentral Regional Office Williamsport, PA 570.327.3636	Northcentral Regional Office Bellefonte, PA 814.359.5250	Lewisburg, PA 570.524.3860	Northcentral Regional Office Jersey Shore, PA 570.398.4744
Venango	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Franklin, PA 814.676.2832	Northwest Regional Office Franklin, PA 814.432.3188
Warren	Northwest Regional Office Meadville, PA 814.332.6945	Northwest Regional Office Meadville, PA 814.337.0444	Warren, PA 814.726.1441	Northwest Regional Office Franklin, PA 814.432.3188
Washington	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Washington, PA 724.228.6774	Southwest Regional Office Bolivar, PA 724.238.9523
Wayne	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Honesdale, PA 570.253.0930	Northeast Regional Office Dallas, PA 570.675.1143
Westmoreland	Southwest Regional Office Pittsburgh, PA 412.442.4000	Southwest Regional Office Somerset, PA 814.445.8974	Greensburg, PA 724.837.5271	Southwest Regional Office Bolivar, PA 724.238.9523
Wyoming	Northeast Regional Office Wilkes-Barre, PA 570.826.2511	Northeast Regional Office Sweet Valley, PA 570.477.5717	Tunkhannock, PA 570.836.2589	Northeast Regional Office Dallas, PA 570.675.1143
York	Southcentral Regional Office Harrisburg, PA 717.705.4700	Southcentral Regional Office Newville, PA 717.486.7087	York, PA 717.840.7430	Southeast Regional Office Reading, PA 610.926.3136

EPA Region III Marcellus Shale Natural Gas Drilling Tipline

Phone: 1.877.919.4372
Email: eyesondrilling@epa.gov

You can provide tips anonymously if you do not want to identify yourself.

Pennsylvania DCNR Forestry Offices

State Forest	Office Location	Telephone Number
Bald Eagle	Milmont	570.922.3344
Buchanan	McConnellsburg	717.485.3248
Clear Creek	Clarion	814.226.1901
Cornplanter	North Warren	814.723.0262
Delaware	Swiftwater	570.895.4000
Elk	Emporium	814.486.3353
Forbes	Laughlintown	724.238.1200
Gallitzin	Ebensburg	814.472.1862
Lackawanna	Scranton	570.963.4561
Loyalsock	Dushore	570.946.4049
Michaux	Fayetteville	717.352.2211
Moshannon	Penfield	814.765.0821
Rothrock	Huntingdon	814.643.2340
Sproul	Renovo	570.923.6011
Susquehannock	Coudersport	814.272.3600
Tiadaghton	South Williamsport	570.327.3450
Tioga	Wellsboro	570.724.2868
Tuscarora	Blain	717.536.3191
Weiser	Cressona	570.385.7800
William Penn	Elverson	610.582.9660