

## 4 Assessment of Health Impacts

Eight potential stressors to health were identified and assessed: air quality; water and soil quality; traffic and transportation; noise, vibration and lighting; community wellness; employment and economy; health system infrastructure; and accidents and malfunctions. These assessments take into account Antero’s proposed control plans and mitigation strategies, to the extent that they are known (from public presentations, Surface Use Agreement, and other information provided by Antero). Any significant deviation from the available information will not necessarily be reflected in this assessment. Each stressor was then characterized based on seven attributes relevant to public health: direction of health effects; geographic extent; likelihood; vulnerable populations; duration of exposure; frequency of exposure; and magnitude/severity of health effects. For each attribute, consistent definitions were created and numerical values were assigned to each level of the attributes, as shown in the tables below. The characterization consists of describing and ranking each potential health impact in terms of each attribute. To compare the relative importance of the potential stressors to one another, these numeric rankings were summed for each health impact to create a relative rank. Both the numerical value assigned to each attribute level and the summed rank are qualitative with the sole purpose of helping to describe the relative importance of each potential health impact to the other potential health impacts identified in this HIA. As such, any individual ranking is only meaningful when used in context with another ranking within this HIA. The numeric levels and summed ranks do not represent a quantitative estimate of risk, nor should they be used to compare health impacts identified in this HIA to other HIAs, risk assessments, or health standards.

### Direction of Potential Health Effects

Positive	Changes that may improve health in the community	+
Negative	Changes that may detract from health in the community	-

### Geographic Extent of Health Effects

Localized	Effects mainly occur in close proximity to drilling or other related activities	1
Community-wide	Effects occur across most or all of the Battlement Mesa PUD	2

### Presence of Vulnerable Populations within Battlement Mesa

Yes	Disproportionately affects subpopulations that are more vulnerable to health impacts (e.g. children, the elderly or people with pre-existing health conditions)	2
No	Affects all subpopulations evenly	1

**Duration of Exposure**

Short	Lasts less than one month	1
Medium	Lasts at least one month but less than one year	2
Long	Lasts one year or more	3

**Frequency of Exposure**

Infrequent	Occurs sporadically or rarely	1
Frequent	Occurs constantly, recurrently and/or numerously	2

**Likelihood of Health Effects**

Unlikely	There is little evidence that health effects will occur as a result of this the Antero drilling in the PUD	1
Possible	Evidence suggests that health effects may occur, but are not common in similar situations	2
Likely	Evidence suggests that health effects commonly occur in projects of this type	3

**Magnitude/Severity of Health Effects**

Low	Causes health effects that can be quickly and easily managed or do not require treatment	1
Medium	Causes health effects that necessitate treatment or medical management and are reversible	2
High	Causes health effects that are chronic, irreversible or fatal	3

**EXAMPLE:**

The following characterization of a hypothetical health impact from Antero’s plan illustrates how attribute levels are assigned and then summed to provide a relative ranking for the potential health.

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Hypothetical	Negative:-	Localized: 1	No: 1	Short: 1	Infrequent: 1	Unlikely: 1	Low: 1	-6

The hypothetical health impact may produce **negative health effects** only in areas in close proximity to the development areas and is **localized**. No particular pollution is more vulnerable to the health effect. The duration of the hypothetical impact is expected to be less than a month, **short**, and only occur once, **infrequent**. It is **unlikely** to occur and any health effects could be

easily managed at home and would be **low**. The hypothetical health impact is has a ranking of -6 out of 15.

The following sections provide an assessment, characterization, and recommendations for each potential health impact.

#### ***4.1 Assessment of Air Quality on Health in Battlement Mesa***

“What happens if the air is so bad that I have to close all my windows and shut off my swamp cooler?”

*June 15 stakeholder meeting*

Exposure to airborne contaminants from natural gas development and production is a major concern to Battlement Mesa residents. There is the potential for release of hundreds of airborne contaminants during most if not all natural gas development and production. The potential for release of contaminants to air increases with well installation errors, blow outs, or well fires. Sources of contaminants during these operations include the natural gas resource itself, chemicals used in well development operations, such as fracking, wastes from well development activities such as produced water, and diesel exhaust from trucks and generators.

##### **4.1.1 Air Quality and Health**

Natural gas development and production and the diesel engines used to support them have the potential to release hundreds of hydrocarbons, carbonyls, and other contaminants into the air. People can be exposed to these contaminants as they breathe ambient air in and outside of their homes. Some of these contaminants, such as benzene, diesel exhaust, and PM<sub>2.5</sub>, are human carcinogens. Others, such as carbonyls, alkanes, ground-level ozone, and 1,2,4-trimethylbenzene, can act as irritants of the eyes, skin, and respiratory tract or cause neurological effects<sup>29-30</sup>. In addition, hydrocarbons, carbonyls, and nitrogen oxides serve as precursors for ground level ozone formation. The health effects of many other of the potential contaminants are not known. Descriptions of health effects of the air contaminants of potential concern are presented in Section 4 of the Human Health Risk Assessment (Appendix D). The Human Health Risk Assessment reviews ambient air data collected in Garfield County between 2002 and 2009.

In addition to the effects that each of these substances can produce by itself, there is also the possibility of complex health reactions occurring as a result of the interaction of multiple substances. There is some indication that complex mixtures can act additively or synergistically to increase effects on human health. For example, studies on air pollution indicate that continuous exposure of healthy human adults to sulfur dioxide or nitrogen dioxide increases ozone absorption, suggesting that co-exposure to other gaseous pollutants in the ambient air may enhance ozone absorption. Studies that evaluated response to allergens in asthmatics (allergic and dust-mite sensitive) suggest that ozone enhances response to allergen challenge. Other

studies have reported increased response (lung tissue injury, inflammatory and phagocytosis) to the mixture of PM and ozone compared to either PM or ozone alone<sup>30-31</sup>.

#### **4.1.2 Current Air Quality Conditions**

There are several sources of air emissions that currently affect air quality in Battlement Mesa. The main sources are vehicle emissions and natural gas development and production, as described below.

Battlement Mesa residences are located one mile from Interstate-70, which likely has some impacts on the current ambient air quality. The Garfield County emissions inventory indicates that highway vehicles were a primary contributor to carbon monoxide, sulfur dioxide, and nitrogen dioxide emissions in 2007<sup>32</sup>. The current traffic in the Battlement Mesa PUD, described in Antero's traffic analysis, also has impact on the current ambient air quality.

With the exception of two natural gas wells, Battlement Mesa does not currently house any industrial activity. While there are many gas wells located to the north, east, and south of the PUD boundaries, the impact on the ambient air quality within the PUD is estimated to be similar to other rural locations in Western Garfield County without significant natural gas development and production. There currently is no baseline air quality data specific to Battlement Mesa, although the GCPH plans to begin collecting air quality data (carbonyls, SNOMCs, and meteorology) in Battlement Mesa beginning in the Fall of 2010. Therefore, this can be verified when the results from the ambient air sampling in Battlement Mesa are available.

The air quality measurements and risks determined for the Silt-Daley and Silt-Cox monitoring sites in the Human Health Risk Assessment performed with the 2005-2007 ambient air study data and background samples collected in the 2008 Garfield County Air Toxics study were employed to estimate baseline air quality and risk within the Battlement Mesa PUD<sup>33-34</sup>. The Silt-Daley and Silt-Cox monitoring sites are described as rural sites without natural gas development and production.

The average PM<sub>10</sub> levels at Silt-Daley (9.2 µg/m<sup>3</sup>) and Silt-Cox (13.6 µg/m<sup>3</sup>) were well below the 150 µg/m<sup>3</sup> National Ambient Air Quality Standard. Chemical speciation of the PM<sub>10</sub> samples indicated that the main source of carbon in the samples is most likely from a combination of oil and gas production and building heating<sup>18</sup>. The 24-hour average PM<sub>2.5</sub> levels measured in background samples the Garfield County Air Toxics Study Summer 2008 ranged from 4.9 to 10.3 µg/m<sup>3</sup>, and were well below the 35 µg/m<sup>3</sup> National Ambient Air Quality Standard<sup>34</sup>.

Baseline cancer risk estimates ranged from 6.2 excess cancers per 1 million individuals at Silt-Daley to 21 excess cancers per 1 million individuals at Silt-Cox, after adjusting for a 30-year exposure duration and 350 day/year exposure frequency. The difference in cancer risk between the two sites is because different contaminants are driving the risk. The cancer risk at Silt-Daley

is driven by benzene, which was not detected at Silt-Cox. The cancer risk at Silt-Cox is driven by 1,4-dichlorobenzene, which was not detected at Silt-Daly. At both sites the non-cancer hazard was less the one, below which health effects are not expected to occur.

It is important to note that 2005-2007 and 2008 studies were limited to determining only 128 possible air contaminants. Several other potential air contaminants, such as, ozone, and PAHs, were not measured<sup>33</sup> and therefore not included in the Human Health Risk Assessment or other Human Health Risk Assessment conducted by CDPHE in the past.

EnCana Oil and Gas (USA) Incorporated (EnCana) began conducting ozone measurements in 2007 at their mountain station in Garfield County. The mountain station is located at 8407 feet above sea level in a remote area with very little natural gas development and production. Ozone levels averaged over 8 hours ranged from 17 ppb to 74 ppb. While Encana's ozone data are from a rural area within Western Garfield County, it may not be a good estimate of ambient ozone levels in the Battlement Mesa PUD. This is because of the 3200 foot elevation difference between the two areas (the elevation of the PUD is approximately 5200 feet above sea level). Ground level ozone concentrations vary by elevation, with higher concentrations at higher elevations.

### **4.1.3 Antero Drilling Plans in Battlement Mesa and Air Quality**

Garfield County's 2007 emission inventory indicates that the oil and gas industry (point and non-point sources combined) is the highest contributor to nitrogen dioxide, benzene, and sulfur dioxide emissions within Garfield County. For example, the oil and gas industry contributes five times more benzene to the inventory than any other emission source listed. The oil and gas industry also is a significant contributor to VOC, PM<sub>10</sub>, and carbon monoxide emissions<sup>32</sup>. Therefore, it is expected that Antero's project will impact air quality in the PUD.

The VOC emissions from natural gas development and production have the potential to degrade the air quality within the PUD, if they are not adequately controlled. There is the potential for the production tank on each well pad to emit 37 tons per year (tpy) VOCs (including methane), based on Antero's estimate of 0.36 tpy benzene and the composition of the condensate at the Watson Ranch Well located on the south east border of the PUD (Antero Battlement Mesa Natural Gas Development Plan Meeting #7, October 7, 2009, Information provided by Antero). Antero has specified that they will use combustors to control VOC emissions from production tanks<sup>7</sup> to achieve a 95% VOC control efficiency in compliance with COGCC rule 805b<sup>9</sup>. Applying a 95% control efficiency to the potential VOCs emissions results in 18.6 tpy VOC emissions from the production tanks on all 10 proposed well pads combined. Production tanks are only one of a number of potential sources of VOCs emissions from natural gas production activities. Some sources, such as flow back operations, are likely to cause a higher emission rate of VOCs, while others may have VOC emissions similar to the production tanks. It is important to note that while combustors may decrease VOC emissions, they have the potential to increase carbon monoxide, carbon dioxide, and nitrogen oxides emissions.

COGCC Rule 324A requires operators to take precautions to prevent significant negative impacts to air; COGCC Rule 317 requires that any gas escaping during drilling must be directed a safe distance from the well and burned (flared); and COGCC Rule 805b requires that gas facilities and equipment shall be operated in such a manner that odors and dust do not constitute a nuisance or hazard to public welfare. However, natural gas development and production may have some impact on localized air quality at residences near the well pad, as evidenced by odor complaints to COGCC and the Garfield County Oil and Gas Department from Battlement Mesa residents in July 2010 (COGCC complaint reports)<sup>9</sup>. The odor complaints occurred during flow back operations at Antero’s Watson Ranch Pad located on the southeast border of the PUD, within approximately ½ a mile from several residences, and resulted in COGCC issuing a notice of alleged violation (also known as NOAV) to Antero on 7/14/2010. In the 2005 to 2007 Garfield County Ambient Air study, air samples collected when residents noticed odors (thought to be from natural gas development and production), contained levels of benzene, ethylbenzene, toluene, and xylenes that were greater than EPA regional screening levels for residential ambient air<sup>18</sup>. EPA Regional Screening Levels are health-based levels above which health effects may occur.

Diesel exhaust from heavy trucks and generators has the potential to impact air quality within the PUD. The transportation and traffic assessment discusses the number of expected truck trips that were used to estimate the annual emissions from Antero’s projected heavy truck activity as summarized in the following table.

**Estimated Annual Emissions from Trucks**

Contaminant	five year Well Development (Phases 1 through 3)	20 - 30 Years of Well Production and Operations
PM (tons/year) <sup>1</sup>	0.26 to 0.75	0.05 to 0.12
Nitrogen dioxide (tons/year) <sup>2</sup>	0.35 to 0.45	0.068
Carbonyls (tons/year) <sup>3</sup>	0.063 to 0.082	0.012
Alkanes (tons/year) <sup>4</sup>	0.05 to 0.064	0.0097
PAHs (tons/year) <sup>5</sup>	0.14 to 0.18	0.027

<sup>1</sup>assuming a PM emission rate of 0.64 to 1.4 grams per mile<sup>35</sup>, a fuel efficiency of 5.5 miles per gallon of diesel, and 10 miles within the PUD per trip

<sup>2</sup>assuming a nitrogen dioxide emission rate of 0.84 grams per mile<sup>36</sup>, a fuel efficiency of 5.5 miles per gallon of diesel, and 10 miles within the PUD per trip

<sup>3</sup>assuming a carbonyl emission rate of 0.15 grams per mile<sup>36</sup>, a fuel efficiency of 5.5 miles per gallon of diesel, and 10 miles within the PUD per trip

<sup>4</sup>assuming an alkane emission rate of 0.121 grams per mile<sup>37</sup>, a fuel efficiency of 5.5 miles per gallon of diesel, and 10 miles within the PUD per trip

<sup>5</sup>assuming a PAH emission rate of 0.0338 grams per mile<sup>37</sup>, a fuel efficiency of 5.5 miles per gallon of diesel, and 10 miles within the PUD per trip

The estimated emissions are based on the period of time during which trucks are moving and do not include emissions created during idling and emissions from diesel powered generators. Each of the proposed truck routes is near at least one Battlement Mesa housing area<sup>38</sup>.

With the following control measures in place, project dust from construction activities, well pads, and access roads is not expected to significantly impact Battlement Mesa air quality. COGCC rule 805b requires operators to employ practices for control of fugitive dust caused by their operations. Antero has specified the following dust control measures: (1) soiltac and/or liquid dust suppressants will be used; (2) all access roads and well pads will be graveled; (3) truck traffic will not exceed 20 miles per hour (mph); and (4) all contractors will be notified they must obey traffic laws and that they will be disciplined, up to removal from Antero's project, if they fail to comply<sup>7</sup>.

Fugitive emissions from pipes, valves, pneumatic devices, and wellheads have the potential to impact Battlement Mesa air quality and can do so over the life of the well, estimated to be at least 20 years. In addition, VOCs may be vented during maintenance ("pigging") of pipes, occurring intermittently over 20 years. COGCC rules require that no bleed valves be used on pneumatic devices, where technically feasible. Appendix B discusses specific requirements for pipelines within the PUD, as agreed in the Surface Use Agreement. No centralized compressor stations will be located in the PUD<sup>7</sup>.

Appendix D contains a Human Health Risk Assessment that was performed by the CSPH team to estimate the potential impacts to the public health from Antero's proposed project. The Human Health Risk Assessment was conducted using five years of data from the Bell-Melton Ranch monitoring station, the 2008 Air Toxics study, and the 2005-2007 air study. Three exposure scenarios were evaluated: (1) chronic exposure of all residents within the Battlement Mesa PUD; (2) chronic exposure of residents within the PUD living adjacent to a well pad; and (3) acute exposure of child residents living within the PUD living adjacent to a well pad. The Human Health Risk Assessment concludes that there is a potential for natural gas development and production within the Battlement Mesa PUD to adversely impact public health. The highest risk is projected for residents living adjacent to well pads through acute exposure to air contaminants emitted during well completion activities. Following is a summary of the conclusions of the Human Health Risk Assessment:

- These non-cancer hazards and cancer risks may be significantly underestimated because there is currently little or no information for many contaminants associated with natural gas operations. They may be even higher if information were available for polycyclic aromatic hydrocarbons (PAHs), chemicals in fracking fluids, ozone, PM<sub>2.5</sub>, PM<sub>10</sub>, and contaminants without toxicity values. In addition, little information is available for soil and water.
- For Battlement Mesa residents living adjacent to a well pad, the estimated Hazard Index of 40 for acute non-cancer hazard and the estimated Hazard Index of 2 for the chronic

non-cancer both are greater than one, above which health effects may occur. Both of these hazard estimates are driven by trimethylbenzenes and benzene in ambient air.

- For chronic exposure of Battlement Mesa residents living adjacent to a well pad, the estimated lifetime excess cancer risk of 83 cancers per one million people, while within EPA’s acceptable range of one to 100 cancers per one million people, exceeds EPA’s goal of less than one cancer per million people and is near the high end of the acceptable range. This translates to a population attributable risk of less than one cancer for a population of 5,041. The contribution of benzene, methylene chloride, and ethylbenzene also exceed the contribution of these contaminants to the baseline cancer risks measured at the Silt-Daley and Silt-Cox monitoring stations.
- For chronic exposure of Battlement Mesa residents not living adjacent to well pads, the estimated Hazard Index of 0.6 for non-cancer hazards is less than one, below which health effects are not expected to occur.
- For Battlement Mesa residents not living adjacent to well pads, the estimated lifetime excess cancer risk of 71 cancers per one million people, while within EPA’s acceptable range of one to 100 cancers per one million people, exceeds EPA’s goal of less than one cancer per million people and is near the high end of the acceptable range. This translates to a population attributable risk of less than one cancer for a population of 5,041.

#### 4.1.4 Characterization of the Air Quality on Health

The impact of air quality due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Air Quality	Negative(-)	Community wide	Yes	Long	Frequent	Likely	Moderate to High	-14.5*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering anticipated air contaminant exposures associated with the Antero development within the Battlement Mesa PUD, air quality will likely produce **undesirable health effects** in the areas both in near development areas and **community wide**. Much of the community will be near sources of air contamination and ambient air quality will affect the entire community. Children, older adults, and individuals with respiratory diseases may be more vulnerable to the air contaminants and are considered **vulnerable populations**. Air quality degradation may last for the duration of Antero’s project, from well pad preparation through well abandonment, and therefore could be long in duration. The impacts to air quality are expected to be **frequent** and occur constantly and/or reoccur. It is **likely** that contaminant concentrations in residential ambient air may be high enough to cause short-term and long-term disease. Health effects may

include respiratory disease, neurological problems, and cancer. It is likely that medical attention will be necessary for some of these effects and that some of these effects will not be reversible. Therefore the impacts are rated as **moderate to high** magnitude. Using the numerical ranking scheme, air quality impacts are expected to produce a negative rank of -14.5 on a scale of  $\pm 6-15$ .

#### **4.1.5 Findings and Recommendations from Air Quality Assessment**

**What we know:** Air pollution is a hazard to the public health. GCPH and CDPHE ambient air studies, air toxics studies, and the broader scientific literature demonstrate that natural gas development and production contribute diminish air quality. These studies also show that the largest volume of emissions to air occur during well development. The Human Health Risk Assessment in this HIA, previous CDPHE risk assessments, and Saccomanno Study all conclude that there is likely to be an increased risk of cancer and other chronic and acute health effects from residential exposure to air emissions that can result from natural gas development and production. There have been several odor complaints associated with the Watson-Ranch well pad at the perimeter of the PUD filed with the COGCC. These odor complaints resulted in COGCC issuing a Notice of Alleged Violation.

**What we do not know:** The ambient air quality within the Battlement Mesa PUD is not known. The levels of air emissions during all stages of natural gas development and production are not known. Many types of possible emissions, such as PAHs and fracking chemicals, as well as the contribution of PM and ozone have not been assessed. It is not known if the set backs of wells from occupied buildings are adequate to protect public health.

#### **Recommendations to Reduce Impacts to Public Health from Air Pollution**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of air emissions.

1. Require submission of a quality assurance project plan (also known as a QAPP) to GCPH for review and approval for all monitoring specified in these recommendations to assure monitoring information will be adequate for informing public health decisions.
2. Require Antero monitoring results conducted in response to CDPHE consultation (dated 4/12/2010) be made available to the public in a timely manner to provide accessible information and transparency.
3. Require corrective action when odor events occur, including notification of the GCPH and residents to reduce impacts.
4. Require adherence to COGCC 805b green completion practices, with no variances, and EPA natural gas STAR program to reduce VOC emissions to the lowest level technically possible.
5. Require use of electrically powered generators in place of diesel powered generators for well drilling and fracking operations to reduce VOC, PAH, and PM emissions.
6. Require a valid emissions permit from the CDPHE for each well pad, per COGCC rule 805b to establish inspection and monitoring requirements.

7. To reduce VOC emission, require pilot lights on production tank combustors remain lit through use of appropriate technology, such as spark igniters.
8. Require adherence to dust control measures and traffic measures specified in the Surface Use Agreement.
9. Require that Antero establish and implement a plan that ensures all trucks used for its plan within the PUD meet emission standards specified in the Clean Fuel Vehicles (heavy trucks) for the Clean Fuel Fleet Program (CFR Part 88.105-94) to reduce VOC, PAH, and PM emissions.
10. Require truck loads of dirt, sand, aggregate materials, drilling cuttings, and similar materials be covered to reduce dust and PM emissions.
11. Require pits at the water storage facility to be covered to reduce VOC emissions.
12. Require air monitoring of water storage facility for VOC/BTEX and report results to GCPH.

The recommendations to address information gaps are in Section 5.

## ***4.2 Assessment of Water and Soil Quality on Health in Battlement Mesa***

“What will be the effect of chemicals on the water supply?”  
*June 15 stakeholder meeting*

The impact of natural gas development and production on water and soil quality and the water supply is a major concern to Battlement Mesa residents. Surface run-off, and infiltration from drilling cuttings and produced water stored in pits on well pads or off-site locations; well installation errors; and uncontrolled well development (kick backs, blow outs, and well fires) could result in emissions of contaminants to groundwater, subsurface soil, surface soil and surface water. Spills of fracking fluids, drilling muds, condensate, and diesel could result in contamination of surface soil. Run-off and infiltration then could result in subsequent contamination of surface waters and of groundwater and subsurface soil, respectively. Exhaust from diesel engines (through dry deposition of particulates) and wind erosion from drill cuttings could contaminate surface soils (through deposition of particulates). If the groundwater or subsurface soil is contaminated, VOCs could infiltrate and accumulate in the air of buildings. Sources of contaminants include the natural gas resource itself, chemicals used in well production activities, wastes from well production activities, and exhaust from machinery used in well production and maintenance.

### **4.2.1 Water and Soil Quality Impacts on Health**

Natural gas development and production and the diesel engines used to support them have the potential to release hundreds of metals, salts, hydrocarbons, carbonyls, and other contaminants to groundwater, surface water, and soil. People can be exposed to these contaminants through ingestion of water, incidental ingestion of soil, dermal absorption from water, inhalation of soil particulates, inhalation of VOCs released from water during activities such as showering, and

inhalation of VOCs in building air. Some of these contaminants, such as benzene<sup>39</sup> and several of the PAHs, are human carcinogens. Others, such as the carbonyls, alkanes, and 1,2,4-trimethylbenzene, can act as irritants of the eyes and skin or cause neurologic effects<sup>29</sup>. Specific health effects of several potential contaminants are described in the Air Quality Assessment and in the Human Health Risk Assessment (Appendix D).

Significant contamination of water supplies with salts, such as those containing chloride, can make the water unsuitable for human consumption and stress water treatment facilities. The water requirements for natural gas development and production are large, with the potential to tax local water supplies, particularly in the event of a drought.

#### 4.2.2 Current Conditions of Water and Soil Quality

The primary source of drinking and domestic water in Battlement Mesa is the Colorado River. The Battlement Mesa Water Treatment Plant draws water from two intakes located in the middle of the river for treatment. The available baseline groundwater and surface water data specific to Battlement Mesa is limited to the annual testing of the surface water intake and back-up groundwater wells at the Battlement Mesa Water treatment facility. These results indicate that there is no VOC, herbicide, pesticide or carbamate contamination of either drinking water supply. In addition, a domestic well at the Historic Battlement Mesa Schoolhouse was sampled on May 17, 2010 in response to an anonymous request from a landowner in the vicinity of Antero's Watson Ranch Well. The COGCC concluded the laboratory analysis did not indicate any impacts to this domestic water well from natural gas production operation<sup>40</sup>.

A baseline water quality study for the Piceance Basin was performed in 2006<sup>22</sup>. Seventy groundwater samples were collected from water supply wells located north of the Colorado River and south of the upland "Hogback" between the communities of Rifle and Parachute. The inorganic results are not applicable to Battlement Mesa, because the water chemistry between these two areas could be quite different. However, the BTEX and methyl-tert-butyl-ether (also known as MTBE) results could be somewhat representative of Battlement Mesa, because they are not naturally occurring. No measureable concentrations of BTEX, methyl-tert-butyl ether, or methane were detected in any of the samples.

There is no baseline data for surface soil or subsurface soil within the PUD and current conditions are not known.

The Colorado Department of Labor & Employment's Oil and Public Safety Division has permitted ten underground storage tanks within the PUD, summarized in the following table.

Permit Holder	Fuel	Tank Capacity (gallons)
Battlement Mesa Service	Gasoline	1,000

<b>Permit Holder</b>	<b>Fuel</b>	<b>Tank Capacity (gallons)</b>
Battlement Mesa Service	Diesel	1,000
Battlement Mesa Golf Course	Gasoline	2,000
Battlement Mesa Golf Course	Diesel	1,000
Kum and Go, Stone Quarry Road	Gasoline	20,000
Kum and Go, Stone Quarry Road	Gasoline	12,000
Kum and Go, Stone Quarry Road	Diesel	12,000
Kum and Go, Tamarisk Trail	Gasoline	10,000
Kum and Go, Tamarisk Trail	Gasoline	10,000
Kum and Go, Tamarisk Trail	Gasoline	8,000

These underground storage tanks have the potential to leak and contaminant subsurface soil and groundwater with fuel contaminants, including benzene. The permit holder is required to perform weekly leak tests on the underground storage tanks and the Oil and Gas Public Safety Division performs an annual inspection of the underground storage tank. Review of the Oil and Gas Public Safety Division files on August 18, 2010 indicated no leaks or contamination of soil or groundwater associated with these underground storage tanks.

There also are natural gas productions operations occurring on the border of the PUD that could potentially impact the water and soil quality within the PUD, as well as the water supply. Other potential sources of contamination to groundwater and soil are the golf course and landscaping operations (e.g. application of fertilizers, herbicides and pesticides).

In the event that the Battlement Mesa Water Treatment Plant was shut down, drinking and domestic water for Battlement Mesa residents would be supplied from four groundwater wells along the south bank of the Colorado River. These wells are not supplied with water from the Colorado River and it is believed that the source of water in these wells is from an up-gradient aquifer. There could be a hydrologic connection between these wells and the aquifer on Battlement Mesa, allowing for a conduit of natural gas extraction activity contaminants to the secondary drinking water source, although this has not been verified.

### **4.2.3 Antero Drilling Plans in Battlement Mesa and Water and Soil Quality**

The Mamm Creek field, located approximately 20 miles to the east of Battlement Mesa in Garfield County, has experienced extensive natural gas development and production, with over 1100 gas wells installed between 2000 and 2007. The two phase hydrogeologic study conducted between 2006 and 2007 on the Mamm Creek field<sup>21-22</sup> provides data that is useful in estimating potential impacts from natural gas development and production on water quality in Battlement Mesa. An increasing temporal trend of methane and chloride groundwater concentrations coincident with the increasing number of gas wells installed was observed in the hydrogeologic

study<sup>21-22, 41</sup>. The isotopic methane data indicate a thermogenic origin of methane, which may be attributed to the Williams Fork gas. The increasing chloride concentrations are attributed to Williams Fork production water.

In the Mamm Creek field hydrogeologic study, chloride concentrations did not exceed regulatory limits and there is no regulatory limit for methane. Benzene was only detected in groundwater and surface water samples collected in proximity to the West Divide Creek seep and the Amos well. Many of the benzene concentrations in these samples exceeded the 5 µg/L regulatory limit and the 0.41 µg/L EPA Regional Screening Level for tap water. At the West Divide Creek seep, a faulty cement job on the casing of the Schwartz well resulted in the migration of natural gas and BTEX over 2,000 feet southeast of the well and seepage into Divide Creek. At the Amos well, Williams Fork gas from poorly installed wells are believed to be responsible for the contamination.

Pavillion Wyoming, a community of approximately 166 residents located in Fremont County, also has experienced intensive natural gas development and production, with 211 active gas wells, 30 plugged and abandoned wells, 20 “shut-in” wells, and 37 production pits in an 8 square mile area. In response to complaints from Pavillion residents of odors and off-tastes in domestic water, EPA conducted sampling of both domestic and monitoring wells in the area between 2009 and 2010. The sampling results indicate that domestic wells are contaminated with low levels of petroleum hydrocarbons and thermogenic methane and that the shallow groundwater is heavily contaminated with petroleum hydrocarbons and BTEX. Natural gas development and production are the most likely source of the petroleum hydrocarbons and BTEX. Several inorganic compounds, such as sodium, sulfate, and nitrate, also were detected which could have sources other than natural gas development and production. The hydrologic connection between the drinking water aquifer and shallow groundwater is not well characterized. In their health consultation based on EPA’s results, ATSDR found the quality of the drinking water in several of the domestic wells was not acceptable and concluded that exposure to some of the contaminants could result in health effects<sup>42-43</sup>. While the groundwater contamination that occurred in Pavillion is not directly comparable to Battlement Mesa because of differences in the natural gas resource and state regulations, it does indicate that natural gas development and production can adversely impact groundwater quality.

Review of water quality data in the USGS and COGCC databases indicate that groundwater and surface water contamination from natural gas development and production at levels with the potential to impact water quality and exceed regulatory levels results from incidents such as loss of well control during development, well installation errors, and spills from produced water pits, as described in the Accidents and -Malfunctions Assessment. Available routine monitoring data in these databases indicate routine natural gas development and production (i.e. without incidents) may not be a significant source of water contamination, however, routine monitoring is limited and may not be representative of all instances of gas development and production. It is noted, that samples are most often collected in response to a complaint or incident or as part of a remedial action. There is very little data for routine monitoring of impacts to water quality at gas

wells or exploration and production (also known as E&P) waste pits, with the exception of required monitoring in the 3-mile perimeter of Project Rulison. This small amount of data limits the ability to make a true estimate of exposures from groundwater and surface water.

The Mamm Creek field hydrogeologic study results and USGS and COGCC databases indicate that routine natural gas development and production could impact water quality in Battlement Mesa, but not to an extent that causes exceedence of regulatory standards and triggers regulatory action. It is possible that increasing chloride concentrations could eventually affect the potable groundwater. Incidents resulting from well installation errors, uncontrolled well development, and spills could significantly affect the potable groundwater and water quality, as well as soil quality, in Battlement Mesa.

While there is no permanent surface water body in the PUD, there are intermittent drainages and creeks that could discharge to the Colorado River. Monument Creek, one of the major drainages off of Battlement Mesa discharges to the river downstream of domestic water intakes. It still is possible that surface run-off could introduce contaminants from upstream well pads into the river. However, the Colorado River has a high volume of water and it is most likely that any contamination would be diluted to non-harmful concentrations. The annual surface water quality results have not indicated any detectable levels of contamination from natural gas development and production at the intakes. In addition, natural gas operators must inform the Battlement Mesa Water Treatment Plant of upstream spills or incidents affecting the river (COGCC rule 317B)<sup>9</sup>. In the event of such a spill or incident, the intakes to the treatment plant can be shut down. The treatment plant routinely stores a week's supply of water allowing time for remediation of spills. The Battlement Mesa Metropolitan District is subject to the protections of COGCC Rule 317B, which regulates natural gas operations in surface water supply areas.

Antero is proposing to employ pitless drilling systems on the well pads within the PUD and to distribute and store production water at a centralized water storage facility, within the PUD. COGCC rule 904 requires liners for pits at centralized water storage facilities and has a provision<sup>9</sup>, at the discretion of the director, for the installation of leak detection systems in sensitive areas such as the PUD. COGCC rule 908 requires that centralized water storage facilities be permitted<sup>9</sup>; the geologic and hydrogeologic characterization of site; control of public access; fire lanes; surface water diversion systems, waste characterization profiles; an operating plan; baseline groundwater sampling and analysis; groundwater and surface water monitoring (at the discretion of the COGCC director); and groundwater and soil sampling when a pit is closed and the site remediated. Adherence to these rules, including the discretionary leak detection and monitoring, will significantly reduce the potential for impacts to water and soil quality from produced water and other exploration and production waste stored in the centralized pit. However, leaking pipelines and spills from chemical and production water hauling trucks could still create the potential to impact surface water quality. COGCC rules do not specifically address water pipeline leaks.

Any spills that occur on the pads could potentially impact water and soil quality by surface run-off and infiltration during precipitation events. This potential is evidenced in a sample of snow melt collected from a project Rulison well pad contained levels of benzene greater than regulatory limits<sup>44</sup>. COGCC rule 603 specifies that in high density areas, such as the PUD, berms (or other secondary containment devices) capable of containing 150 percent of the fluid in the largest tank within the berm be constructed around produced water and condensate tanks<sup>9</sup>. However, this rule does not provide for containment of spills that may occur outside the berm perimeter, such as during transfer of chemicals and materials to and from trucks and at well heads.

Wind erosion and surface run-off from drill cuttings stored on Antero's pads could impact surface water and surface soil quality. The COGCC rules do not specifically address drill cutting stored on well pads<sup>9</sup>.

At time of preparation of this HIA, it was not known if Antero is planning for deep injection of exploration and production wastewater within the PUD. COGCC rule requires written permission from the COGCC director prior to construction of an injection well. The HIA would need to be updated to include potential impacts to public health, if injections wells are proposed.

The Battlement Mesa Metropolitan District has a capacity of 6 million gallons of water per day. Currently, 3-3 ½ million gallons per day are used, allowing for the accommodation of Antero's water needs during well development operations. If water capacity were to significantly decrease, the needs of Battlement Mesa would take precedence to Antero's needs.

It is unlikely that Antero's proposed project will have a significant impact on the primary domestic water supply for Battlement Mesa. The potential for a significant impact to the secondary water supply may exist. If the potable groundwater is impaired, Battlement Mesa may not have a back up source of domestic water. In addition, there is the potential for the Antero's project to impact the water quality of intermittent streams, creeks, and puddles, as well as soil quality. Finally, it is possible that shallow aquifer contamination could cause VOC off gassing into Battlement Mesa homes, but since the hydrology of the area is not well understood, the likelihood of such an occurrence is not clear.

#### **4.2.4 Characterization of the impact on Water and Soil Quality**

The impact of water and soil quality due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Water and Soil Quality	Negative(-)	Community wide	Yes	Long	Infrequent	Unlikely	Moderate to High	-11.5*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering anticipated water and soil contaminant exposures associated with the Antero development within the Battlement Mesa PUD, water and soil quality may produce **negative health impacts** in the areas in close proximity to the development areas and community wide. If the domestic water supply were to be contaminated, the health effects would be **community wide**. Effects of wind erosion and surface run-off could be more localized, and could impact children more than adults. Children, older adults, and individuals with pre-existing disease may be more vulnerable to water and soil contaminants and are considered a **vulnerable population**. The duration of water quality degradation could be **long** and may last through the life of the Antero’s project, from well pad preparation through well abandonment. The impacts to water quality are expected to be **infrequent**. It is, however, **unlikely** that contaminant concentrations in water and soil will be high enough to cause short-term and long-term disease because the current supply of domestic water is the Colorado River and the COGCC has extensive rules to protect this resource. If exposure were to occur, health impacts may include skin and eye irritation, neurological problems, and cancer. It is likely that medical attention would be necessary for some of these impacts and that some of these impacts will not be reversible. Therefore the health impacts, if exposure were to occur, are rated as **moderate to high** magnitude. . Using the numerical ranking scheme, water and soil quality impacts are expected to produce a negative rank of -11.5 on a scale of ±6-15.

#### 4.2.5 Findings and Recommendations from Water and Soil Quality Assessment

**What we know:** Water pollution is hazardous to the public health. Garfield County Oil and Gas studies, EPA studies, and other studies demonstrate that natural gas development and production can release contaminants to domestic water supplies and compromise water quality. Individual circumstances can influence the potential contamination of water. In Garfield County, accidents and malfunctions have been the most common cause of water contamination from natural gas development and production. If a domestic water resource is contaminated, remediation is time and cost intensive and may not restore the water resource to a quality for domestic use.

**What we do not know:** The hydrogeology in Battlement Mesa has not been characterized and the relationship between groundwater, domestic water supplies, and the Colorado River in not well understood. The quality of groundwater in the Battlement Mesa PUD is not known and the extent of routine natural gas development and production on water quality is not known.

### **Recommendations to Reduce Impacts to Public Health from Water and Soil Pollution**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of water and soil pollution.

1. Require COGCC rules 317B, 603, 904, and 908, including those at the discretion of the director, be applied with no variances or exemptions, to prevent pollution of water and soil.
2. Require Antero to develop and implement plans to ensure removal of mud from vehicles leaving the well pads and access roads to prevent tracking of mud onto Battlement Mesa and Garfield County roads.
3. Require full disclosure of all chemicals, with their volumes, concentrations, and Material Safety Data Sheets (also known as MSDS), used in natural gas development process to GCPH and Battlement Mesa Residents.
4. Require continuation of all baseline and continuing monitoring requirements for groundwater, surface water, and soil and leak detection to prevent pollution of potential domestic water supplies.
5. Require the berming of the down gradient well pad perimeters, as well as surface water diversion ditches for each well pad to prevent pollution of water and soil.
6. Require monthly inspection of water and gas pipeline for leaks to prevent water and soil pollution.
7. Require immediate notification of GCPH (in addition to COGCC) in the event of a spill of five barrels to protect public health.
8. Require that drill cuttings be covered during storage on well pads to prevent wind transport and soil pollution.
9. Place an inlet protection system, similar to the system in place for Rifle and planned for Parachute, on the two intakes for the Battlement Mesa water treatment plant that would shut off the intakes if contaminants are detected to protect public health.

The recommendations to address information gaps are in Section 5.

#### ***4.3 Assessment of Transportation and Traffic on Health in Battlement Mesa***

Will there be motor vehicle accidents and related injury and death?

*February 3, 2010 stakeholder meeting*

Increases in transportation and traffic can impact health and safety of a community by increasing the risk of motor vehicle accidents, release of hazardous pollutants, creation of road dust, and impediment of walking and biking routes. Development of natural gas wells can cause significant increases in a variety of traffic, especially large truck traffic. Workers driving at high speeds may place residents at risk for severe injury or death. Residents living in Battlement Mesa have expressed concerns that traffic associated with the Antero gas project will impact the health

and safety of those living in the community. This assessment will address traffic impacts to the safety of Battlement Mesa citizens. Air quality, noise, and quality of life impacts due to increased traffic are addressed in other sections.

### 4.3.1 Traffic and Safety

Vehicular traffic is a known hazard to safety. Increases in traffic are associated with increased risk of motor vehicle injury and death, due to vehicle-vehicle, vehicle-pedestrian, and vehicle-bicycle accidents. Motor vehicle accidents can be associated with speeding, poor traffic management at intersections, and heavy vehicle movement. Numbers of injuries/fatalities are directly related to vehicle volume and severity of injury is directly related to vehicle speed<sup>45-46</sup>.

### 4.3.2 Current Traffic Conditions

Currently, large truck traffic within the PUD is mainly from delivery trucks supplying the local businesses, including gas stations and convenience and grocery stores. There are established county approved haul routes along the perimeter of the PUD, while most roads within the perimeter are limited to small vehicles. There are two entries into Battlement Mesa. The main entrance is just south of Exit 75 off of Interstate-70. A traffic analysis conducted by Schmueser/Gordon/Meyer, Inc. (SGM) for Antero in September 2009<sup>38</sup> found that this entrance had the highest traffic count in Battlement Mesa with 8,662 vehicle trips per day (vt/d). The second entry into Battlement Mesa is from Exit 75 via US 6 west to County Road (CR) 300 (CR 300/Stone Quarry Road) on the southwest side of Battlement Mesa. Traffic counts at the US 6/CR 300 intersection were 2,300 vt/d, but were only 648 vt/d on CR 300 where it enters the PUD west of the recreational vehicle (RV) park. Other counts indicate that on West Battlement Mesa Parkway there were 5,340 vt/d and on CR 307 (River Bluff Road) there were 371 vt/d. Since there is no current industrial activity and very few retail stores, it is assumed that the large majority of these vehicle trips were passenger cars and light trucks, although this is not specifically stated in the traffic report. The report also projects an increase of 2.3% vehicle trips annually unrelated to the Antero drilling plan, based on average annual growth of Garfield County.

Motor vehicle accidents in Garfield County are handled by the county sheriff's office, local municipal law enforcement and the Colorado State Patrol. When looking at accidents handled by the state patrol, Garfield County had the 9<sup>th</sup> highest number of motor vehicle accidents in the state in 2008, with 1,091 accidents total (14 fatal crashes, 116 that resulted in injury and 961 that resulted in property damage)<sup>47</sup>. Data from the county sheriff's office and data specific to Battlement Mesa are not currently available.

<p><b>Top 10 Colorado Counties</b> <b>2008 Fatal, Injury, and Property Damage Crashes by County</b> <b>as Covered by the Colorado State Patrol (not all Colorado Crashes)</b> <a href="http://csp.state.co.us/TS_CrashStat.html">http://csp.state.co.us/TS_CrashStat.html</a></p>
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<b>County</b>	<b>Fatal</b>	<b>Injury</b>	<b>Property Damage</b>	<b>Grand Total</b>
Jefferson	19	395	2,530	2,944
El Paso	20	278	1,953	2,251
Adams	13	233	1,773	2,019
Mesa	7	211	1,188	1,406
Larimer	14	275	1,080	1,369
Weld	28	258	1,065	1,351
Eagle	6	132	1,073	1,211
Douglas	10	145	1,032	1,187
Garfield	14	116	961	1,091
Boulder	14	182	860	1,056
<b>Grand Total</b>	<b>290</b>	<b>3,895</b>	<b>23,028</b>	<b>27,213</b>

Children attending school in Battlement Mesa arrive and leave via passenger car, school bus, walking, or bicycle. Underwood Elementary (grades 1-3), St. John Elementary (grades 4-5) and Grand Valley Middle School (grades 6-8) are in Battlement Mesa. The Early Childhood Center (PreK-Kindergarten) and Grand Valley High School are in Parachute. Some students are not offered bus service if they live within a “Walk” zone. Specifically, students attending Underwood Elementary and living in Saddleback Village, Tamarisk Village, Tamarack Meadows are not offered bus service; children attending St. John Elementary and living in Willow Ridge, Willow Park, Valley View, Monument Creek Village, Canyon View, and Stone Ridge are not offered bus service; and children attending Grand Valley Middle School and living in Mesa Ridge, Eagle’s Point, Willow Ridge, Willow Park, and Valley View are not offered bus service. (Battlement Mesa early childhood students and high school students are all offered bus service and ride together.) School hours in Battlement Mesa schools are 8:40 am -3:40 pm at Underwood (early release at 2:10pm); 8:25am- 3:25pm at St. John (early release at 1:55pm); and 7:50am-7:15pm at Grand Valley Middle School (1:45pm early release). A map detailing Antero’s planned haul routes and school bus stops will be included in the final report.

### 4.3.3 Antero Drilling Plans in Battlement Mesa and Traffic

Traffic associated with natural gas development is related to earth moving construction of well pads; movement of materials and waste to and from the well site; installation of pipelines; long term production; maintenance operations; final reclamation of the site after production is completed; and travel of workers to/from work. The most traffic intensive phases involve pad construction, drilling and well completion and pipeline construction.

Antero has described a three phase development plan for the Battlement Mesa project as described in the public meetings powerpoints. Phase 1 will develop the Stierberger Pad, Pad E,

Pad G, and the water storage facility (Pad F) on the south side of the PUD. Phase 2 will develop the Parks and Rec Pad, Pad A, Pad B, and Pad D on the north side of the PUD. The Parks and Rec pad replaces the Pad C originally planned. Phase 3 will develop the L and M pads on the northeast side of the PUD. Each phase will involve access road, pad and pipeline construction needed to develop the wells and tie them to the water movement system and the gas gathering lines at the eastern edge of the PUD.

The traffic analysis conducted by SGM used estimates from previous Antero development sites in the Mamm Creek area to project average and maximum trips per day, for the Battlement Mesa project. Trips per day range from 2 (production phase) to 280 or more (intensive construction phase). Drilling completion, light construction, and pipeline installation range from on average 16-31 vt/d and a maximum of 30-46 vt/d. The duration of the pad construction ranges from 10-30 days and the other phase durations *per well* are drilling (18 days); completion (30 days); pipe installation (60 days/ mile); duration of each phase per pad was not calculated but efficiencies associated with drilling multiple wells sequentially on a pad will reduce the time of each phase on a pad. Production is projected to last 20 years. Reclamation after production is expected to have 7-10 vt/d for 11 days per pad.

Although initial presentations to the public describe well development phases to last 3-4 years, more recent estimates in the traffic analysis indicate that well development is expected to occur for at least five years, maybe longer, depending on economic and regulatory conditions. Well development phases will overlap on different well pads so that while pad construction is occurring on one pad, drilling is accomplished on another and completion may be occurring on another pad. Therefore, traffic will be overlapping as well, with trucks associated with construction, drilling, pipeline and completion using the haul routes simultaneously. Trips per day for each of these phases are added to estimate the number of trips per day expected during the first five years when well development is occurring. The number of trips per day is estimated to be 90-120 vt/d when light construction is occurring. When more intense well pad construction is occurring (during the Phase 2 well pad construction) traffic is projected to be 340 vt/d for approximately 120 days. Some activities will occur 24 hours a day and the vehicle trips will be spread throughout the day and night. Antero has stated they will limit truck hauling to hours outside of school zone hours. The majority of these trips are expected to be heavy trucks.

Antero plans to use county haul routes for traffic. During all phases entrance and exit from Battlement Mesa will be via the US 6/ CR 300 route (Stone Quarry Road), on the southwest side of the PUD. Phase 1 also will utilize CR 303, CR 308 and CR 302. Phase 2 will utilize CR 303, CR 308, East Battlement Mesa Parkway, South Battlement Mesa Parkway, and CR 307 (River Bluff Road). Phase 3 will utilize CR 303, CR 308, East Battlement Mesa Parkway, North Battlement Mesa Parkway, and West Battlement Mesa Parkway. The county restricts hauling on CR302, CR 307, South Battlement Mesa Parkway, and West Battlement Mesa Parkway. It is assumed that Antero will be required to obtain special permits to use these roads.

School buses for all the schools use and cross Antero haul routes. Although all children in the PUD may be impacted by crossing the haul routes while going to and from school, middle school age children may be the most impacted since the middle school is near two haul routes and children this age are more likely than younger children to be walking or bicycling on their own. According to the traffic analysis plan, Antero has decided to avoid any heavy truck hauling during school zone hours. Children going to/from school outside of school zone hours will be crossing haul routes while truck traffic is occurring.

Antero has planned mitigations to decrease impacts of traffic on the Battlement Mesa Community. Of significance, Antero has committed to building a water management system comprised of water distribution pipes going from the well pads to the water storage site on the south side of the PUD. This water management system is intended to decrease movement of water by trucks and it is estimated that there will be fewer trips during the development phases because of this system.

In addition to heavy truck traffic, there will be workers coming into Battlement Mesa and traveling within Battlement Mesa in passenger cars and light trucks. It is estimated that there will be an average of 120-150 workers in Battlement Mesa during the five year development period. Antero intends to house some workers in Battlement Mesa to decrease worker movement into and out of the PUD. Workers exceeding speed limits can put other vehicles and pedestrians at risk for injury and fatality. Antero management emphasizes safe driving but a formal safe driving program does not exist.

It is expected that the increase in heavy truck volume from negligible to tens or hundreds per day within the PUD may compromise road integrity and needs for increased road maintenance is anticipated. County funds will be needed to maintain haul routes as well as installation of road and pedestrian safety mitigations if needed. Utilization of county funds for roads and road safety may divert funds from other county programs, including health programs, there by potentially impacting public health infrastructure.

#### 4.3.4 Characterization of Traffic Impacts on Safety

The following table summarizes the characterization of impacts from traffic.

Impact	Direction of health effects	Geographic extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Ranked
Traffic and Transportation	Negative (-)	Community-wide	Yes	Long	Frequent	Possible	Low to high	-13.0*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering public health to residents of Battlement Mesa, the increased traffic within the PUD is likely to create **negative** health effects due to increased safety risks. Because the haul routes include the entire circle of the Battlement Mesa Parkway as well as other roads within and on the perimeter of the PUD, the impact of the traffic is likely to be **community-wide**. There will be certain parts of the community that will be greater impacts for the duration of Antero's project (those homes next to CR300/Stone Quarry Road) while others will be impacted by very high volume traffic during the construction of the Phase 3 pads (those along River Bluff Road). Because children often walk and ride bicycles and are not as safety conscious, they are more **vulnerable** than most adults to the impacts of traffic within the PUD. Antero has committed to limit heavy truck traffic during school zone hours which will decrease risk to children traveling to and from school at those times. Children staying after school for sports and other activities may be at risk for traffic incidents related to truck traffic outside of those hours. Furthermore, truck traffic is likely to continue on weekends and holidays and children may be crossing haul routes at those times. The duration of exposure to increased traffic will be **long**, spanning the entire duration of the development of all three phases, at least five years. The traffic will be frequent, in some cases (River Bluff Road), several hundred trucks will be passing a day for several months. Along Stone Quarry road, there will be 45 to 113 trucks passing a day for approximately five years. Increased traffic is known to be associated with increased risk of traffic accidents and it is **possible** that there will be traffic related accident as a result of the Antero project. The magnitude will depend upon how well the traffic is controlled, how well mitigation efforts are adhered to, and to unrelated or perhaps chance factors. Traffic can cause minor to severe/fatal injuries and as such, the magnitude of the impacts will be **low to high**. Using the numerical ranking scheme, traffic impacts are expected to produce a negative rank of -13.0 on a scale of  $\pm 6-15$ .

#### **4.3.5 Findings and Recommendations from Traffic and Transportation Assessment**

**What we know:** An increase in traffic is associated with an increase in risk for motor vehicle accidents that can involve cars, pedestrians, and bicycles. The risk of severe injuries in motor vehicle accidents increases as the speed of traffic increases. Increased traffic also increases air pollution and noise levels.

**What we do not know:** We do not know if Battlement Mesa has dangerous traffic spots or the normal pedestrian/bicycle patterns.

#### **Recommendations to Reduce Impacts to Public Health from Traffic and Transportation**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of traffic and transportation.

1. Require Antero to build water treatment facility and associated pipelines in advance of well development, to immediately remove water hauling traffic from PUD.
2. Require Antero to communicate and coordinate with local school district to develop plan for transportation and safety needs of all children going to and from school by car, bus, bicycle and walking during and outside of school zone hours to prevent injury to school children.
3. Reduce truck speed limits to 20 mph in areas where there is existing pedestrian traffic that is not buffered from haul routes to prevent accidents and to reduce the severity of injury should an accident occur.
4. Consider speed control measures on worker ingress and egress routes (ie decreased speed limits, signage, real time speed measurement signs, photo speed ticket vans, speed bumps or other measures) to prevent workers from speeding.
5. Mark pedestrian/bike high use routes and establish safe crossing zones where they intersect Battlement Mesa Parkway or other haul routes to alert drivers of potential pedestrians and bicyclers.
6. Install safety measures (ie, signaled cross walks, elevated side walks, green space buffers) for pedestrians/bikes where established walking/biking routes overlap/run along haul routes to prevent accidents.
7. Request that the Garfield County Sheriff's Department or other qualified entity to review Antero's Traffic Impact Analysis and request feedback on possible safety mitigations and traffic hot spots to ensure the plan has is protective of public health.
8. Require safe driver training for workers and implement penalty system for unsafe drivers, to encourage safe driving.
9. Require Antero to have a system to identify and remove unsafe drivers to prevent accidents and injuries.
10. Provide Sheriff's Auxiliary Unit with authority to log speeding and unsafe driving incidents and complaints within the PUD, which can be provided to Antero, subcontractors and the Sheriff's department so that problems can be resolved, to identify unsafe conditions.

The recommendations to address information gaps are in Section 5.

#### ***4.4 Assessment of Noise, Vibration, and Light Pollution on Health in Battlement Mesa***

"I am concerned that noise and vibration will affect my sleep. Will these be addressed?"

*June 15 stakeholder meeting*

Increased noise, vibration, and light are common concerns for citizens near construction and industrial sites. At natural gas sites noise and vibration can occur in the construction phase, drilling and completion phases, and due to truck traffic. Light pollution can occur due to 24 hour lighting during development and production operations. Because of these sources, noise,

vibration, and light concerns have been expressed by Battlement Mesa residents at stakeholder meetings.

COGCC Rule 802<sup>48</sup>, based upon the State of Colorado Noise Ordinance<sup>49</sup>, states that pad construction operations are considered industrial sites and site noise may not exceed 80 decibels (dB) in the day and 75 dB at night. Residential noise must not exceed 55 dB in the day and 50 dB at night. COGCC Rule 803<sup>50</sup> states “site lighting shall be directed downward and internally so as to avoid glare on public roads and building units within seven (700) hundred feet.” COGCC does not have a rule limiting ground vibration, but according to the US Department of Transportation ground vibration is generally not felt below 65 VdB and annoyance can be experienced at 70 VdB<sup>51</sup>.

According to EPA research, construction equipment can produce noise ranging from 80-89 dB at a distance of 50 feet and 60-69 dB at 500 feet<sup>52</sup>. Heavy construction equipment can cause vibration of 85 VdB 50 feet from the source<sup>51</sup>.

Because there is a potential for noise, light and vibration to exceed COGCC rules and background levels, a review of potential noise, vibration and light impacts is warranted.

#### **4.4.1 Noise, Vibration, Light pollution and Health**

Both acute loud noise and chronic lower level noise have been associated with a variety of negative health effects. Hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise (greater than 85 dB). The odds of hearing loss increase as the decibel level increases. A dose relationship between noise level and hearing loss exists<sup>53</sup>.

Studies looking at the relationship between noise and cardiovascular disease, hypertension, psychological symptoms, and respiratory impairment are numerous. Reviews and meta-analysis of these studies conclude that noise has the potential to impact these health outcomes<sup>54-57</sup>. Cardiovascular risk factors have been shown to be impacted by noise levels in the range of 51-70 dB in persons with several years of exposure<sup>58</sup>.

Noise annoyance can lead to stress related impacts on health such as feelings of displeasure, interference with thoughts, feelings, and activities and disturbed sleep and can have impacts on mood, performance, fatigue, and cognition<sup>59</sup>. Noise levels that produce these impacts can vary: annoyance can occur at 55dB; school performance can be impacted at 70 dB; and sleep can be impacted by as little as 35-60 dB. Ground vibration and low frequency noise may cause health impacts similar to those associated with noise annoyance.

Establishment of causal relationships between noise/ vibration and health impacts is complicated by the fact that noise annoyance in particular can vary with pitch, frequency, and duration. In addition, individual adaptation to noise can vary and complicates subjective reporting as well as expected outcomes.

Preliminary research suggests that light at night may affect health by disrupting normal circadian rhythms<sup>60-61</sup>. The International Agency for Research on Cancer has listed shift work a Class 2A (probable) carcinogen based on epidemiologic links to breast cancer. Mechanisms for the health effects of light at night are actively being studied and include altered melatonin and other hormone release<sup>62</sup>.

#### **4.4.2 Current Noise, Vibration, and Light Conditions**

Residences in Battlement Mesa are located one mile or more from Interstate-70 and are not likely to have noise impacts from this source. As such, background noise is likely to be comparable to other non-industrial, rural/semi-rural communities. In 2002, La Plata County, Colorado conducted noise sampling in rural, residential, traffic corridors and light industrial areas<sup>63</sup>. Twenty-four hour residential subdivision noise ranged from 37-53 dB, with an average of 42-45 dB. Traffic corridors ranged from 55-65 dB, with an average of 57 on a state highway and 45 on a collector road. Battlement Mesa neighborhoods are likely to have noise levels similar to those measured in La Plata County. Likewise, night time light is likely to be similar to other residential areas, consisting of municipal street and outdoor home lighting. Baseline lighting measures for Battlement Mesa do not exist.

Some residences in Battlement Mesa, however, may already be proximate to natural gas production sites located outside the PUD and maybe experiencing or have experienced noise and light trespass elevated above background in relation to this development. There not currently any significant sources of vibration within the PUD.

#### **4.4.3 Antero Drilling Plans in Battlement Mesa and Noise/Vibration/Light**

Sources of noise will include: large truck traffic; road and well pad construction machinery; diesel engines used during drilling; fracking and completion stages; and drill rig brakes. Antero has stated that they will use electric engines for some drilling operations within the PUD but that diesel engines will be used for all completion activities. Antero indicates that well pads are expected to be at least 500 feet from residences and much well pad noise will be abated by distance. However, without ancillary noise abatement, it is likely that the Antero project will produce noise above background, and possibly above COGCC levels, during the construction and well development phases and during well maintenance (workovers). The topography of the land may play an important role in increasing or decreasing noise emanating from the well pad. Noise is expected to range from intermittent (traffic and drill rig brakes) to continuous (diesel engine use during drilling and fracking) for several weeks to months. Drilling and associated noise will also round the clock. Although specific distances from truck haul routes to schools is not available, rough estimates indicate that schools are roughly 1,000 feet or more from truck routes and may not experience significant noise impacts. Residents living less than 500 feet from truck routes, such as along CR 300 (Saddleback Village) or West Battlement Mesa Parkway (Willow Creek Village), are close enough to experience noise that could be between 65

and 85 dB when trucks are passing, at times 9- 12 times per hour or more. These areas could experience some associated intermittent vibration as well.

Because drilling operations occur round the clock, the well pad is lighted and may contribute to light at night at nearby residences. Elevated light levels would be expected to last throughout the drilling period for each pad. In addition, Antero may choose to light well pads for security reasons.

In community meetings, Antero has described possible noise and light abatement strategies. According to meetings documents and the Surface Use Agreement, Antero is not planning centralized compression (a significant noise source). Well head compression if utilized will be housed with noise suppression equipment. Other noise abatement strategies may include use of hay bale walls around the pad, noise blankets for diesel engines, and electric grid power for drilling. Antero documents also indicated possible use of drill rig placement strategies and sodium vapor lights to decrease light trespass. At this time, it is unclear which of these mitigations will be included in the Major Land Use Impact Review and Comprehensive Drilling Plan permit application. However, because Battlement Mesa currently enjoys very low ambient noise and light levels, the Antero project will likely produce noise and light above ambient levels during construction and well development/workover stages and along haul routes, and may at times exceed COGCC rules.

#### 4.4.4 Characterization of Noise, Vibration and Light Impacts

The impact of noise due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable Populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Noise, Vibration, Light	Negative (-)	Local	No	Long	Frequent	Possible	Low-Medium	-10.5*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering anticipated noise, vibration, and light exposures associated with the Antero development within the Battlement Mesa PUD, noise, vibration and light may produce **negative** health effects. Of the three, noise is likely to be the significant health driver. Distance and light mitigations should decrease light at night to the point where there are not significant health impacts. Vibration may occur as a result of truck traffic but health effects are more likely to be due to noise annoyance in these situations. While all or most parts of the community may be proximate to noise sources at different times, it is not likely that the entire community will be

affected by noise during the development of an individual pad or by truck traffic. There are some residents close to haul routes that may experience elevated noise due to truck traffic for five years or more. Noise impacts will therefore be **local** to areas in close proximity to the development areas and areas close to truck traffic routes. There are **no vulnerable populations** in Battlement Mesa, although truck traffic passing by the St. John Elementary School and the Grand Valley Middle School may be disruptive during school hours. The elevated noise is expected to be associated with construction and development phases and with truck traffic on haul routes. The pad development phases will last several months, while nearby truck traffic may last several years for some residents, and so, duration of exposure is expected to be **long** depending on location. Significant noise levels are not expected during normal production phases in the years subsequent to well development. Should reworking of wells be conducted, noise levels are expected to increase, again for several months, during the reworking phase. When noise occurs is expected to occur **frequently** as it will be constant and/or frequently reoccurring. It is unlikely that residential noise will be loud enough to cause noise induced hearing loss or long enough in duration to impact cardiovascular disease. In general, health impacts are likely to result from annoyance due to noise above background and may cause sleep disturbance, displeasure, fatigue, etc. It is not likely that medical attention will be necessary for most people, although some may seek medical assistance. Therefore the health effects are rated as **low-medium magnitude**. It is possible that in some individuals, noise levels will produce significant annoyance and may produce larger health effects. Using the numerical ranking scheme, noise/vibration/light impacts are expected to produce a negative rank of -10.5 on a scale of  $\pm 6-15$ .

#### **4.4.5 Findings and Recommendations from Noise, Vibration, and Light Assessment**

**What we know:** Noise can have negative effects on public health that can vary at the individual level. Background noise levels in Battlement Mesa are low.

**What we do not know:** The potential noise levels at COGCC and Antero's proposed set backs and along truck haul routes are not known.

#### **Recommendations to Reduce Impacts to Public Health from Noise, Vibration, and Light**

Based on these findings, the following are some of the suggested ways to reduce the potential impact of noise, vibration, and light pollution.

1. Reduce speed limits for trucks within the PUD to 20 miles per hour to reduce noise and vibration levels.
2. Require best available noise reduction technology for heavy equipment, including trucks and truck brakes, to reduce noise levels.
3. Require Antero to alert residents of anticipated noise, including time, duration, decibel levels, and machinery to be used to protect public health.

4. Require Antero, in cooperation with Battlement Mesa residents and GCPH, to develop and implement a plan that includes a variety of noise control strategies to address the Battlement Mesa resident's noise concerns to protect public health and to prevent long-term nuisance noise levels.
5. Provide residents the option of requiring Antero to install permanent/semi-permanent noise mitigation structures (sound walls) along haul routes CR300 and other routes where trucks are anticipated to be passing throughout the development period to reduce noise levels.
6. Consider installation of traffic noise barriers near the St. John Elementary School and Grand Valley Middle School to reduce noise levels at schools.

The recommendations to address information gaps are in Section 5.

#### ***4.5 Assessment of Impacts on Community Wellness***

Will the development have impacts on education? What will be the mental health impacts? Will there be more or less services in the community?

*February 3, 2010 stakeholder meeting*

Residents of Battlement Mesa are concerned that the Antero project may affect the well-being of their social and community environment. Current epidemiologic literature cites a myriad of challenges in understanding the specific effects of the community and social environment on individual physical and psychological health. Largely, this is due to the difficulty in analyzing the separate and complex processes through which community and individual factors work together to influence health<sup>64-65</sup>. As such, it is difficult to identify and measure community factors which may influence health and well-being independent of individual level risk factors. Never the less, it is widely accepted that societal factors contribute to the health status of individuals through either the promotion or hindering of healthy choices and behaviors, and it is the collective health of individuals which contribute to the broader sense of community well-being among residents<sup>66-67</sup>.

While there is no single determinant or definition of a healthy community, the CSPH team assessed current community wellness conditions through societal-based factors which were expressed as concerns by Battlement Mesa citizens. School enrollment, crime rates, prevalence of substance abuse, prevalence of sexually transmitted infection, and social service availability were assessed as surrogate measures of community health. Other measures of quality of life, such as the availability of and participation in recreational activities and the depth and breadth of active social networks, may also speak to the health status of a community, but these are more difficult to codify with data.

##### **4.5.1 Current Community Wellness Conditions**

Primary data on several baseline community health characteristics were collected and are cited and described in detail in Appendix C, including data on school enrollment, criminal activity, mental health and substance abuse, and sexually transmitted infections. The years 2005-2008 appear to be a period of increase for several of the measures observed. During this time, school enrollment in Garfield County's District 16 increased by 37.4%. There was a substantive change in the racial/ethnic distribution of students enrolled during this time, demonstrated by the decrease in the proportion of Caucasian/non-Hispanic students accompanied by a rise in the percentage of Hispanic children. Criminal activity was elevated during 2005-08, with a calculated average of over 300 arrests per year during that time. Chlamydia and gonorrhea counts in Garfield County steadily increased during the 2005-2008 time period. However, counts for Battlement Mesa varied, with a larger number of cases occurring in 2007 and 2008. For the purposes of community health monitoring, it is important to review these data prospectively to evaluate future changes and trends.

Longitudinal data on mental health, substance abuse and suicide were not available for similar analysis. Results from a 2006 public health survey conducted by the Garfield GCPH found that upwards of 17% of residents were burdened by at least one of these conditions. Further, in many cases, when respondents reported experiencing mental health problems (defined as experiencing depression or stress), they also reported difficulties coping with substance abuse issues and engaging in physical activity<sup>68</sup>. A 2006 study of hospital discharge data for Garfield County regional hospitals found that 275 persons had been hospitalized for alcohol/substance abuse or suicidal behavior during the period 2003-05. Of those 275, 47 (17.1%) had an alcohol/drug abuse diagnosis and 228 (82.9%) had a diagnosis of suicidal behavior<sup>69</sup>.

To meet area community health needs, Garfield County operates a comprehensive Public Health Department (the GCPH) with locations in Rifle and Glenwood Springs<sup>70</sup>. Battlement Mesa residents are eligible for all services provided by the GCPH. Some services relevant to the community health measures discussed include:

- General health education and screenings
- Communicable disease surveillance
- STD/HIV screening
- Crisis support hotlines for domestic violence, suicide and mental health
- Tobacco prevention
- Emergency service and assistance
- Adult education programs
- Human services, including employment, food and housing assistance programs
- Services of a designated environmental health department, including the C.A.R.E.S. project for responding to community concern about environmental health issues

#### **4.5.2 Antero Drilling Plans in Battlement Mesa and Community Wellness**

While numerous case studies and assessments have been done around boomtown and industrial effects on psychosocial and community health, very little peer-reviewed research has looked at the relationship between natural gas development and production exposure and social-based health effects, and the existing literature appears to be mixed. While there are several studies providing evidence that exposure to natural gas development and production can have negative psycho-social health implications, there are also studies that find positive effects<sup>71 72-75</sup>. Additionally, there are a few studies that find no association at all between natural gas development and production and social and psychological health<sup>17, 76</sup>. Based on the current state of this literature, it is difficult to estimate social and community health effects related to natural gas development and production.

There is some literature available which discusses the relationship of “boomtown” economies and community health. According to information provided by Antero, the workforce for Antero’s project is likely to average 120-150 workers. The impact of the Antero workforce may produce some “boomtown” effects, but the magnitude of these effects will depend a great deal upon the makeup of the workforce (number of single men, number of families, living in or out of Battlement Mesa, etc.). Some commonly recognized social impacts of boomtown economies, many of which can be attributed to rapid increases in population and changes in the economic base, are: stresses on local government support and planning agencies; shortages of permanent housing units; and changing employment and business trends, both positive and negative<sup>77</sup>. The social problems of mental health, criminal activity, divorce, suicide and alcoholism are said to occur at disproportionate rates in boomtown economies compared to non-impacted communities<sup>77</sup>. Boomtown literature also describes disruptions in social cohesion due to population influx and the likely opposition that arises between the “new comers” (both temporary and permanent new residents) and the “old timers”<sup>77</sup>. However, both groups are vulnerable to combination of positive and negative community impacts.

Due to limited availability of readily accessible data measures, only the following topics were assessed to address uncertainty and community concern for community impacts of Antero’s project.

**Education:** Inherent with changes in population come changes to school enrollment; increased population generally leads to an increase in the class size, which may dictate an increase in the ratio of students-to-teachers. Larger class sizes also put a strain on the physical aspects of educational facilities with increased wear-and-tear on furniture, books and equipment and need for more physical space. Influx of a semi-permanent or long-term work force coupled with a booming local economy could increase local school enrollments beyond capacity and expected annual growth rates. Increase school enrollment may also have positive effects in that the schools may qualify for increased funds to improve educational services and options.

**Crime:** Several research studies have correlated increased crime rates with communities involved in natural gas development and production, including crimes such as domestic violence,

rape, prostitution, assault, child abuse, and homicide<sup>72-75</sup>. Because jobs in natural gas development and production usually attract a transient workforce, residents in affected communities often attribute increasing crime rates to the industry workers. On the other hand, there has also been some literature reporting lower crime rates after the commencement of natural gas development and production<sup>71</sup> and some research arguing that there is no association at all between natural gas development and production and social and psychological health outcomes<sup>17, 76</sup>. Due to the uncertainty and potential for high impact on community residents, it is important to examine and monitor the available crime data for Battlement Mesa.

***Substance Abuse:*** Several studies have reported an increased burden of substance abuse behaviors in communities involved in natural gas development and production, with primary emphasis being that substance abuse is prevalent among workers in the oil natural gas development and production<sup>71, 75, 78</sup>. In some cases, increased illegal substance activity has been associated with seasonal increases in natural gas development and production<sup>79</sup>. At the local level, a 2006 survey of EnCana subcontractors working in Colorado, conducted by White River Counseling, reported that 66.3% of subcontractors were concerned about methamphetamine use among their employees, and 68.9% were concerned about heavy drinking. Concern was rated primarily with respect to productivity and workplace safety, however questions about community impact were also assessed. Notably, the respondents who reported higher levels of concern about the potential impact of employee substance abuse affecting the local community also had stronger feelings about being proactive to prevent alcohol and drug abuse<sup>80</sup>. While not a conclusive study, this indicates that workers may be receptive to substance abuse prevention and intervention efforts presented as part of a community health initiative. For these reasons, it is important to monitor whether drug and alcohol use among community residents shifts with the introduction of gas drilling.

***Mental Health and Suicide:*** Treatment for mental health conditions and suicidal tendencies is conducted predominantly in the outpatient setting. As such, hospital discharge data for these and related conditions generally do not reflect the true burden of these issues in any given community. Additionally, due to their highly sensitive nature, outpatient data for these issues at the local community level is not publicly available. Studies of the community impacts of boomtown industries do not offer clear evidence for direct impacts to mental health, other than to suggest that changes in other measures may add or subtract from the levels stress, worry, and satisfaction experienced by individuals in the community<sup>77, 79</sup>.

***Sexually Transmitted Infection:*** In any population, sexually transmitted infections are an important public health prevention priority. Undetected and untreated infection with certain sexually transmitted infections can cause long term health problems. As described by the National Institute of Allergy and Infectious Diseases, some of the health complications that arise from sexually transmitted infections include pelvic inflammatory disease, infertility, tubal or ectopic pregnancy, cervical cancer, and perinatal or congenital infections in infants born to infected mothers<sup>81</sup>. In addition, syphilis and HIV/AIDS cause substantial health problems in all those infected. In addition to long-term health effects of acquired sexually transmitted

infection's, there are the daily consequences of pain, discomfort, and often embarrassment. Loss of worker productivity is also a concern with sexually transmitted infection, due to time required away from work to access testing, and received results and treatment, a process which may involve two days off work depending on travel distance to the nearest confidential testing/treatment center<sup>82-83</sup>.

Increases in the community burden of sexually transmitted infection have been identified as a health effect of extraction industries in many low- and middle-income countries<sup>82-83</sup>. The same association has not been causally established by research conducted in relation to North American energy-extraction; however, it stands to reason that this is an area which should be monitored. Key factors perceived to increase the spread of sexually transmitted infection with the influx of extraction-industries include the transient nature of the in-migrant worker population who are away from social controls of their home community, the long and difficult work days possibly fostering desire for drug and alcohol binges during time off, and high salaries and disposable income in a young work-force<sup>82-83</sup>. These contributing factors are concerning given the difficulties often experienced in providing sexually transmitted infection prevention and treatment for an itinerant natural gas development and production workforce. In addition to the inherent stigmas often associated with sexually transmitted infection testing/treatment, workers cite lack of access to sexually transmitted infection services due to geographic isolation from sexually transmitted infection services, lack of available walk-in testing and sexually transmitted infection clinic hours overlapping with their own working hours<sup>82-83</sup>.

***Lifestyle/Recreation:*** Many residents of Battlement Mesa seek the enjoyment of outdoor recreational activities, and thus expressed concern over potential impediments to participating in activities such as hiking, biking, fishing, hunting, and golfing. Negative effects to community engagement in these activities would likely be due to changes in the surrounding wilderness and public lands that may be caused by natural gas development and production. We were unable to assess whether public access to recreational activities would be altered by this project, and the extent of potential environmental effects are not known at this time. In addition to outdoor recreation, Battlement Mesa offers residents a 53,000 square-foot indoor recreation facility. An increase in local population may raise membership at the activity center, however this is not expected to supersede capacity as the facility was designed and built as part of the planned community of Battlement Mesa<sup>11</sup>.

***Social Capital/Social Cohesion:*** Perhaps the biggest contributor to the social cohesion of Battlement Mesa is its status as a “planned community”, where business, schools, and facilities and access for recreation are cohesively integrated with residential living<sup>11</sup>. Well-planned combinations of built and natural environments promote social interaction and pride in community living, which are in turn determinants of mental health and well-being<sup>66</sup>. Strong social support and community networks have generally positive effects on physical and mental health of individuals<sup>84</sup>. As such, effects on the social cohesion of Battlement Mesa residents may be determined and intertwined with physical effects to the community itself, such as damaged or neglected roads, neighboring homes and businesses, public lands and parks. There is limited

data available to directly assess the functioning level of social capital and cohesion in any community, yet surrogate measures can be monitored. These include many of the issues already discussed, as well as monitoring access and use of public health and social services. As population of an area changes or grows, it is expected that the infrastructure of services rendered to that community may need to adapt to meet increasing or changing demands

### 4.5.3 Characterization of Community Wellness Impacts

As described above, community wellness is characterized by a compilation of factors such as school enrollment, rates of sexually transmitted infection, incidence of criminal activity, burden of substance abuse, and other immeasurable factors such as quality of life, social cohesion, and social capital. For the purposes of this project, the impact due to the Antero project in Battlement Mesa on the community wellness of local residents was calculated as a single factor as follows:

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Community Wellness	Mixed (±)	Community Wide	Yes	Long	Infrequent	Possible	Low to Medium	±11.5*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

Community health effects are expected to be **mixed**, both positive and negative. Positive effects might include less stress over finances if increased demand for local business trickles down through the local economy, and increased access to social resources, services and infrastructure expanded to support a growing and changing population<sup>77</sup>. Negative effects that may be experienced include stresses associated with perceived or real increased threat of crime, heavier industrial traffic and visible impacts to natural environment and recreation areas. Community impacts would be expected to be **community-wide**, affecting the entire geographic extent of the Battlement Mesa PUD equivalently. It is possible that the elderly or youth of the community are more **vulnerable** to impacts of community well-being. Elderly may be more vulnerable to crimes of theft or burglary, and are the likely group most affected by changes in social service availability and accessibility. Children would be most affected by changes in school enrollment and class size. They may also be affected by changes in outdoor areas used for play, which may overlap with areas prone to more industrial activity or along roadsides used more frequently for hauling drilling materials. We expect the community impacts to continue for the duration of Antero’s project (five years), and therefore be **long**. Because the Antero project is relatively small, it is expected that exposure to altered community wellness will actually be **infrequent**. The overall magnitude of health effects is **low to medium**. This assessment is made based on

the nature of community impacts, which do not often present through acute mechanisms. Given adequate coverage and support offered by social infrastructure, we expect the residents of Battlement Mesa will be able to successfully tolerate and adjust to community well-being impacts. Using the numerical ranking scheme, community wellness impacts are expected to produce a negative rank of -11.5 on a scale of  $\pm 6-15$ .

#### **4.5.4 Findings and Recommendations Related to Community Wellness**

**What we know:** A variety of physical and social factors impact the health of a community. The little information available on these physical and social factors for Battlement Mesa show the community is in good health, as compared to the population of Colorado.

**What we do not know:** We do not know the actual population count, demographics, physical and social health specific to the Battlement Mesa PUD because information has not been collected at this level. In addition, several physical and social health measurements are not routinely monitored.

#### **Recommendations to Reduce Impacts to Community Wellness**

Based on these findings, the following are some of the suggested ways to reduce the potential impact to Community Wellness.

1. Establish a mechanism to facilitate on-going community engagement between Antero, GCPH officials and residents of Battlement Mesa for early identification of impacts to community wellness.
2. Review sexually transmitted infection clinic access, outreach and education, with particular attention to in-migrant workforce to reduce spread of sexually transmitted infections within the community.
3. Identify employers that have implemented drug and alcohol free work-place programs and encourage other employers to do so to reduce drug and alcohol abuse. Provide education to employers regarding benefits of such programs.

The recommendations to address information gaps are in Section 5.

#### ***4.6 Assessment of Economic and Employment Impacts on Health in Battlement Mesa***

***Will a boom and bust cycle occur? We are now in a bust and the food banks drying up.***  
*February 3, 2010 stakeholder meeting*

Economic conditions of a region can have significant impact on the health of the population. Employment status can impact individual health and well being and economic uncertainty can impact health by increasing stress. Economic development of poor and rural areas is often credited with bringing resources that support health; however “boom town” growth related to natural gas development in Garfield County and other parts of the West have had mixed economic impacts. Residents of Battlement Mesa have expressed concerns that sudden economic growth within their community may negatively impact the community by causing housing and goods inflation, and impacting services. Others in the community are concerned that gas industry development will decrease the appeal of the community and cause a decrease in home values. A review of economic and employment impacts of the Antero gas project in Battlement Mesa is warranted.

#### **4.6.1 Economy, employment, and health**

Income and employment influence many central determinants of health and wellbeing, including quality of housing, education, diet, lifestyle, access to health services, etc. Income sufficient to support these basics is strongly related to life expectancy: internationally, annual per capita income above \$5,000- \$10,000 translates into decades of increased longevity for the population<sup>85</sup>. For individuals, employment is directly related to positive health outcomes<sup>86</sup> and stress related to job loss, unemployment, and job instability is strongly correlated with self-report of poor health<sup>87</sup>. In addition, in the United States, health insurance access is directly related to employment for those under the age of 65. Loss of insurance can lead to decreased health care access and poorer health.

Increased economic activity of a region can increase tax revenues which in turn can be used to support public services, thereby enhancing community wellness. However, if an economy grows too fast, it can create excessive demands on public services and community wellness can suffer. In addition, housing prices and property taxes can rise in response to growing local economies and stress finances of local residents, particularly those on fixed incomes. Increased wages and growing populations associated with new industry can increase demand for all goods, can also create price inflation, which in turn can impact residents’ ability to maintain health.

Furthermore, if economic booms are followed by economic busts, loss of resources and jobs can devastate community and individual wellbeing. Repeated boom/bust cycles, where jobs, wages, and services are recurrently out of balance, can lead to significant community stress.

#### **4.6.2 Current Economic and Employment Conditions**

Housing prices in Battlement Mesa have been rising steadily over the last decade and have increased faster than average income. In 2008, the estimated median value for a house or condominium was \$201,116, nearly 150% higher than estimated values in 2000 (\$136,100). Meanwhile, the estimated median household income in 2008 was \$42,882—up 17% from the median income in 2000 (\$36,680), but still lower than the estimated 2008 state average

(\$56,993)<sup>88</sup>. Housing price inflation was for the most part due to the regional natural gas boom. The decline of natural gas development in 2008-09 has relieved some pressure on housing prices and availability.

In 2008, Battlement Mesa had a lower poverty rate than Colorado (6.0% vs 9.3%). Primary industries for males is construction, mining, natural gas development and production, and accommodations, and for females health care, education, and food and beverage stores<sup>88</sup>.

Residents in Garfield County generally rate themselves to be in good health. In 2008, the Saccamano Institute conducted a survey of Garfield County residents. The results found that 85% of residents surveyed perceived themselves to be in excellent or good health, and that about 76% of those surveyed reported feeling about the same or better level of health than one year prior. Similar results were recorded for the Battlement Mesa/Parachute zip code, with approximately 83% excellent or good health<sup>23</sup>.

#### **4.6.3 Antero Drilling Plans in Battlement Mesa and Economics and Employment**

Natural gas development has created boom economies in Wyoming, Colorado and other regions of the West over the last decade, with mixed economic impacts to local residents and workers. Examination of natural gas boomtown economics in three towns in Wyoming, related to approximately 40-60 operating rigs in the county, revealed that itinerant workers in the natural natural gas development and production benefited the most from high industry wages, while local residents and workers experienced negative economic impacts associated with inflation, increased property taxes and decreased services<sup>89-90</sup>. This boomtown model predicts changes for other communities involved in the natural gas development and production. Some local businesses may benefit from an increase in commerce, but some may not be able to expand to meet demand and quality of service declines. Increased commerce may bring “box” stores and other new businesses, putting more strain on longtime local business, and some may end up closing. Local residents not earning high industry wages may not be able to keep up with rising cost of living, housing prices, property taxes, and other signs of inflation. Such a change in the economy can cause psychological stress to local workers and residents, resulting in possible mood disturbance, disturbance of thought, sleep disturbance, and immune system effects<sup>91</sup>. Because the gas well development phase is very labor intensive, boom economics associated with worker population influx predictably cycles to bust economics when the development phase for the area is over and development moves on to other regions.

The number of workers involved in well development can vary widely according to pad site topography and geology, number of wells per pad, characteristics of the gas, etc. Most workers are employees of companies subcontracted to perform very specific development jobs and remain on a given pad only as long as needed, sometimes only days, weeks or a few months. Antero plans to use two rigs to develop approximately 200 wells in the PUD over the course of five years. This kind of serial operation may keep many of the workers working within the PUD for much of that time, moving from one site to the next as development progresses. Influx of

workers associated with all stages of development during this period is likely to have the most significant economic impact to the area. Once all the wells in the PUD are developed, the workforce needed to maintain the wells over the 20 years of production is relatively very small.

When comparing the economics of the two rig operation in Battlement Mesa to the 40-60 rig boomtown economics of Wyoming and Colorado it becomes apparent that the Antero project is relatively small and the economic benefits and detriments are expected to be small as well. Furthermore, these impacts are not expected to be restricted to Battlement Mesa, but are more likely to be absorbed into the general Garfield County economy. Some workers may live in Battlement Mesa, thereby creating demand for housing, but many may live outside of the Battlement Mesa community as well. Tax revenues from the Antero project will be realized at a county level. By itself, this operation is not likely to create a significant boom economy

Antero estimates of number of workers needed for well development to be an average of 60-75 workers per rig operation. This number is necessarily an average and an estimate and actual numbers of workers are likely to vary significantly from day to day, and well pad to well pad. Once in production, only a small number of workers are needed for routine maintenance of wells.

Economic benefits of higher wages will be primarily realized by industry itinerant workers. The presence of 120-150 workers in the PUD will provide economic benefits to some local businesses, however, these businesses will also be negatively impacted when the development stages are over and the workers leave. Local residents not employed by the industry or supporting businesses may not benefit from economic growth but may be at risk for negative impacts of housing and goods price inflation, rising property taxes and potentially compromised services.

#### 4.6.4 Characterization of the Economy and Employment Impacts on Health

The impact on the economy and employment due to the Antero project in Battlement Mesa on the health of local residents can be characterized as follows:

Impact	Direction of health effects	Geographic Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Employment and economy	Mixed (±)	Community wide	Yes	Long	Infrequent or constant	Unlikely	Low	±10.5*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

Based upon estimates of 100-200 workers for a 2 rig operation over five years, the health effects of the Antero project on Battlement Mesa citizens is likely to be **mixed** with positive effects of

higher wages for some residents and higher inflation and no wage increase for others. Economic impacts are likely to be experienced **community-wide** and those on fixed incomes are more **vulnerable** to the negative effects of inflation. The impacts of increased economic activity are likely to be **long**, lasting at least five years, and the frequency of having a health impact (stress, sleep disturbance) as a result of the economic activity is likely to be either **infrequent or constant**, depending upon the individual circumstances. Given the small economic size of Antero's plan and the probability that the economic impacts will be absorbed into the county, it is **unlikely** that there will be health impacts due to changing economic conditions and the magnitude of any health impacts will be **low**. Using the numerical ranking scheme, economic and employment impacts are expected to produce a mixed rank of  $\pm 10.5$  on a scale of  $\pm 6-15$ .

#### **4.6.5 Findings and Recommendations from Economic and Employment Assessment**

**What we know:** Boom and bust industries, such as natural gas development and production, can affect public health through rises and falls in the local economy and employment. However, Antero's project within the PUD is too small to initiate a boom and bust cycle.

**What we do not know:** We do not know the affect Antero's plan will have on housing prices within the PUD.

#### **Recommendations to Reduce Impacts from Boom and Bust Cycles**

Based on these findings, the following are some of the suggested ways to reduce the potential negative aspects and maximize potential positive aspects from economic and employment impacts.

1. Review local tax structure to ensure that revenue from natural gas development and production are used to mitigate impacts in areas most affected by the industry development in order for the community to realize the economic benefits.
2. Continue to consider public health as a high level priority when judging uses of local government revenues derived from the natural gas development and production to maximize protection of public health.
3. Engage in long term planning to maintain affordable housing, education, and public services to protect residents from sudden industry downturns (e.g. the bust).
4. Consider mechanisms for providing property tax relief for residents on fixed income should home values rise rapidly to reduce negative economic impacts.
5. Engage local educational institutions to provide industry related training so that local residents can be employed by the industry.
6. Engage local educational institutions to provide retraining for residents employed by the industry so that they can find future employment when industry development is complete and development jobs are no long available locally to reduce impacts from sudden industry downturns.

The recommendations to address information gaps are in Section 5.

#### ***4.7 Assessment of Impacts to Health Infrastructure in Battlement Mesa***

“What will be the impacts to health care in Battlement Mesa?”

*February 3 stakeholder meeting*

Health infrastructure can include private and public medical services, hospitals, and emergency transport services. Availability, access and quality of local clinical and public health services can be limited in small communities, due to small populations, low rates of insured patients, and limited public resources. New industry can lead to positive and /or negative impacts on the health care infrastructure. Industrialization of a rural community can increase the insured population and local revenues, which may provide resources for expansion of local clinical and public health care services. On the other hand, without substantial investment in health infrastructure, population and employment changes may increase both clinical and public health care utilization, stretching already limited resources. The citizens in the rural community of Battlement Mesa have expressed concerns that development of natural gas resources in their community may negatively impact available medical resources. Because the Battlement Mesa health infrastructure may be exposed to utilization changes, a review of potential health impacts is needed.

##### **4.7.1 Private and Public Health Services and Health**

Availability, access and quality of medical health services can have direct impacts on individual physical health. Research demonstrates that residents of rural communities often have decreased clinical health care services available to them, negatively impacting health<sup>92-95</sup>. Limited availability can be due to a combination of small population and low health insurance coverage, both of which limit the financial viability of both clinical and public services. As a result, residents of rural communities may need to travel long distances for care.

Increased economic activity in a community may bring more patients and insurance coverage which can support increased and diversified clinical medical services. On the other hand, a rapid increase in population, particularly uninsured population, can increase utilization of services beyond capacity and may strain the finances of small medical facilities and decrease incentive to increase services<sup>77</sup>.

Public health programs provide services to the general community and can fill some gaps for the un-insured<sup>96-97</sup>. Vaccination programs, health screenings, and communicable disease clinics provide limited clinical health care to uninsured populations. Public health programs that focus on food safety programs and health education programs benefit the community at large. When the local population increases, particularly an uninsured population, local public health services

may experience increased utilization while capacity may lag or never catch up. Cyclical economic conditions may also cause intermittent strain on public health programs while making it difficult to adjust capacity to need. On the other hand, local revenues may be able to increase public health services, should tax and royalty structures and community priorities permit it. In some cases, severance taxes from extractive industries are sent to state agencies, with little benefit to the localities where the industrial activity is occurring<sup>77</sup>.

#### **4.7.2 Current Health Infrastructure Conditions**

Currently, primary clinical health services in Battlement Mesa include a primary care clinic administered by the Grand River Hospital District, staffed five days a week by family medicine providers and visiting specialists. The clinic also provides physical therapy services three days a week. There is also separate chiropractic, orthopedic, and dental services in Battlement Mesa. There are four hospitals within 60 minutes of Battlement Mesa. The closest hospital is Grand River Medical Center in Rifle, 20 minutes away. This is a 12-bed hospital with an emergency room, surgical, acute care facilities, and outpatient clinics. Grand River Medical Center is a Level 4 trauma center; it does not provide have obstetric (baby delivery) services. Valley View Hospital in Glenwood Springs, 46 miles away, has 80 beds, a 24 hour emergency department, and obstetric services. Community Hospital in Grand Junction, 48 mile away, has 78 beds and does not provide obstetric services. St. Mary's Hospital in Grand Junction, 49 miles away, is a Level 2 trauma center and has obstetric services. The closest Level 1 trauma center is 4 hours away in Denver. Patients needing such services may be airlifted. Emergency response and transport is provided by the Grand Valley Fire Protection District. There is an occupational health clinic operated by Grand River Hospital District in Battlement Mesa that sees work related injuries five days a week.

There is a 40 room assisted living facility in Battlement Mesa. The closest skilled nursing facility is in Rifle and there are other nursing facilities in the county. Meals on Wheels is offered in Battlement Mesa and a senior center in Parachute offers lunch daily.

Public Health services for Battlement Mesa citizens are offered by GCPH. Services include vaccination clinics, communicable disease surveillance, health education programs, safety programs, health screening for Medicaid patients, and programs for underinsured children and low income families. The Environmental Health Program serves the public by evaluation and education regarding environmental health risks related to air and water quality, sewage treatment, mosquito control, and environmental sustainability. The GCPH offices are located in Rifle and Glenwood Springs.

Insurance coverage rates for Battlement Mesa residents are not available. According to the Colorado Household survey conducted in 2008-9 by the Colorado Department of Health Care Policy and Financing<sup>98</sup>, 14% of Colorado residents were uninsured and in the five county region that included Garfield County, 21% of the population was uninsured (the highest in the state). In

Colorado, 15% of employed adults were uninsured. Insurance status for natural gas industry workers is unavailable.

### **4.7.3 Antero Drilling Plans in Battlement Mesa and Healthcare Infrastructure**

The development of natural gas wells requires several labor intensive phases, which can last several years for large natural gas projects. Most health infrastructure impacts relate to the expanded workforce during the well development phase. Antero estimates an average of 120-150 workers will be working in Battlement Mesa.

Workers associated with natural gas development and production projects can increase utilization of emergency services due to increased work related and transportation related accidents associated with the injury<sup>77</sup>. Insured natural gas workers utilizing the health care system could provide positive support to the system as long as the utilization does not exceed capacity. Should utilization exceed capacity, then the availability of services may be negatively impacted. Uninsured workers strain the health care system. Public health programs may see an increase of utilization as a result of an increase the insured and uninsured population. On the other hand, public health programs may benefit from increased local revenues, as long as utilization does not exceed capacity. Should this happen without increased supporting revenue dedicated to public health, then services may be compromised. The cyclical nature of the natural gas development and production, which is dependent upon market influences, technological advances and regulatory forces, can make both clinical and public health infrastructure planning difficult and lead to a mismatch between needs and services.

Workers and their families are expected to utilize clinical and public health services in Battlement Mesa and other local services. According to Antero representatives, Antero workers are offered health insurance; however, information regarding health insurance coverage for subcontracted workers (the majority) is not available. Some clinical services may see a disproportional increase in utilization, including emergency, urgent care and trauma services and services related to pediatric care for young families. Depending on the insurance status of the workers, these services may or may not be directly supported by the industry. Clinical and emergency providers may be negatively impacted by uncompensated care, and public health services may see an increase in local needs without increased funding. Utilization of health services by insured gas workers will support the health system. Revenues to Garfield County could be used to support public health services, depending upon prioritization of needs.

### **4.7.4 Characterization of Healthcare Infrastructure Impacts**

Impact	Direction of health effects	Geographic Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects as a result of Project	Magnitude of health effects	Rank
Health Infrastructure	Mixed (±)	Community-wide	Yes	Long	Infrequent	Unlikely	Low	±10*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering anticipated impacts to local health infrastructure associated with the Antero development within the Battlement Mesa PUD, the increase in workforce and the associated potential health care utilization could have **mixed** health effects in Battlement Mesa community; however, impacts to the health care system are anticipated to be small given Antero’s project only involves 120 to 150 workers, spread into a community of approximately 5,000 in Battlement Mesa and 55,000 in Garfield county. There is a potential for increased utilization of the health care services to strain existing services, however, the extent of such a strain may be small enough that it is unlikely to lead to decreased availability and quality of services. Likewise, insured workers will support local health services but the extent of such support may not be sufficient to lead to increased availability and quality of services. Local tax revenues from the Antero project will contribute to the overall county fund are not likely to be large enough to directly impact public health services in Battlement Mesa. Impacts of uninsured workers are likely to be noted by providers, but it is unclear that this would reach a level that would negatively impact either clinical or public health services. Should health services be impacted in Battlement Mesa, the impacts would affect the **entire community**, although those that utilize health care services most frequently such as the elderly, young children and disabled may be more **vulnerable** to negative impacts such as decreased availability. Likewise, those groups may benefit from expanded health care services. Should health service impacts occur, they are likely to be noted in the first few **years** of Antero’s project as the health infrastructure adjusts to new needs. Impacts to the health care infrastructure are not anticipated to last the entire duration of Antero’s project. The frequency of both positive and negative on impacts the health care system and therefore on the community are likely to be **sporadic**, given that the relatively small number of workers and families associated with the Antero project. It is possible that large financial strain to local providers, particularly emergency care providers, could occur should expensive emergent care become necessary for an uninsured worker, but this is anticipated to be an infrequent event. Potential impact to vulnerable groups, the community at large and the multiple years of potential exposure drive a high summary statistic, however, it is **unlikely** that Battlement Mesa citizens will experience positive or negative health impacts as a result of changes to the health care infrastructure related to the Antero project. The overall magnitude of health effects due to health infrastructure impacts are expected to be **low**. Using the numerical ranking scheme, healthcare infrastructure impacts are expected to produce a mixed rank of ±10.0 on a scale of ±6-15.

#### 4.7.5 Findings and Recommendations Related to Health Care Infrastructure

**What we know:** The availability of healthcare facilities and professionals affects public health. The level of health insurance in an area affects health care infrastructure.

**What we do not know:** The level of health insurance in natural gas development and production is not known.

### **Recommendations to Prepare for Impacts to Health Care Infrastructure**

Based on these findings, the following are some of the suggested ways to prepare for the potential impact to the Health Care infrastructure.

1. Monitor which companies, including Antero and subcontracting companies, provide health insurance to employees to determine direction of impact.
2. Review county tax structure for adequacy of revenues necessary to meet increased county services, including public health services.

The recommendations to address information gaps are in Section 5.

### ***4.8 Assessment of Accidents and Malfunctions Impacts on Health***

<p>Is there a plan to prevent pipeline leaks and explosions? <i>February 3, 2010 stakeholders meeting</i></p>
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Accidents and malfunctions can occur as a result of a variety of causes, including equipment failure, human error, and environmental hazards. Identification of potential sources of accidents and malfunctions can lead to effective prevention efforts, while recognition of potential health, community, and environmental effects can direct response strategies which can decrease impacts should an incident occur. COGCC addresses accident prevention (fire, explosion, hazardous materials release, pipeline maintenance) throughout the Rules Document<sup>9</sup>. The 600 series rules address safety regulations. For example, setbacks for pad locations are 150 feet in low population density areas, 350 feet in high population areas and 1000 feet for other facilities such as schools, hospitals, etc. Rule 906 specifies reporting, prevention and clean up requirements for spills and releases. Pipeline regulations are found in Rules 1101-1103, however, there is not a designated setback for pipelines in the COGCC rules.

According to the Denver Post, there were over 1,000 spills statewide and over 230 in Garfield County reported to the COGCC between January 2008 and June 2010<sup>99</sup>. There were 21 fires, loss of well control (including gas kicks), and explosions in Garfield County that were reported to the COGCC from January 1997 to August 2010 (COGCC database). The Battlement Mesa citizens have expressed concerns regarding the potential for accidents and spills and the potential

for related health and safety impacts. Because incidents of this nature happen with low, but predictable, regularity, an assessment of potential health impacts is warranted.

#### 4.8.1 Accidents, Malfunctions and Health

Accidents and malfunctions can occur as a result of well installation errors, material failure, construction and operations accidents, equipment accidents and failures, third party activities, and environmental episodes. Incidents can manifest as fires, explosions, hazardous material losses, and/or spills. Fires and explosions may result from well blowouts, gas kicks, pipeline leak or rupture, ignition of flammable materials during storage, transportation or transfer. Hazardous materials spills/loss may be due to transportation accidents or equipment failure, during material transfer, leaking valves, fittings, etc in storage equipment, well blowouts, and improper disposal of hazardous materials. Environmental conditions such as wildfires, tornados, lighting, blizzards, and extreme heat and cold may cause or exacerbate incidents.

These incidents may result in release of contaminants into surface water, ground water, soil, and air. Releases associated with significant accidents and malfunctions are likely to be acute, high level emissions. Releases of produced water into soil and water sources contain salts, metals, VOC/BTEX, drilling fluids, muds and fracking chemicals. Spills of drilling and fracking materials could include a variety of chemicals such as diesel fuel and other hydrocarbons, BTEX, acids, glutaraldehyde, and other proprietary chemicals. Releases of natural gas into water or air contain VOC/BTEX. Combustion products of hydrocarbons released during fires contain PAHs, including naphthalene, sulfur oxides, nitrogen oxides, PM and other chemicals.

Examples of potential health effects of chemicals given sufficient exposure:

<b>Chemical</b>	<b>Acute health effect</b>
VOC	Irritant, neurological
Benzene	Neurological, anemia
Naphthalene	Anemia
Combustion Products	Respiratory, cardiovascular, irritants
Hydrochloric acid	Irritant
Glutaraldehyde	Irritant, allergic reactions

In addition to chemical exposures, accidents and malfunctions can expose nearby persons to injury or death. Although outcomes are potentially severe, these exposures are generally short-term, very rare and only those in close vicinity at the time of the accident are at risk. Employees on the well pad during a fire or explosion are at most risk for injury. Although the likelihood of an explosion involving a pipeline occur is very small, persons in the community may be at risk for injury should such an incident occur. An explosion occurred in a rural area of Johnson County Texas on July 7, 2010 when crews installing a communications pole hit a 36-inch gas transmission line. Newspaper reports indicated that one worker was killed, and seven injured.

The fire was reported to be 400-600 feet in circumference and intense heat was felt 900 feet away. The gas line valves were shut off 1.5 hours after the explosion, and the fire stopped. A more recent explosion of a 30 inch gas distribution line in San Bruno, California on September 9, 2010, destroyed 150 homes and killed four people. The cause of this explosion is still unknown. Other accounts of explosions related to natural gas development, production, and distribution can be found in newspaper accounts throughout the country.

#### **4.8.2 Current Conditions for Accidents and Malfunctions**

According to the Denver Post, 236 spills in Garfield County were reported to the COGCC between January 1, 2008 and June 15 2010, involving 66,386 barrels of fluids (primarily drilling liquids and produced water)<sup>99</sup>. During that time, Antero submitted approximately 5 percent of the gas permits in Garfield County, reported 15 spills to the COGCC (6 percent of the spills). Antero's contribution of 1707 barrels of fluids to the total barrels spilled in Garfield is small (2.6 percent). Five of Antero's 15 spills have required remedial action and one resulted in a notice of alleged violation (also known as NOAV) because of failure to report the spill to COGCC per the oil and gas rules.

Antero has received three other Notice of Alleged Violations since January 1, 2008. The latest, on July 14, 2010, was in response to several odor complaints filed during flow back operations on the Watson Ranch well pad. Another Notice of Alleged Violation issued on January 04, 2010, resulted from lack of secondary containment of condensate from fracking tanks and observation of condensate lying on the ground around fracking tanks and separation units. COGCC issued a third Notice of Alleged Violation because Antero spudded a well prior to permit approval in June 2009<sup>100</sup>.

Local newspapers and COGCC databases have recorded incidents of well fires, blowouts, tanker spills, condensate tank emissions and pit discharges in Garfield County. These incidents have resulted in contamination of surface and ground water with BTEX, and other chemicals. Residents have reported a variety of health effects, including acute and long term neurological complaints, upper respiratory issues, headaches and fatigue, and nausea. There have been no reported fatal injuries related to accidents or malfunctions in Garfield County reported to COGCC.

#### **4.8.3 Antero Drilling Plans in Battlement Mesa and Accidents and Malfunctions**

Applying Antero's spill rate of 15 spills per 252 permit applications (6 percent) and rate of 5 remediations per 15 spills to the 200 wells proposed for Battlement Mesa it is estimated that approximately 12 spills of 5 gallons or more may be expected in Battlement Mesa. It can be expected that at least four of these spills may have some impact to soil, groundwater, or surface water requiring remediation and have the potential to impact public health.

As discussed in the Water and Soil Quality Assessment, Battlement Mesa residents use a municipal water system that draws water from the Colorado River. Secondary water supplies include four shallow ground water wells which were used prior to the establishment of the water treatment plant. These wells are monitored once a year for quality.

The Surface Use Agreement between Antero and The BMC specifies a temporary 50 foot easement for pipeline construction and a permanent 25 foot easement for gas gathering lines. Antero also plans to build a wastewater pipeline system along the same easements. The Surface Use Agreement states that the gas gathering lines will be 48 inches below the surface. The gas gathering lines in Battlement Mesa will be 12 inches in diameter. According to maps provided at community meetings, the pipelines primarily follow haul routes, however, a pipeline there is one pipeline that will cross an open space in a residential area between Valley View Village and Fairways Village. It is unclear from available maps how far this pipeline, or any other pipeline on the map, is from residences, schools and other buildings.

Although the COGCC rules allow for 350 foot well pad setbacks in densely populated areas, the Antero well pads in Battlement Mesa are all at least 500 feet from the nearest residence.

#### 4.8.4 Characterization of the Impact from Accidents and Malfunctions

Impact	Direction of health effects	Geographical Extent of exposure	Vulnerable populations	Duration of exposure	Frequency of exposure	Likelihood of health effects	Magnitude of health effects	Rank
Accidents and malfunctions	Negative (-)	Local or Community wide	Yes	Short	Infrequent	Possible	Low to high	-10*

\*For an explanation of the numerical ranking system used, see the chart at the beginning of Section 4.

When considering the possible health impacts due to an accident or malfunction of Antero gas operations in Battlement Mesa, the health effects are likely to be **negative**. Depending upon the size and nature of the incident, health and safety impacts may be felt only in close proximity (**local**) or throughout the PUD (**community-wide**). Again, depending upon the nature of the incident, certain populations may be more **vulnerable** to health impacts. For instance, elderly or frail and those living in the assisted living facility, may have difficulty evacuating an area quickly. Children in school may also be slower to evacuate. Those with underlying medical conditions such as pulmonary or cardiovascular disease, may have negative health effects to fires or air emissions at levels that are may not have significant impact to others. Accidents and malfunctions are likely to be **short in duration** and **infrequent**. Given the 6% rate of incidents in the industry and within Antero’s other operations in Garfield County, incidents are likely to occur and it is **possible** that health impacts will occur. The health effects will be **low to high** in magnitude, potentially ranging from minor irritation to more severe exacerbation of underlying health conditions to severe injury or death. Using the numerical ranking scheme, accidents and malfunction impacts are expected to produce a negative rank of -10.0 on a scale of ±6-15.

#### **4.8.5 Findings and Recommendations from Assessment of Accidents and Malfunctions**

**What we know:** A small number of accidents and malfunctions occur on a regular basis in natural gas development and production. These accidents and malfunctions can have minor to catastrophic consequences and can impact air, water, and soil quality. Lack of adherence to rules and regulations, as well as regulatory oversight and enforcement can result in accidents and malfunctions.

**What we do not know:** We do not know if the current setbacks and placements of pads, pipes, and maintenance stations are sufficient to protect residents from catastrophic malfunctions. We also do not know if there are emergency plans in place that address catastrophic malfunctions.

#### **Recommendations to Reduce Impacts from Accidents and Malfunctions**

Based on these findings, the following are some of the suggested ways to reduce the potential public health impact from accidents and malfunctions.

1. Require review of evacuation, shelter in place and air intake plans for all locations with high concentrations of persons, such as the schools, the assisted living facility, and recreation center to protect the public health and reduce injury. Allow these entities an opportunity to comment on Antero and community emergency response plans.
2. Require emergency responders to review evacuation and shelter in place plans for Battlement Mesa community and Antero emergency response plans to protect public health and reduce injury.
3. Periodically test emergency communications systems. Consider siren, reverse 911, or other system of other mass alert to protect the public health and reduce injury.
4. Require periodic maintenance review of water and gas gathering lines to highest industry standards to reduce accidents and malfunctions.
5. Institute mechanism for reporting safety concerns, near-misses, etc to the appropriate designated county agency or department to reduce accidents and malfunctions. Ensure timely follow up of all concerns.
6. Review procedures for utility permissions to dig near line location to reduce accidents and malfunctions.
7. Require permanent gas line markers in the field, and other standard practice safety procedures to reduce accidents and malfunctions.
8. Review pipeline system for routes that avoid proximity to homes, schools or other areas used by residents to protect the public health and reduce injury.

The recommendations to address information gaps are in Section 5.

#### ***4.9 Summary of Assessments on Health in Battlement Mesa***

The following table summarizes the characterization of stressors and the numerical ranking of impacts on the health in Battlement Mesa. By ranking the stressors we are able to conclude that air quality impacts are likely to produce important negative health impacts to residents throughout the community. Other stressors that may produce relatively important health impacts include traffic, and noise. Compromise of water supplies could produce important effects to health but are not likely to occur. Some stressors may produce both positive and negative impacts (mixed) but health impacts will be of low to medium magnitude. These include stressors to community wellness, the economy and health infrastructure. The driving force for those impacts is primarily the workforce associated with the five year development phase. Accidents and malfunctions may impact health but incidents of this nature are difficult to predict. Recent events demonstrate, that although accidents and malfunctions are infrequent, on rare occasions they can be devastating and significant care should be taken to prevent them.

<b>Assessment</b>	<b>Direction of health effects</b>	<b>Geographical Extent of exposure</b>	<b>Vulnerable populations</b>	<b>Duration of exposure</b>	<b>Frequency of exposure</b>	<b>Likelihood of health effects as a result of Project</b>	<b>Magnitude of health effects</b>	<b>Rank</b>
Air Quality	Negative (-)	Community-wide	Yes	Long	Frequent	Likely	Moderate to High	-14.5
Water and Soil Quality	Negative (-)	Community-wide	Yes	Long	Infrequent	Unlikely	Moderate to High	-11.5
Traffic	Negative (-)	Community-wide	Yes	Long	Frequent	Possible	Low to high	-13
Noise, Vibration, Light	Negative (-)	Local	No	Long	Frequent	Possible	Low-Medium	-10.5
Community Wellness	Mixed (±)	Community-wide	Yes	Long	Infrequent	Possible	Low to Medium	± 11.5
Employment and economy	Mixed (±)	Community-wide	Yes	Long	Frequent	Unlikely	Low	±10.5
Health Infrastructure	Mixed (±)	Community-wide	Yes	Long	Infrequent	Unlikely	Low	±-10
Accidents and malfunctions	Negative (-)	Local or Community-wide	Yes	Short	Infrequent	Possible	Low to high	-10