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Marcellus Matters EASE: Marcellus Community Science Volunteers

Formative Evaluation Report

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Background

Marcellus Matters: EASE

Marcellus Matters: EASE (Engaging Adults in Science and Energy) is a program of Penn State University's Marcellus Center for Outreach and Research (MCOR) in collaboration with other experts across the university. The first year of program activities took place in 2012 in communities located in central Pennsylvania and the Marcellus shale gas play.

In the short term, EASE is designed to add to local knowledge using four different program approaches with the goal of increasing rural adults' science and energy literacy and encouraging science-informed community deliberations; the present report addresses one of the four program activities. The project states five overall goals:

1. Participants will increase their knowledge of science and engineering related to energy consumption, production, and policy;
2. Participants will build a shared knowledge base on science and energy to empower rural communities in making decisions and managing change;
3. Participants will apply the skills of scientific inquiry and investigation by engaging in "community" or "citizen" science;
4. Participants will learn effective strategies for deliberation of complex environmental issues;
5. A model of community engagement and capacity building in science and energy will be created.

The first four goals are constructed into the four activities of the program and the fifth is an overall summation of the program approach.

Penn State Marcellus Community Science Volunteer Program

A pilot cohort of 25 individuals participated in this portion of the program in June and July of 2012. Eight weekly sessions, mostly classroom-based, addressed a series of topics relevant to Marcellus shale, gas drilling, and related science concepts and/or community issues. (A list of session topics appears below.) In addition to formative evaluation instruments administered at the session level, the pilot cycle of this program was also evaluated using a set of final items that asked participants to reflect on the program as a whole. Although this instrument was used at the end of the cycle and some of these items directly addressed the intended outcomes of the program, it should not be considered a true summative evaluation due to the pilot / non-final nature of this program cycle.

After completing the classroom sessions, participants will also participate in citizen science activities such as assisting with ongoing Marcellus- or gas drilling-related research in their area. However, that additional activity is beyond the scope of the present study.

As this is the most contact intensive activity of EASE, it is in this effort where the most significant impact on individuals is possible. To that end, those participants who participate in the multi-week training and subsequent hours of volunteer service should have the greatest stake in the outcomes of the program of all participants across the activities.

The session topics were addressed in the following order:

- Week 1: Nature of science/scientific process & skills (“think like a scientist”)
- Week 2: Geology of Marcellus shale, engineering (part I), chemistry of hydrocarbons
- Week 3: Community issues and impacts (gas drilling-related), critical media skills
- Week 4: Engineering (part II)
- Week 5: Hydrology and water testing
- Week 6: Land use planning
- Week 7: Energy choices
- Week 8: Economic and workforce development, “constructive conversation” dialogue skills

Evaluation Questions:

The formative evaluation of the Community Science Volunteer activity served to identify the most successful elements of the activity, relative to the content they addressed, in order to inform final program and curriculum design for subsequent iterations of this activity. A summative evaluation of the activity will follow with subsequent cohorts, including a set of post- and delayed post measures beginning in the fall of 2012; the instruments for that evaluation were developed alongside formative-stage instruments and revised based on findings from the formative evaluation.

Two key questions, then, were at the center of this formative evaluation:

1. To what extent is the program effective at cultivating...
 - Participants’ knowledge of gas drilling-related science content?
 - Participants’ self-perceived knowledge / expertise on gas drilling-related issues?
 - Participants’ informal use and/or sharing of new gas drilling-related information in their communities?
2. Which of the program sessions’ structures (i.e., written materials, lecture, hands-on activity, discussion, large vs. small group work, etc.) do participants find most effective at conveying the various topics of the program?

Methods

The formative evaluation was a census study of all participants in the pilot cohort. Four different questionnaires were distributed to participants¹ at different times in relation to each of the activity’s eight sessions:

- pre-session items addressed the structure of written overview materials that were distributed for each session topic;
- post-session items about a session’s effectiveness were completed immediately following each session; and

¹ Due to weekly variation in instructors and other factors, all four questionnaires were not necessarily distributed at each session. The instruments used in each session are noted in the Findings section below.

- a “reflective worksheet,” distributed for completion between one session and the next, asked participants to recall main ideas of the previous session after a short delay;² and
- a post-program questionnaire rated the success of the program at developing specific content knowledge and skill sets.

Each of the instruments was generated in paper-and-pencil form, and then distributed and collected by EASE program staff. Completed questionnaires were scanned and forwarded to the evaluation team for analysis. Open-ended items from all three instruments were categorized to facilitate some quantitative analysis (e.g., were participants’ pre-session and post-session questions similar to or different from one another). Responses were then coded using emergent categories; where applicable, these coded items were analyzed alongside parallel quantitative items using SPSS. Individual responses to items were mainly analyzed in aggregate across each session.

A post-program questionnaire was also used to solicit participants’ reactions to the program as a whole. This instrument was distributed by mail to a census of the pilot cohort of 25; 22 completed responses were received for a response rate of 88%. A series of rating scales were co-developed with the program team to reflect the eight sessions’ effectiveness at conveying specific knowledge and skill outcomes. Open-ended items about interesting and important program topics were included to explore which topics, if any, were particularly engaging. These items were coded by identifying in a series of dichotomous variables the program session(s), from 1 to 8, where named topics occurred. Two other open-ended items which asked for participant suggestions to change or improve the program were added to provide respondents with opportunities for more concrete critique; these were analyzed and described based on trends which emerged from the data. All quantitative data was analyzed using SPSS.

Findings

This formative study only partially addressed the evaluation questions that pertain to the activity’s intended outcomes; instead it focused mostly on describing the structural effectiveness of the Community Science Volunteer Program: which session topics, activities, and structures the participants found most relevant and/or useful for their learning. In the session-specific portions of this evaluation, the following items (and the instruments on which they appeared) were used to address these different kinds of effectiveness:

- Whether each session was seen as being too simple or too complex (*pre- and post-session*)
- What content-related questions may have been unanswered in each session (*pre- and post-session*)
- What other information, if any, participants wished to see in each session (*pre- and post-session*)
- The extent to which particular activities (e.g. lectures or group discussion) were viewed as helpful (*post-session*)
- Whether participants found any elements of each session as particularly effective, ineffective, or as things they would change about the program (*post-session*)

² For some sessions, the “reflective worksheet” also asked about participants’ use of the previous session’s content, while in others “use” was the topic of an in-session group discussion.

- What participants viewed as the “big ideas” of each session, and of the program overall (*reflection*)
- Which topics or activities, if any, were particularly memorable for or familiar to participants (*reflection*)
- Whether particular descriptions (e.g. “relevant,” “boring,” etc.) evoked particular reactions about or memories of the program for participants (*reflection*)
- Whether and how participants used (or could imagine using) content from the program in their everyday lives (*reflection*).

In order to facilitate use for program development, findings related to each of these items are provided here and divided into responses about each of the eight program sessions. The findings presented here have been assembled to provide a session- and program-level view of the Community Science Volunteer Program’s successes and areas for improvement. An appendix (under separate cover) which includes tables of responses to all open-ended items will be an additional, more “fine grain” tool to support curriculum development and revision in future cycles of the program. This appendix can serve as a reference document for more detailed analysis – for instance, looking for common phrasing or differences in participant understanding of concepts across sessions – that is not addressed in this report.

Some trends across sessions

Across all sessions where data were collected, a strong majority of participants reported that both the program sessions (143 of 160 responses, or 92%) and pre-session overview (52 of 61, 85%) materials were “about right” in terms of complexity. Comments describing both “too simple” and “to complex” responses tended to focus on the amount of detail in the session or materials, often noting missing nuance or an abundance of technical language. (See the separate appendix of tables for complete listings of related comments for each questionnaire item.)

Participants were asked what seemed to be “missing” from pre-session overview materials for sessions 2, 4, and 6/7; several relatively consistent patterns emerged across the three sets of responses. In each case, at least ten participants made comments for this item, indicating substantial demand for “more” in general. In the two earlier sessions, but not the later ones, respondents named “missing” information that would appear later in the program. (The fourth session in particular seemed to generate interest in topics that were only addressed in subsequent weeks.) Comments that were related to the topics of the respective sessions, in addition to expressing an interest in greater depth or breadth of information, often called for greater relevance and concreteness of the sessions. They ranged from an interest in Marcellus- or Clearfield County-specific study data to an interest in more detail-oriented resources so participants knew “how and what we can do” to be informed citizens about drilling regulations and landowners’ rights. The spirit of these comments reappeared in responses that showed interest in more content at the end of each session, and are elaborated upon below.

A handful of respondents – one each in sessions 1, 2, 6/7, and 8, and two in session 4 – also reported that there should be less information in the sessions. In general, these comments reflected a view that there was not enough time to cover the content presented in each session. One participant each said that geology in session 2, “measuring Marcellus shale” in session 4, and the energy chart in session 7 all deserved less attention. However, two of these three topics also

garnered requests for *more* time and attention. One participant felt they would not have occasion to use the conversation skills learned in session 8.

Session 1: “Think like a Scientist”

The first session’s topic was “Think like a scientist.” Data were collected about this session using a post-session questionnaire.

Twenty participants (87%) felt this session had a good level of complexity, while three (13%) felt it was too complex. Those who felt it was “about right” noted that the session’s content was understandable yet included new information and skills. They also made positive mention of the topic’s relevance to Marcellus-related issues and viewed in-session discussion and the visual presentation of content (as with the card activity) as helpful learning tools.

Pre-session questions in the first session reveal more about participants’ expectations of the program than anything else. Several expressed surprise at the topic or questioned its relevance to Marcellus Shale. Others illustrated participants’ own goals and agendas – about how drilling and its regulation and oversight work, or simple “what do I need to be concerned about Marcellus activity?” Post-session questions, on the other hand, showed an incorporation of session content. Several focused on where and how to find the kind of objective information they were exposed to in the session. These questions were framed as both “who can we trust” in general and “how to find unbiased information on Marcellus Shale” in particular. Overall, there were very few questions reported around this session – six of 23 (26% of participants) pre-session, eight of 23 (35% post-session) – which suggests the newness of the topic for participants.

When participants were asked which topics from session 1 needed to receive more attention, several pointed to specific topics within the session, particularly correlation versus causation and interpreting graphs and charts. Other respondents noted that the information they wanted was “not from this evening’s topics,” suggesting both a certain degree of patience with the multi-week program and that science process skills were not a primary motivator of program participation.

Participants were asked to rate their agreement (on a seven-point scale) with a series of statements about the effectiveness of different elements of each session. In session 1, respondents (n=23) were asked if the session’s hands-on activities helped them understand the session topic(s). Agreement with this item was moderately strong, with a mean rating of 5.52 (SD=1.377). They rated a statement about whether they had enough time to complete the session’s activities more strongly (6.04, SD 1.364).

When asked to suggest changes to session 1, participants generally responded with concrete ideas. Several requested a glossary of key vocabulary (a request that appeared in other sessions as well), and others wished for better presentation skills (greater clarity, volume, organization, and classroom or discussion management) from the instructors.

Session 2: Geology, Hydrocarbons, and Engineering Part I

The second session’s topics were geology, hydrocarbons and engineering (part I). Data were collected about this session using pre- and post-session questionnaires and a reflective worksheet.

Four of 19 respondents (21%) felt that this session's overview materials were too complicated, while one of 22 (5%) felt that the session was too simple; the remainder felt that both were "about right" in terms of complexity. As in the previous week, respondents said they found the content interesting, new, and relevant. The pre-session overview in particular was described as having just the right amount of detail. Participants' comments were also strongly supportive of the visual and hands-on nature of this session; several made specific mention of how hydrocarbon models were helpful. As one individual put it "chemistry, by far my weakest subject in school, was much easier to understand with the hands on."

Participants reported questions mostly about understanding risk, the earth's layers and how Marcellus Shale was formed, seismicity as a drilling-related hazard, and other risks related to water use. Post-overview and pre-session questions were similarly focused, with slightly more interest in what can be done to manage those risks. Retrospective pre-session questions were mostly about technical details of well engineering, with some still focused on hazards. Post-session questions also focused on these details, but risk-related questions were more concrete: wondering what will happen at a local plant, for example, or how to make the drilling process more energy efficient. The number of questions did not diminish dramatically between pre- and post- items (15 of 19 pre-overview, 79%; 12 of 19 post-overview, 63%; 13 of 23 pre-session, 56%; 14 of 23 post-session, 61%). However, only two participants reported questions that were unanswered by the session (i.e., the pre- and post-session questions they named were the same).

In the second session, participants reported an interest in more of nearly everything. Some suggested dividing the session into two or even three separate sessions in order to make more time for more detail in each, but particularly for the engineering and geology materials. Requests for "more" were mostly focused on additional content, though some also described a need for more time with the existing content. Most of the desired information participants described appeared in later weeks; this is a testament to the strength of the program's curriculum, but also suggests an opportunity to better manage participant expectations about when topics will be addressed.

Participants were asked to rate their agreement with a series of statements about the effectiveness of different elements of each session. In session 2 (n=23), the "enough time" item received a mean rating of 5.30 (SD 1.259), and the "hands-on activities" statement was rated 5.64 (\bar{x} =SD 1.620). Respondents were asked similar questions about the effectiveness of other session structures: small group work (\bar{x} =5.70, SD 1.363), the pre-session overview materials (\bar{x} =5.87, SD 1.058), instructor presentations (\bar{x} =6.00, SD 1.049), group discussions (\bar{x} =6.05, SD 0.999), and the session's effectiveness in general (\bar{x} =6.14, SD 0.889). Ratings of six or more and low deviations suggest both strong agreement by individuals and strong consensus within the group.

The aspect of this session reported as being most effective was its variety. Most respondents names multiple parts of the session as "working well," suggesting that they combined powerfully. Geology samples, hydrocarbon model building, power point slides on engineering, and discussion or question-and-answer were all specifically noted by one or more participants. When asked about things that did not work well, most comments had to do with a need for more time: for explanation, discussion, or complexity around the various session topics. This demand was echoed in suggested session changes, where interest more time and more information were also noted. Providing additional print resources (again, including a glossary) was offered as one possible solution to this demand for detail; another also felt that the "model hydrocarbons" activity could have been better contextualized within a broader discussion of fuels.

In the days following session 2, participants were asked to articulate what they felt were the “big ideas” of both the session and the program overall. For the program overall, named ideas tended to reflect the main topics of the sessions conducted prior to respondents’ completion of the questionnaire; however, a majority of “big ideas” listed (36 of 54, or 67%) provided more specific topics or elaboration beyond naming session or topic titles. Thirty-one named ideas came from session 2, while 22 others were from session 1 – suggesting some recollection from one week to the next. See Table 6 below, on page 20, for details of which session’s content was considered a “big idea” in each session’s reflection worksheet.

Session-focused “big ideas” were similarly detailed, and most divided evenly among references to the three main topics of geology, well engineering, and hydrocarbons. (Of 54 named ideas 35, or 65%, were more specific than the names of the key topics.) About half as many comments as each of these groups referred more specifically to well or drilling safety and risk management ideas.

Most of the memorable (or “sticky”) ideas participants recalled after session 2 were from this session. References to the session topics – geology, engineering, and hydrocarbons – were about equally common. Somewhat more common were specific references to two things from the session, the hydrocarbon model-building activity and rock “stretching” demonstration. A few other comments related to the scientific thinking addressed in session 1, while still others mentioned the safety of the drilling process.

Participants reported some familiarity with the session’s topics. Eleven of 17 (65%) wrote about having some degree of familiarity with well or drilling engineering (seven mentions), chemistry or hydrocarbons (seven mentions), and/or geology (eight mentions). Sources of this prior knowledge included school or college, other adult education opportunities, hobbies or contact with other organizations, and public broadcasting. Despite naming these information sources, participants rated their own expertise at only 2.93 on a seven-point scale (SD 1.141) – indicating less confidence than their other comments might suggest.

To identify any parts of the session that may have generated particularly strong reactions, participants were asked to respond to a set of “reflection words” by describing what, if anything, each word evoked from their memory of this session. The table below summarizes these reactions and how often they were mentioned in this item.

Session 3: Community Impacts

The third session’s topic was “Community impacts.” Data were collected about this session using a post-session questionnaire and a reflective worksheet.

One of 24 participants (4%) felt that this session was too simple overall, while the remainder found it “about right.” The comments elaborating on this description most strongly suggest that group discussion and question-and-answer opportunities made the session particularly understandable and informative. Other participants described the session as being thought provoking or relevant.

Participants’ pre-session questions focused on session content and especially its relevance and reliability. Some wanted to know more specifically *what* the impacts of an event like gas drilling might be, and others wanted locally specific information on perceptions. Another wanted to know *how* various “community impacts” happen. Several, perhaps using new skills from session 1, wondered what affected the collection and validity of the data or studies in the session materials.

Post-session questions continued this healthy skepticism (“can we ever get the proper information from socially related data?”), which may have implications for the design of the first session. Participants were also curious about the landscape of social science research around Marcellus Shale, asking what studies were being conducted and for more specific data on negative impacts. Again, there were relatively few questions, 10 of 24 pre-session (24%) and six of 24 post-session (25%), and only two “unanswered” questions.

Table 1. Session 2 content described as evoking ten “reaction words”

Words	Session elements described
Important	Safety or protection (4), well construction / engineering (3), everything (3), geology (2), distinguishing fact from opinion (2), hydrocarbons (1), the need for natural gas use (1)
Confusing	Scientific thinking (3), hydrocarbons / chemistry (2), engineering (1), news reports and publications (1), “to dig or not to dig” (1)
Unnecessary	Learning about molecular structures (1), acknowledgement of controversy (1)
Interesting	Geology (5), drilling / engineering (4), everything (3), hydrocarbons – models and/or burning (3), seismicity (1), scientific thinking (1), economics of gas development (1), balanced presentations (1)
Boring	None (2), chemistry – did not see relevance (1), hydrocarbons – did not understand (1), hydrocarbons – wanted more depth (1)
Relevant	Everything / science / interconnection of topics (7), geology (6), drilling / construction / engineering (5), drilling impacts and safety (3), seismicity (1)
Familiar	Drilling / fracturing / construction (4), geology / wet vs. dry gas (2), everything (2), impacts of gas development (1), scientific thinking (1), “hidden agendas by special interests” (1)
Unfamiliar	Drilling / fracturing / construction (4), well construction (3), hydrocarbons (2), geology (1), wet vs. dry gas (1), scientific thinking (1), everything (1), impacts of gas development (1)
Oversimplified	Seismicity (1), hydrocarbons (1)
Valuable	Drilling information (5), everything (4), geology (3), session activities (2), seismicity (1), acquiring natural gas / energy independence (1), “ideas & testing” (1)

Demand for more attention in the third session, while lower than in other sessions, tended to focus on finding the right scope for addressing “community impacts.” One individual mentioned an interest in seeing locally relevant data on the session’s topics (rather than non-Pennsylvania cases?), while another wished to broaden the discussion of “institutional trust” to include a wider range of actors on drilling-related issues. Two others had suggestions related to the program’s balance between limited time and thorough information: pointing participants toward additional out-of-class resources (especially online) and more actively managing questions and discussion (or planning more time for them) so that they do not limit time for lectures or other structured activities.

Participants were asked to rate their agreement with a series of statements about the effectiveness of different elements of each session. In session 3 (n=24), most statements garnered moderate to strong agreement, with means ranging from 5.67 (for hands-on activities) to 6.04 (group discussions) and deviations between 0.7 and 1.3. The item about this session’s overview materials, however, had much weaker agreement (\bar{x} =4.50, SD 1.504), which suggests an area for improvement in the program.

Overall, participants reported that group discussion was the part of session 3 that worked best. Some also made comments about the value of knowing “what was going on” in communities – in terms of both impacts or change and the research being done to identify them. Lack of time was once again named as the primary thing that did not work about the session. Participants’ suggested changes expanded upon this demand a bit: comments focused on the need for more specific data, more local relevance (particularly when considering research studies based in non-Pennsylvania communities), and more discussion of boom-and-bust cycles. They also expressed interest in reading more in-class material in advance and limiting time for open (or tangential) questions, in order to create more time for discussion and detail.

In the days following session 3, participants were asked to articulate what they felt were the “big ideas” of both the session and the program overall. For the program overall, named ideas tended to reflect the main topics of the sessions conducted prior to respondents’ completion of the questionnaire; however, a majority of “big ideas” listed (30 of 50, or 60%) provided more specific topics or elaboration beyond naming session or topic titles. Twenty-one named ideas came from session 3, while 20 others were from session 2 and only nine from session 1. See Table 6 below, on page 20, for details of which session’s content was considered a “big idea” in each session’s reflection worksheet.

Session-focused “big ideas” were even more detailed, and mostly described the session’s main topics. (Of 55 named ideas 47, or 85%, were more specific than simply mentioning “community impacts.”) The most named items noted that these impacts exist, and nearly as many referred to correlation and causation. Institutional trust, evaluating media, and risk perceptions were also mentioned by several participants. Three other “big idea” comments suggest skepticism of the research presented in this session, noting a “lack of sociologic data” linking Marcellus to community impacts.

Most of the memorable (or “sticky”) ideas participants recalled after session 3 were from this session. While “community impacts” were mentioned by some, descriptions of critical reading and viewing of media were the most common idea named. A handful of other participants described ideas around risk, wet and dry gas, institutional trust. One respondent mentioned an interests in “How to explain what Marcellus is & why it is being used,” and two others were most struck by their classmates’ comments and reactions in the session and discussion.

Participants reported some familiarity with the session’s topics, but made fewer mentions overall than in the previous session. Eleven of 16 (69%) wrote about having some degree of familiarity with the material. References to “community impacts” (four mentions) and the boom-bust cycle (two mentions) were most common. Risk perception, correlation / causation, and the infrastructure costs of drilling were each also mentioned once. Sources of this prior knowledge included work experience and public broadcasting, but most respondents did not mention where their information came from. On average, participants rated their own expertise somewhat above neutral, at 3.71 on a seven-point scale (SD 1.384).

To identify any parts of the session that may have generated particularly strong reactions, participants were asked to respond to a set of “reflection words” by describing what, if anything, each word evoked from their memory of this session. The table below summarizes these reactions and how often they were mentioned in this item.

Table 2. Session 3 content described as evoking ten “reaction words”

Words	Session elements described
Important	Being informed / critical reading / “facts” (9), correlation and causation (2), community (2), water (1), boom-bust cycle (1), “the wild west phenomenon of the construction workers” (1), “that the truth be presented so the public can make their own decision” (1)
Confusing	Media and trust (2), “data available” (1), “scientific statements” (1)
Unnecessary	Time spent on this topic (1)
Interesting	Community impacts / boom-bust cycle (6), group discussion / others’ reactions (6), correlation and causation (2), everything (2), “how so many things relate” (1)
Boring	None (1)
Relevant	Community impacts (3), the need for this research (3), risk perception (1), trust exercise (1), community responsibility (1), “newspaper articles” (1), “just be aware” (1)
Familiar	Community impacts / boom-bust cycle – general or specific (6), some or most topics (2), “people blame changes for any problems that happen” (1)
Unfamiliar	Community impacts – specific (3), volume of fossil fuels (1), water used in fracturing (1)
Oversimplified	Effects of community impacts (1), trust exercise (1), none (1)
Valuable	Understanding community impacts / boom-bust cycle (4), everything (3), session resources and tools (2), evaluation skills (2), natural resources (1), energy extraction (1)

Participants were asked to reflect on whether and how they had (or might) use what they had learned in session 3. About equal numbers described speaking with friends, family, co-workers or others about the material; one other mentioned using it at public meetings. Others named more self-focused actions, either further study to satisfy one’s own interests or using the materials as tools in their role as a land- or homeowner. Several others also used this item primarily as an opportunity to share their own opinions about gas drilling-related issues. Participants’ primary actual or imagined result of this use was to share information they have learned with others, though a few also mentioned learning more for one’s own benefit. They mostly imagined the session content could be used in their work life and in the management of their own property, though a few others also mentioned use at public meetings or in promotion of the Community Science Volunteer program itself.

Session 4: Engineering Part II

The fourth session’s topics were shale gas estimation and well completion. Data were collected about this session using pre- and post-session questionnaires and a reflective worksheet. Two of 21 participants (10%) found the pre-session materials “too complicated,” as did one of 22 (5%) when asked about the session itself; the remainder found both to be “about right.” Among that majority, understandability was a strong theme: the quality of materials, instruction, and in-class explanation were all noted as being helpful. The pre-session materials were described by several individuals as being “just enough” for a clear overview – not so much as to overwhelm some respondents, but also not the level of detail others had hoped for. Similar comments were made about the “loaded with information” session, including one respondent who enjoyed the large-group format for questions and discussion in this case.

As in the previous engineering session, participant pre-overview questions were a mix of technical detail (about gas estimation, water and chemical use, and safety regulations and controls) and

questions on the potential hazards and long term impacts of the same. One individual had a question about the local applicability of answers as well, asking specifically about faults in Marcellus Shale areas of Pennsylvania. Post-overview, pre-session questions included some of this attention to detail and risk, but a stronger focus on how to use practical information (how to obtain a gas estimate, for instance) and various parties' rights and responsibilities around gas drilling. Retrospective pre-session questions were all very concrete and specific, wondering more about the details of drilling and extraction processes and their impacts, as well as gas estimation and its role in considering risk and reward. Post-session questions were similarly detail-oriented, with strong emphasis on water use and treatment. Most participants had questions around the overview (19 of 21 pre, 90%; 15 of 21 post, 71%), and nearly as many around the session itself (17 of 22 pre, 77%; 13 of 22 post, 59%). Nearly one in four participants (five of 22) listed the same, "unanswered" pre- and post-session questions.

As with the second session, participants reported interest in adding more technical information to session 4. They described a need for more detailed or comprehensive discussions of injection wells, pipelines, and water use and treatment in particular. A few mentioned an understanding that these topics would be addressed more in the following week's session, and others noted that the session included a good amount of information given the time allotted.

Participants were asked to rate their agreement with a series of statements about the effectiveness of different elements of each session. Responses to these items in session 4 (n=22) varied more widely than in any other session. While there was very strong agreement about the effectiveness of the session overall (\bar{x} =6.36, SD 0.492) and the instructor presentations (\bar{x} =6.41, SD 0.590), there was also moderate *disagreement* about the value of hands-on activities (\bar{x} =3.05, SD 1.638). When asked if small group work would have been more helpful than the large group discussion that took place in this session, participants also disagreed (\bar{x} =2.53, SD 1.429), suggesting that this structure was relatively effective. Ratings of statements about group discussion and overview materials received moderately strong agreement consistent with previous sessions (\bar{x} =5.55 / SD 1.471 and \bar{x} =6.05 / SD 0.899, respectively).

Participants responded positively to both the structure and content of session 4. The amount of detailed information on water use and on the costs and benefits of natural gas development garnered appreciative comments. Several individuals also praised the lecture-with-slides format as it both presented lots of information and facilitated one's own note-taking. They acknowledged that this week's topics did not lend themselves well to small group discussion, and that question-and-answer with the full group was a better strategy for sharing information with the full group. Participants' noting that detailed information worked well did not prevent them from also repeating the need for still more detail, however. There was particular interest in hearing more about the chemicals added to water for hydraulic fracturing and about gas pipelines. One individual also suggested combining the engineering topics from multiple sessions into a single (admittedly long) day for the sake of continuity.

In the days following session 4, participants were asked to articulate what they felt were the "big ideas" of both the session and the program overall. For the program overall, named ideas tended to reflect the main topics of the sessions conducted prior to respondents' completion of the questionnaire; however, a majority of "big ideas" listed (22 of 40, or 55%) provided more specific topics or elaboration beyond naming session or topic titles. Eleven named ideas came from this session, while 17 others were from session 3. This continues the pattern of recollection from the two most recent sessions, but also suggests that "community impacts" content was viewed as

particularly valuable. See Table 6 below, on page 20, for details of which session's content was considered a "big idea" in each session's reflection worksheet.

Session-focused "big ideas" were also detailed in session 4, and remained focused on the session's main topics. (Of 41 named ideas 36, or 88%, were more specific than simply mentioning "engineering.") The most named elaborated on the topic, mentioning the processes and engineering of wells and gas extraction. Nearly equal amounts reported that water use and related concerns were "big ideas," as well as risk perception and management (including descriptions of hazards, safe practices, and economic risk and reward). A smaller number of named ideas related to the process of gas estimation, and two others mentioned trust – perhaps a remnant of conversations in the previous week.

Most of the memorable (or "sticky") ideas participants recalled after session 4 were from this session, and ranged more widely than in other sessions. Water use or contamination, risk perception, and the drilling process were all mentioned somewhat often. A few other responses mentioned institutional trust, boomtowns, wet and dry gas differences, and the process of conducting a survey. Still others described the need or desire for further information, both for themselves and for others.

Still fewer participants reported familiarity with this session's topics, though they represent a similar proportion of respondents. Eight of the 13 participants who completed this item (62%) wrote about having some degree of familiarity with the material. References to fracturing and drilling were most common (mentioned four times). Methane migration, flowback fluids, and the variation in gas estimates were each mentioned one time. One individual reported that "I knew most of the information...and was disappointed that the presenter made some mistakes." No specific sources of prior knowledge were named by any respondents. Participants rated their own expertise slightly less than neutral, with a mean rating of 3.23 on a seven-point scale (SD 1.589).

To identify any parts of the session that may have generated particularly strong reactions, participants were asked to respond to a set of "reflection words" by describing what, if anything, each word evoked from their memory of this session. The table below summarizes these reactions and how often they were mentioned in this item.

Participants were asked to reflect on whether and how they had (or might) use what they had learned in session 4. Some reported or imagined sharing with friends, family, colleagues, or fellow meeting attendees, but most indicated conversation with unspecified "other people." The personal uses described included gathering more information on the topic (seemingly for its intrinsic value), as well as opportunities for interesting discussion and personal reflection. Again, several others used the item to share their opinions of the program topics more generally. The primary end result of these uses respondents named, as in session 3, was to share the information with others. Settings they imagined the materials would be relevant included work, general conversations, public meetings or speaking, and for one's own understanding.

Table 3. Session 4 content described as evoking ten “reaction words”

Words	Session elements described
Important	Safe practices – including well casings (4), methane migration (2), waste water (1), identifying and remediating problems (1)
Confusing	Gas estimates (3), boom-bust cycle (1), “chemicals not revealed” (1)
Unnecessary	Drilling new wells without compiling data on existing ones (1)
Interesting	Trust (1), risk perception (1), methane (1), drilling rig (1), everything (1)
Relevant	Well casings (2), water treatment (1), drilling process (1), methane migration (1), energy independence (1), “to my job” (1)
Familiar	Conventional drilling (1), survey process (1), methane migration (1), water quality concerns (1)
Unfamiliar	Drilling process (1)
Oversimplified	Peer review (1), “the relationship between the gas [companies] and the people they impact [for] good / bad” (1)
Valuable	Ensuring safety (3), everything (2), “knowing the truth” (1)
Boring	[no responses]

Session 5: Hydrology

The fifth session’s topics were engineering (part II) and water quality. Data were collected about this session using a post-session questionnaire.

Three of 19 participants (16%) felt that this session was too simple, and two others (10%) felt it was too complicated; the other 74% felt that it was “about right.” Respondent comments suggested an appreciation of the balance between lecture-style sharing of detailed material (with handouts on which to follow along) and the hands-on water testing activity. The activity in particular was described as both interesting and valuable – a highly relevant, concrete skill that participants could see themselves using in the future. Since, as one individual put it, “testing water makes you feel like a single person can actually make a difference,” several participants emphasized the need for this activity to be explained and contextualized well.

There were a number of pre-session technical questions in session 5 about water use, treatment, and safety. However, many were use-focused as well: participants wondered exactly what water might need testing and how the results should be used. This practical interest was even stronger in the post-session questions; participants were curious not only about what individuals could and should do to obtain and use water use information, but also other drilling stakeholders’ (e.g. drilling companies, local governments) responsibilities as well. Several also wondered about the conclusion and meaning of the in-session activity, and asked about what the results of their tests meant and what actions those results might prompt. A majority and near-majority of participants described questions about this session – 13 of 21 pre-session (62%), and 10 of 21 post-session (48%) – and three noted the same questions pre- and post-session.

The additional topics requested in session 5 had to do with building relevant context around an already strong hands-on activity. Participants expressed interest in learning why specific tests were conducted, what the results meant and their implications (both what they mean and what actions to take in different circumstances) for water users, and what preventative or corrective actions might precede or follow water testing and/or pollution. Several respondents suggested

that, if possible, testing at least one contaminated water sample (in comparison to samples like the ones they collected) could be a useful catalyst for these discussions.

Participants were asked to rate their agreement with a series of statements about the effectiveness of different elements of each session. As in the third session, participants agreed moderately with statements about session 5 (n=21). Their agreement in this case, though, was somewhat weaker (means from 5.05 to 5.81) and was distributed more widely (SDs from 1.030 to 1.779). Relative to other sessions, ratings for all items except the hands-on activities were the lowest among all sessions where a particular item was asked.

At the end of session 5, participants felt that the water testing activity worked particularly well – they recognized it as an important skill that was best learned in a hands-on fashion. However, they also felt that the activity itself was not contextualized enough. As they did when asked what was missing from the session, participants expressed interest in discussing the findings of their own testing and the significance and subsequent actions around the results. They also pointed out that more advance instruction about using the water meters (and, in some cases, meters that had been pre-tested to work properly) would have made the activity work more smoothly.

Sessions 6 and 7: Land Use Planning and Energy Choices

The sixth session's topic was land use, and the seventh's was "Energy choices." Data were collected about these two sessions using a single set of pre- and post-session questionnaires and reflective worksheets.

Taken together, one of 21 participants (5%) felt the overview materials for these sessions were too simple, while two others (10%) felt they were complicated. One respondent (of 21, 5%) also felt that the sessions themselves were too simple. The remainder identified both as being "about right." The overview materials were generally seen as understandable because of the glossary and charts that made new information more accessible. Some comments also suggested that these documents' high levels of detail and local specificity would make them valuable resources for participants after the end of the program. In comments about the session itself, the well placement activity was mentioned often for a number of reasons: it was described as a good way to digest the many regulations around well placement, but also as an exercise that inspired empathy for those whose job it is to select sites. Several individuals also specifically mentioned the opportunity to discuss the activity with group members and share ideas together.

Prior to sessions 6 and 7, participants still reported questions on previous topics: water and chemical use and treatment, how much gas is recoverable from shale, and the environmental impacts of drilling. But a second set of pre-overview questions emerged as well, about the legal and regulatory landscape of Marcellus Shale drilling and the need for resources detailing landowners' rights and responsibilities. Some also had questions about alternative fuels. Post-overview and pre-session, participants named similar questions with a greater emphasis overall on legal and regulatory details and resources. Both these and the pre-session questions returned to an interest in split estate considerations; the latter group of responses was more action-oriented, with a focus on what individual people do (and why) regarding land use rights and concerns as well as fossil fuel and alternative energy use. Post-session questions echoed these topics and practical sentiments as well, including interest in whether there were "right answers" to the land use activity. About two-thirds of participants had overview questions (17 of 22 pre, 77%; 14 of 22 post, 64%), and less than

half had session questions (ten of 25 pre, 40%; eleven of 25 post; 44%). Three participants shared “unanswered” pre and post questions.

After sessions 6 and 7, participants reported interest in more detail about both land use and energy sources. Some of these requests were for “more” in general, but others related to the questions begged by the session content: more information about promoting energy efficiency, for example, or details about how (perhaps theoretical) regulation of land use might compare to (perhaps more pragmatic) day-to-day oversight. Another thread through these comments was interest in more actionable information, on individual (or institutional) rights and responsibilities around a given topic – a need for information on how split estate ownership relates to land use planning was one example of such requests.

Participants were asked to rate their agreement with a series of statements about the effectiveness of different elements of each session. In the sixth and seventh sessions (n=24), agreement about the session elements’ effectiveness was much stronger overall. Means ranged from 6.08 to 6.42, and deviations were all between 0.5 and 0.8.³ Four of the five items asked were rated higher in this session than in any other; the fifth, about instructor presentations, was the second-highest rating.

As in session 2, participants at the end of sessions 6 and 7 named a broad range of session activities as having worked particularly well. They noted the well siting activity (and particularly the discussions it engendered), visuals that supported learning about energy sources and use (and which strengthened the instructor presentations), and the session handouts and additional resources that were available. Participants felt the sessions could be improved by providing the written resources in advance, by encouraging the speakers to better prepare for presenting, and by creating more space for on-topic discussion. In particular, they suggested the addition of time to compare and contrast results of the land use activity across groups. Several also requested more specific information on gas development regulations and the rights and responsibilities of landowners. To accommodate these topics, one participant suggested further dividing and expanding the sessions.

In the days following sessions 6 and 7, participants were asked to articulate what they felt were the “big ideas” of both the session and the program overall. For the program overall, named ideas tended to reflect the main topics of the sessions conducted prior to respondents’ completion of the questionnaire; however, a majority of “big ideas” listed (32 of 48, or 67%) provided more specific topics or elaboration beyond naming session or topic titles. Twenty-one named ideas came from sessions 6 and 7, while ten others were from session 4 and only six from session 5, again suggesting a higher priority placed on the content of session 4 relative to session 5. See Table 6 below, on page 20, for details of which session’s content was considered a “big idea” in each session’s reflection worksheet.

Session-focused “big ideas” were also detailed in sessions 6 and 7. Most were strongly focused the session’s main topics, but others also suggested broader conclusions from the program. (Of 59 named ideas 52, or 88%, were more specific than simply mentioning “land use” or “energy choices.”) Energy-related ideas – about sources, costs, efficiency, or choice – were named most often by far. About half as often, “big ideas” related to land use planning, including comments about well siting, regulation, and landowners’ rights or responsibilities. A handful of other comments also

³ Note that these high scores and narrow distributions may also indicate a degree of fatigue with completing this instrument so many times at the end of the program. Triangulation of these ratings with responses to other items is necessary for a complete view of their meaning.

mentioned the impacts or dangers of gas development, the idea that it cannot be stopped, and more specific concerns about water safety and “natural resource depletion.”

Most of the memorable (or “sticky”) ideas participants recalled after sessions 6 and 7 were from these sessions. Consensus on these most-memorable topics was strongest in this case than for any other session. The idea of well placement (with the activity that illustrated it) and the presentation of different energy types and uses (with the visuals that helped explain them) were noted almost equally as being the “stickiest” part of these sessions. Act 13, other homeowner or landowner concerns, and water use were each described as most memorable by one participant.

The smallest proportion of participants reported familiarity with these sessions’ topics. Only ten of the 20 participants who completed this item (20%) wrote about having some degree of familiarity with the material. Equal numbers of participants mentioned both land use planning / well placement and energy types / alternative energies (four mentions each). Two others mentioned water testing, and one noted familiarity with the drilling process. About half of participants described their familiarity as coming from personal experience – having used or considered the skills and materials in question. Two others mentioned their own independent study on the subject, and the remainder described no sources. Participants rated their own expertise about these sessions most highly, with a mean rating of 3.85 on a seven-point scale (SD 1.137).

To identify any parts of the sessions that may have generated particularly strong reactions, participants were asked to respond to a set of “reflection words” by describing what, if anything, each word evoked from their memory of these sessions. The table below summarizes these reactions and how often they were mentioned in this item.

Table 4. Sessions 6 and 7 content described as evoking ten “reaction words”

Words	Session elements described
Important	Energy sources / use (6), landowners’ rights / impacts of wells (4), water (1), everything (1)
Confusing	Energy conversion (1), well placement (1), correlation and causation (1)
Unnecessary	Food (1)
Interesting	Energy sources / use / waste (5), well placement / land use (4), everything (2), water testing (1)
Boring	[no responses]
Relevant	Energy sources / use (5), everything (4), energy conversion (1)
Familiar	Energy sources / use / cost (4), well placement / land use (3), “real estate related” (1)
Unfamiliar	Energy sources / use (3), energy conversion (1), where oil comes from (1), Marcellus Shale (1)
Oversimplified	Landowners’ rights (1), water testing (1), backflow (1), “what is energy” (1)
Valuable	Everything (4), energy use and waste (2), “real estate related” (1), session question-and-answer time (1)

Participants were asked to reflect on whether and how they had (or might) use what they had learned in sessions 6 and 7. Fewer respondents described interactions with others than in previous session, but some still mentioned talking about the session with family, friends, co-workers, or “people.” They also described their own interests in learning more and personal reflection (as well as a few mentions of the session’s homework). As in previous sessions, the main result participants described of these uses was to share information with other people, though some also mentioned

their own planned or actual uses. The materials were seen as being useful in work settings as well as in one's role as a land- or homeowner; some others mentioned its value when engaging in conversations more generally.

Session 8: Workforce Development and Communication Skills

The final session's topics were economic and workforce development and "constructive conversations." Data were collected about this session using a post-session questionnaire. Two of 20 participants (10%) felt the session was too complicated; none felt it was too simple. The remainder identified it as being "about right." In comments, the quality of both instructor presentations and group discussions were mentioned most frequently as reasons the session was "about right." Several individuals also specifically the value of the workforce statistics, or that the information more generally was valuable. A few others made a point of saying that they felt able to participate in the session or that their questions were answered. Those who found the session too complex described the rapid pace and minimal explanation around presenting a large number of workforce statistics, suggesting the benefit of further explaining and contextualizing these data.

Pre-session questions in the final week were strongly focused on the session content – particularly its applicability outside the classroom. Several questioned the workforce statistics, wondering exactly how many jobs a single well site might create, how many of those jobs local or Pennsylvania residents might fill, and how to go about doing so. Others focused their attention on the dialogue and discussion topics, wondering about how to manage conflict and noting that "constructive conversations are hard to find" in their communities. One individual had a more holistic view, was curious about "how...you relay all the info that we have gained in the class." Post-session questions echoed these practical considerations: there were more questions named about further enhancing one's listening and communication skills, about job training and the role of gas companies in a community, and lack of clarity around the workforce statistics persisted. Less than half of participants had session questions (nine of 22 for both pre and post, or 41%). Two participants shared "unanswered" pre and post questions.

After the final session, participants reported interest in spending more time honing their communication skills and more information or discussion around the workforce development data that was presented. These interests repeat the mantras of previous iterations of the item: for more time and more actionable information.

Participants were asked to rate their agreement with a series of statements about the effectiveness of different elements of each session. In the eighth session (n=22), agreement about the session elements' effectiveness was much stronger overall. Means ranged from 5.86 to 6.09, and deviations were all between 0.7 and 1.1.

The small-group discussion exercise was overwhelmingly named as the part of session 8 that worked well; participants described it as both good practice and as a good way to engage with one another. (One individual did note that it was difficult to practice disagreement when all three group members agreed, though.) The primary critique of the session, as in previous weeks, was the feeling that there was not enough time to address the material. This was particularly the case for the presentation of workforce development data. Several participants felt the "constructive conversations" material was so important they suggested moving at least part of it to the first week of the program.

Tables referenced above in findings for sessions 1-8

Table 5. Effectiveness of session elements: mean ratings by session

	Session 1		Session 2		Session 3		Session 4	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Instructor presentations	-	-	6.00	1.049	5.92	0.717	6.41	0.590
Hands-on activities	5.52	1.377	5.64	1.620	5.67	1.308	3.05	1.638
Group discussion	-	-	6.05	0.999	6.04	0.806	5.55	1.471
Session in general	-	-	6.14	0.889	6.00	0.834	6.36	0.492
Overview materials	-	-	5.87	1.058	4.50	1.504	6.05	0.899
Small group work	-	-	5.70	1.363	5.71	1.122	-	-
Small grp. would be better	-	-	-	-	-	-	2.53	1.429
Enough time to complete	6.04	1.364	5.30	1.259	5.75	0.989	-	-

	Session 5		Sessions 6/7		Session 8	
	Mean	SD	Mean	SD	Mean	SD
Instructor presentations	5.81	1.030	6.17	0.702	5.86	0.834
Hands-on activities	5.75	1.251	6.42	0.654	6.09	0.868
Group discussion	5.40	1.667	6.08	0.776	6.00	0.837
Session in general	5.80	1.152	6.42	0.504	6.00	0.707
Overview materials	-	-	-	-	-	-
Small group work	5.05	1.779	6.32	0.802	5.86	1.062
Small grp. would be better	-	-	-	-	-	-
Enough time to complete	-	-	-	-	-	-

Table 6. Program “Big ideas” reported by participants

	Session 2	Session 3	Session 4	Sessions 6/7
Big ideas from session 1	22	9	5	1
Big ideas from session 2	31	20	7	5
Big ideas from session 3	1	21	17	4
Big ideas from session 4	0	0	11	10
Big ideas from session 5	0	0	0	6
Big ideas from session 6/7	0	0	0	21

End-of-pilot questionnaire

How well did the program support understanding of gas development-related issues? How well did the program prepare individuals with key understanding and skills?

Participants were asked how well this program would prepare someone to know or use the following information; each statement was rated on a seven-point scale of agreement. There was

moderate-to-strong agreement with these items overall. Tables 7 and 8 below show the range, mean, and standard deviation for each rating item.

Items related to knowledge or understanding (as with engineering processes or energy choices) tended to receive higher mean ratings overall than those focused on skills (such as conversation or interpretation / evaluation skills). Eight of the ten highest-rated items (with ratings of 5.64 or higher) were knowledge-related items; only media literacy skills and skills for conversation with those who agree on an issue appeared in the “top ten.” This finding is consistent with feedback in some individual sessions about seeking more hands-on activity or clearly actionable information.

Table 7. Issue-Related Understanding

Understand how Marcellus Shale development relates to ...	N	Min	Max	Mean	Std. Dev.
... people and communities?	22	4	7	5.64	.848
... the natural environment?	22	4	7	5.55	.963
... land use?	22	3	7	5.45	1.057
... water resources?	22	3	7	5.41	1.182
... energy choices in Pennsylvania and the U.S.?	22	3	7	5.91	1.019

Table 8. Preparation with Knowledge and/or Skills

Prepare a person for ...	N	Min	Max	Mean	Std. Dev.
... talking with people who disagree on a "hot topic"	21	3	7	5.24	0.995
... understanding the difference between correlation and causation	21	3	7	5.33	1.155
... understanding how to hold constructive conversations	21	4	7	5.43	0.870
... interpreting scientific data or findings	21	4	7	5.43	1.028
... evaluating scientific studies or reports	22	3	7	5.50	1.012
... knowing how to determine what sources of information to trust	21	3	7	5.52	1.123
... sharing scientific information with others	22	4	7	5.59	0.908
... understanding methods for collecting data	20	4	7	5.60	0.940
... talking with people who agree on a "hot topic"	21	3	7	5.67	1.111
... knowing what is factual	21	4	7	5.67	0.856
... understanding the engineering of natural gas development	20	3	7	5.70	0.865
... understanding how science is conducted	21	4	7	5.71	0.784
... understanding perceptions of risk and reward in natural gas development	20	5	7	5.80	0.768
... identifying fact, opinion, and bias in media reports	20	4	7	5.80	0.768
... understanding the science of natural gas development	21	5	7	5.90	0.700
... understanding that energy choices are complex	21	5	7	6.24	0.831

What did participants see as most interesting or enjoyable session(s) of the program? What did participants see as the most important topic(s) addressed in the program?

Participants were asked an open-ended question regarding what they felt were most important and most interesting topics. Overall, it would appear that topics for which participants saw more obvious (or pre-existing) connections to Marcellus Shale – in particular engineering, geology, and hydrology – were mentioned more often as being both most important and most interesting.

Participants showed clear favorites they described as “interesting,” with the sessions named most often appearing more than five times as much as those named least often. A somewhat narrower set of frequencies for those topics deemed “important” (only ranging from 18% to 68%, rather than 13% to 77% for “interesting”) suggests a lack of consensus about which topics in the program mattered most. The only session that was mentioned as most important by more than half of participants was the hydrology session. Four of the eight sessions were listed among the “most interesting” by a majority of respondents.

The “energy choices” session was mentioned as most important by the second highest number of participants, but was deemed interesting only fifth most often and by about 10% fewer participants. The land use and planning session, on the other hand was named as most interesting by more than half of participants (fourth most often), but fewer than one third (31.8%) described it as most important – the sixth most often mentioned session.

Two other sessions – the engineering and geology topics from weeks 4 and 2 – were also described as being most important considerably less often than they were named most interesting. The former was mentioned as “most interesting” more than 18% less than “most important,” and the latter was so named more than 27% less. These differences, along with the fact that they were still among the most-named “important” sessions, suggest both the popularity of the topics and illustrate the flatter distribution of “important” sessions.

On the other hand, two of the sessions described elsewhere as having less immediate relevance to the gas development were named as important more often than they were listed as interesting. The first week’s session on “thinking like a scientist” and the third, on community impacts, were deemed “interesting” by only 22.7% and 13.6% of participants, respectively. However, they were described as “most important” by 45.5% and 27.3% of respondents. This suggests that at least some participants do see the value of science process or data interpretation skills and the social sciences; however, it also suggests an opportunity to make these topics more engaging in the future.

The two remaining sessions were each deemed important and interesting by similar proportions of respondents. The very popular hydrology session (week 5) was mentioned in both responses by about 70% of participants. The final session, on communication skills, was mentioned least often in both cases – about 15% of participants named it as interesting and/or important. This suggests that hydrology was a highly-valued and anticipated topic while communication skills may have been somewhat unexpected. However session-specific feedback, where some participants spoke to the enjoyment and value they derived from the session, confound this finding somewhat.

Table 9. Important vs. Interesting Session Content (n=22)

Important			Interesting/enjoyable		
Session	Frequency	Percent	Session	Frequency	Percent
Workforce development / Communication skills	4	18.2	Workforce development / Communication skills	3	13.6
Community impacts	6	27.3	Community impacts	3	13.6
Land use planning	7	31.8	“Think like a scientist”	5	22.7
“Think like a scientist”	10	45.5	Energy choices	9	40.9
Engineering II	10	45.5	Land use planning	12	54.5
Geology, Hydrocarbons, Engineering I	11	50.0	Engineering II	14	63.6
Energy choices	11	50.0	Hydrology	16	72.7
Hydrology	15	68.2	Geology, Hydrocarbons, Engineering I	17	77.3

Why were particular topics seen as being interesting and/or important?

Participants offered relatively consistent explanations of why they felt various topics were interesting or important; several of these explanations overlapped between “interesting” and “important.” The inherent value and applicability of both new information and new skills were mentioned in some comments. The connection between those new things and respondents’ own local context was also noted. Several individuals described topics as covering material they thought was not available (or only available with difficulty) elsewhere. These comments speak to participants’ own goals and agendas upon entering the program, the demand for such a program, and the additional value of locally relevant detail.

Language that was used primarily to explain why topics were “most important” echoed responses from elsewhere in the session-by-session formative evaluation. Several participants mentioned quality instruction as a driver of interesting topics. Others noted the strategies for *how* a topic was presented – particularly hands-on activities, visual materials, and discussion opportunities. Several described their “most important” topic(s) as the reason(s) they chose to participate in the program. These comments suggest and strengthen other findings on the successful diversity of topics and activities in the pilot cycle.

Explanations that were primarily used to discuss the *importance* of topics mainly dealt with the future applicability of that topic. These comments ranged from the abstract (appreciating one’s greater understanding of complex systems or risk, for instance) to the highly concrete (as with how session content would inform one’s future decision-making as a landowner or homeowner). Other participants articulated a more general value, but still did so explicitly, stating that a topic was important because it would have an impact on their own or their family’s way of life. Still others felt that their “most important” topics were things they felt they could (or should) share with others. At least one individual spoke to the demand they heard for information from those outside the program, and another mentioned the importance of feeling prepared to share with others.

These comments about the importance of program topics suggest a need for continued focus on making program content clearly applicable and equipping participants to share what they have learned – even informally.

How did participants recommend improving the program?

Most participants offered feedback on how to improve the program. Sixteen of 22 respondents offered constructive criticism when asked, “What should the instructors know about how to make this program better in the future?” Fourteen also did so when asked, “If you were in charge of this program, what would you do differently? Why?” (These comments are reproduced in full below, on page 8.) A number of themes emerged across these two sets of comments, suggesting a group of specific suggestions for program improvement.

Some topics require more time or attention

There was a lack of consensus on which topics need or deserve more time, which suggests the diversity of participants’ needs and interests. Creating variable opportunities for access to more information, as with out-of-session additional resources, could also satisfy those who seek greater depth than the program’s time constraints permit. Several respondents also suggested re-arranging the order of the sessions to improve the flow between topics.

Several were concerned with creating more time for the topics that “deal directly with Marcellus Shale” such as well engineering by omitting some topics – notably science process and communication skills and discussion of community impacts. On the other hand, a different set of participants found these same topics to be very valuable. They were seen as “necessary but not exciting,” and a few individuals suggested integrating key ideas (correlation and causation, facilitation and communication skills) in smaller pieces throughout the other sessions.

The presence of comments questioning the relevance of a substantial portion of program content, even at the end of the cycle, does more than indicate a need for logistical changes: it also suggests an opportunity to better meet participants’ needs as learners. One respondent indicated difficulty understanding the individual topics, and several mentioned struggling with how the topics related to one another. These comments, along with others challenging the relevance or importance of some topics, highlight room to improve how the materials in each session are explained and contextualized.

Demand for non-lecture experiences

Participants expressed positive reactions to the presence of so much visual material, hands-on activity, small and large group discussion, and question-and-answer time throughout the program – and an interest in even more of these elements. Some also mentioned an interest in more (or more thorough) pre-session reading material, further suggesting the benefits of making additional resources or detail available on-demand.

In a similar vein, some participants described their interest in more meaningful experiences both during and after the program. On one hand this interest took the form of requests for more activities or discussions that mirror “real life” situations, as well as “more relevant home reading materials that aren’t too filled with statistics.” On another, at least one individual expressed a desire to better articulate – or perhaps expand upon – what the program had prepared them for,

saying “I’d create a new mission statement. No adult will pay for a course where their role after finishing it is: a) to find abandoned wells or b) to bird watch.”

A few participant comments also mentioned very concrete amenities that could improve the overall experience of the program. Responses to these items were about adding additional breaks or coffee to the sessions, while a handful of earlier session-specific comments (addressed elsewhere in the full formative evaluation report) requested less food and better climate control in the meeting space.

Advice for instructors

At the end of each session program participants rated the helpfulness of instructors as being very helpful, with mean ratings between 5.8 and 6.4 on a seven-point scale. Despite this overall satisfaction, a number of respondents had suggestions for improving both the quality and the format of instruction in the program.

In addition to suggestions on how to use session time, as noted elsewhere, several participants shared advice for the instructors themselves. One offered a direct critique, highlighting the need to “screen instructors more closely for teaching ability instead of just possessing knowledge.” Another offered gentler ideas that suggest some demand for instructors to engage in more genuine and accessible ways with participants:

Keep open to feedback, don't get lost in their specialty, [show] open mindedness, [be] receptive to others, know their subject and be ready to explore options, recognize their limitations and so state - drop defensiveness - we are only at early stages of understanding the complexity of this whole subject.

Several other participants also suggested one particular individual whom they felt should be invited to be an instructor in the next cycle of the program; a number of others mentioned that instructors sometimes seemed under-prepared for sessions, or did not prepare the participants with enough advance material. These comments suggest several opportunities to better tailor instructors’ practices to the needs of adult, free-choice learners.

Respondents also made suggestions about how instructors’ expertise was presented in the program and what kinds of expertise they wished to see. Some suggested including panel discussions where instructors (with either competing or complementary areas of knowledge) could speak and teach together, rather than in sequence. Several others expressed interest in adding speakers with more “real world” expertise – someone who has faced the decision about whether to lease his or her land, for instance, or someone who has worked at a well site – to the curriculum. These suggestions parallel the interest in dialogue that has recurred throughout the evaluation findings for this program. It suggests that, in addition to the demand for practicing “constructive conversations” mentioned elsewhere, there is also demand among participants for the *modeling* of open dialogue about natural gas development and greater breadth or comparison of perspectives on related issues.

Summary of End-of-Pilot Findings

Overall, participants had relatively strong agreement that the program served as good preparation for the knowledge and skills at the core of program outcomes. Knowledge- and understanding-related items tended to receive higher ratings than skill-related items.

There was slightly more consensus among participants about which program topics were most important than about which were most interesting.

Engineering, geology, and hydrology were often named as being both interesting and important; community impacts and “constructive conversations” were not.

When participants explained why they valued a topic, they tended to describe it in terms of applicability to their own interests, experiences, and needs outside the program.

Participants’ suggestions for program improvement fell into a few main categories of action:

- Increased time for or access to more detailed information;
- Clearer explanation of the relevance of topics, both to one another and in participants’ post-program lives;
- Increased opportunity to both witness and participate in dialogue;
- Improvement of instructors’ preparation for sessions and engagement with participants, including preparing instructors to work with adult free-choice learners.

Discussion and Recommendations

A note on the scope of this report

The preceding findings are derived from a formative evaluation of the Community Science Volunteer Program’s pilot cycle. They are suited for identifying, at the overall programmatic or session level, the content, activities, and session structures that were particularly successful or that should be modified going forward. This report is neither a determination of the program’s success at meeting its stated outcomes nor a tool suitable for informing close revisions of the program’s curriculum. The former will follow in the form of a summative evaluation report later in the course of the program. The latter is available, in part, in the appendix of open-ended questionnaire responses supplied (under separate cover) alongside this report.

How well did the program meet participant interests and needs?

Participant interests and (staff-proscribed) needs seem to have been well met by this pilot program: expressions of interest were overwhelmingly positive, and only a handful of comments across all instruments and sessions expressed skepticism of the value of any program materials.

However, respondents also expressed some dissatisfaction with the program. The need for more time was a common form of this discontent, but comments also suggested the desire for a different lens or approach to the sessions’ content. There seemed to be a range of ways that participants thought about the materials which were not necessarily served by the program’s existing curriculum. While the program seemed focused on the first of the lenses below, participants’ reported interests revolved among:

- Learning about processes or sharing known information: the “what” and “how” of a topic
- Identifying and explicitly, concurrently discussing the risks associated with those processes

- Learning about where or how to obtain more detailed information or take-away resources to use or share outside the program (e.g., where to look for additional research reports or data)
- Identifying their options for how to act or react when a particular situation arises in their lives outside the program (e.g., how to interpret results from a water test, and what to do if it reveals contamination)
- Discussing how theoretical or planned actions may differ from actual practice, and how those differences shape one's risk or course of action (e.g., how and why industry regulation differs from enforcement)

Supplying context for the program's factual content is another area where there appears to be room for growth. In several sessions, participant questions focused on how a conclusion or idea was deemed factual, what it means or its practical implications, and why exactly that idea matters in "real life." Clear local relevance was another form of context sometimes mentioned by respondents. Wherever possible, using studies or data drawn from central Pennsylvania (rather than other gas plays or elsewhere in Marcellus regions) could strengthen the credence participants give to the conclusions presented in the sessions. Alternately, redoubled efforts to explain the applicability of other, comparable studies would likely have a similar effect.

Some participant comments also alluded to the complexity of (or incomplete study around) some topics presented in the program. While a few respondents seemed impressed by the interconnectedness of the many topics and practical concerns, the complexity led to confusion or skepticism from others. Such confusion, along with the perception that some programs were less topical than others, highlight an opportunity to better meet participants' needs as learners by clarifying and emphasizing the connections between and applicability of all session topics.

These reactions also suggest opportunities to acknowledge the many intersecting systems at play around natural gas development, as well as to discuss whether or why there may not be "right" or totally conclusive answers to a particular question – or even to say that that question has yet to be studied. (This was particularly apparent in comments where participants were skeptical of social science research that may not have conformed to the more controlled, predictable research methods that may have been introduced to teach the group how to "think like a scientist.") That several participants' responses conflated the ideas of "fact" and "truth" in describing what they were seeking from the program is also a further indication of this need.

Responsibility for this exploration of nuance largely falls on those preparing and presenting each week's curriculum. There are a handful of other specific needs that participants mentioned across the program sessions which relate to the session's instructors. Classroom management – particularly steering the group gracefully back from tangential or off-topic discussion – was an area for improvement named with some frequency by participants. Several individuals also emphasized that they, as adult learners, had particular needs and interests that were unmet by some instructors (sometimes going so far as to suggest alternate instructors).

Advance preparation, both to improve instructors' organization and their teaching or speaking, was also mentioned for a number of sessions.⁴ The idea of preparation also extended to the

⁴ Note that participants whose comments suggested (through simplicity of language, incompleteness, and/or repetition) they may have had lower levels of literacy than their peers were more likely to focus on and value the

participants' own ability to be ready for a session: advance reading was praised, and the need for resources like a glossary of key terms for the program were mentioned on a number of occasions. These findings might also suggest that some pre-session worksheet, rather than post-session "homework," might be of value to both focus thinking around the readings and their prior understandings, and prepare the participants for the session.

A related demand for post-session resources (i.e., where to go to learn more about a particular idea) speaks to the value of providing varying access points for varying amounts of detail or information, so that individuals who wish for greater depth may pursue it outside of the program.

In addition to these needs, a number of aspects of the program were particularly effective and should remain incorporated in future cycles of the program. Hands-on or small group activities were praised almost unanimously by participants as helping to explain complex topics or foster discussion. These should undoubtedly be retained and built upon, if possible. However participants also recognized in their comments that some topics did not lend themselves well to such activities; overall, the sessions seem to have struck an effective balance of different structures. Participants had positive feedback about the incorporation of visual (rather than only written or verbal) material regardless of how "hands-on" a session or topic was. The only caution about hands-on activities comes from session 5's water testing activity, where some participants seemed disappointed that there was not enough time or working equipment for everyone to take his or her own turn doing the actual testing. Both small and large group discussions garnered similarly positive responses across the program. The act of having one's questions answered by an expert seemed to be a valuable experience for a number of participants. Others, though, realized that robust question-and-answer time may have diminished time in the sessions for other activities. The program team should carefully consider how much time to allow for this participant-driven exploration, balancing the apparently high demands for both "expert" content and discussion of questions.

The balance of time within and across the sessions is a major consideration for this program as well. Almost without exception, each topic addressed in the eight weeks prompted a suggestion of more time or greater depth from at least one participant. The strategies for instructor preparation and classroom management described above may help create more time for the existing curriculum, but there may also be opportunities for re-arrangement of the topics or expansion of selected topics. Such changes seem promising since so many participant-generated questions seem to have been answered by the materials in subsequent weeks. Several particular strategies could mitigate these foreshadowing comments and questions, especially in the earlier weeks of the program:

- Re-combining similar or mutually supporting topics so they are presented together or sequentially;
- Eliminating multi-week topics wherever possible (or making the parts sequential);
- Anticipating participant questions, based on participant responses and the experience of this pilot cycle and integrating answers into the session materials; and
- Being more explicit about where in subsequent weeks' curricula a particular topic will be addressed.

quality of a session's instruction, so improving these skills may also serve to make the session more accessible to a wider variety of learners.

When considering any expansion of the program, the team will need to consider participant demand alongside the feasibility of both participants' and their own time commitments.

A number of highly insightful yet somewhat off-topic questionnaire responses indicate that providing feedback space, though technically an evaluative process rather than a program activity, was important to at least some participants. Continuing to provide spaces for participants to describe what they have learned, what may still be unclear or intriguing, what they think about a topic, or what they wish to discuss further could be a valuable addition to the program. The forthcoming EASE online network could serve this purpose exceptionally well, but there may also be room within the Community Science Volunteer program for such "sharing."

Participants also clearly expressed interest in sharing (or plans to share) what they have learned with others. Although the University's concerns about the appearance of training or certifying community experts are real and valid, a good number of participants persist in seeing themselves in that role (and others see value in someone serving such a capacity in their communities). If participants do in fact become de facto "community scientists" after taking part in this program, perhaps the program team could find some way to indirectly support participants' efforts – while still not making the "public expert" role an explicit part of the program.

Taken as a whole, participants' feedback for this evaluation suggested that they had overwhelmingly positive feelings about the program content, the presentation, and those who shared their expertise in each session. The relatively small number of participants who expressed dissatisfaction with any aspect of the program, rather than temporary confusion or curiosity, indicates that it will be generally successful – though those outliers still merit attention, as they may be bellwethers of literacy or other accessibility concerns. When prompted, though, a substantial number of individuals were able to provide constructive criticism around how best to present the various topics.

Variation among participants' interests in the sessions and topics point to a tension between their perceptions and needs around the program overall. On one hand, the value attributed to technical knowledge around natural gas extraction suggests that the content itself – gathering new, detailed information – was a powerful motivator for participation. Others' emphasis on dialogue and relevance around the session topics (as with the encouragement to integrate communication or data interpretation skills into each session) suggests a similarly strong drive to gain applied knowledge and skills from the course. Future cycles of the program can and should seek to deliberately balance these competing needs for detailed information and for modeling and practice of the skills or decisions participants may encounter outside the program. Participants appear to have a voracious appetite for Marcellus- and gas development-related information and skills, and would like both to be accessible in as comprehensive, action-oriented, and shareable a way as possible.

Appendix A: Open-ended responses, Marcellus EASE Community Science Volunteer Program formative evaluation

[Omitted; for internal use only.]