

## **Executive Summary**

This Health Impact Assessment (HIA) was conducted by members of the faculty and staff of the Department of Environmental and Occupational Health, Colorado School of Public Health (CSPH) at the request of the Garfield County Board of County Commissioners (BOCC), to help address community concerns regarding future land use decisions. The purpose of this HIA is to provide the BOCC with specific health information and recommendations relevant to Antero Resources Corporation (Antero) plans for natural gas development and production in the residential community of the Battlement Mesa Planned Urban Development (PUD), Garfield County, Colorado. To this end, CSPH worked in collaboration with Garfield County Public Health (GCPH) to conduct a qualitative and quantitative analysis of existing environmental, exposure, health, and safety data pertinent to the Battlement Mesa community. CSPH offers the BOCC specific recommendations for its consideration in Antero drilling permit decisions. In addition, the HIA provides baseline information for use in the design of a future prospective exposure and health monitoring project.

### **ES1 Introduction**

Recent domestic energy production has brought industrial processes, and potentially exposures, into close proximity of residential urban, suburban and rural communities across the United States. Garfield County, Colorado is at the epicenter of natural gas development in the Piceance Basin and experienced rapid growth of the industry from 2003 – 2008, and a sudden downturn in 2009. Now, in 2010, permitting for the purpose of development and production is resuming and is expected to continue to increase.

Natural gas development and production is known to produce a variety of physical and chemical hazards that may cause negative health effects. In 2008, CSPH completed a white paper and literature review, outlining potential environmental hazards, vulnerable populations, and possible health outcomes in Garfield County. The 2008 Community Health Risk Analysis of Oil and Gas Industry Impacts in Garfield County, Colorado (referred to as the Saccomanno Study) documented baseline health status and negative health outcome trends potentially linked to natural gas development in Garfield County. Air monitoring in Garfield County has documented levels of some air toxics in ambient air that increase the risk of negative health effects for citizens. Furthermore, recent review of large scale “boom and bust” natural gas development in small and rural communities, such as those found in Garfield County, have the potential to affect community infrastructure. Taken together, this information suggests that natural gas permitting decisions within the residential community of Battlement Mesa has the potential to adversely affect health.

Battlement Mesa is community with a large number of retired citizens as well as young families. According to the 2000 United States Census estimates, the total population of the Battlement

Mesa/Parachute zip code was 5,041; the median age was 37.5 years; 26.0 percent of the population were under 18 years of age, 7.2 percent under five years, and 19.8 percent were 65 years and older. In 2000, the County population was 43,791, rising 30% to 56,298 in 2009.

The Antero project is anticipated to include 200 natural gas wells on 9 pads, a centralized water storage facility with a covered/lined waste pit, and 8.4 miles of water and gas pipeline. Preliminary plans indicate that well pads and pipelines will be distributed throughout the PUD, raising the probability that health impacts could affect the entire community.

Community groups, including Battlement Mesa Service Association (BMSA, the homeowners association) and Battlement Mesa Concerned Citizens (BCC) and Grand Valley Citizens Alliance, expressed concerns about the proximity of natural gas development to homes, recreational areas and schools. At stakeholder meetings, citizens have expressed concerns regarding airborne volatile organic compounds (VOCs), diesel and other particulate matter (PM); hydraulic fracturing (also known as fracking) fluid, hydrocarbons, and VOCs in soil and water; increased risk of fires, explosions, and motor vehicle accidents; and changes in community “livability.”

In November 2009, Battlement Mesa Concerned Citizens formally requested BOCC and GCPH address health concerns before Antero development activities begin. (Attachment 1) The BOCC expressed a desire for the HIA to be conducted by CSPH expeditiously, so that results could be available prior to permitting decisions. At that time, it was anticipated that Antero would be submitting their Major Land Use Impact Review (also known as MLUIR) and Comprehensive Drilling Plan in late spring 2010 and that these documents would be available as part of the basis for the HIA. At this time, however, Antero had not submitted either document. Therefore, we have used public meeting minutes, slides from power point presentations, the Surface Use Agreement with the surface owners the Battlement Mesa Company (BMC) and other information provided to us by Antero as sources for this report. Should Antero ultimately submit permit proposals that substantially differ from this information, our assessments may not necessarily reflect those differences.

The stakeholders for the Antero drilling plan include the residents and citizen groups of Battlement Mesa and nearby communities, Antero and other operators, GCPH, BOCC, the Battlement Mesa Consolidated Metropolitan District which provides drinking water and waste water services to Battlement Mesa, BMC, the Grand River Hospital District and other medical services providers, Colorado Department of Public Health and Environment (CDPHE), and Colorado Oil and Gas Conservation Commission (COGCC). There has been broad support for the HIA from all stakeholders, reflecting a common search for a means to address the concerns of potentially impacted residents in a systematic and impartial manner.

GCPH has been extremely instrumental in helping CSPH accomplish the HIA, by facilitating meetings with stakeholders and Antero; providing local contacts and context, environmental data, review and input on the scope, and analysis of the HIA; acting as the liaison between the

CSPH and the BOCC; providing web support for HIA related minutes, presentations, and this report; and providing information to local media. In addition, at the CSPH, the Mountain and Plains Educational and Research Center has provided outreach support. The Pew Health Impact Project provided funding for consultation with Habitat Health Impact Consulting, a Canadian firm with expertise in HIAs related to resource extraction.

## **ES2 The HIA Process**

An HIA involves several defined steps: screening, scoping, assessment, recommendations and implementation, reporting and monitoring.

This HIA was screened and scoped using information from the white paper and literature review previously conducted by CSPH, concerns raised by the citizens (Table 3), the 2008 Saccomanno Report, as well as input from the BOCC, GCPH, CDPHE, COGCC and Antero obtained in meetings over the course of the last nine months. As a result, the HIA focuses on eight areas of health concern (stressors) associated with natural gas development and production: air emissions, water and soil contaminants, truck traffic, noise/light/vibration, health infrastructure, accidents and malfunctions, community wellness, and economics/employment.

Assessment of each stressor includes a review of its general impact on physical, mental and/or social health as described in relevant medical and social science literature; a compilation and analysis of existing environmental and health data describing current conditions in Battlement Mesa; the means by which Antero plans for drilling might alter the current conditions, and finally a characterization of the stressor's impact on health. Several physical health outcomes linked to potential exposures are considered, including respiratory, cardiovascular, cancer, psychiatric, and injury/motor vehicle-related impacts on vulnerable and general populations in the community. The Battlement Mesa Baseline Health Profile (Appendix C) provides supporting documentation of baseline physical and social health determinants. In addition, a Human Health Risk Assessment (Appendix D) provides a comprehensive review of available air quality and water contamination data and a systematic assessment of related health risk.

The HIA offers recommendations to the BOCC to help it address mitigate some of impacts of the Antero plan. It is important to recognize that it is not possible to mitigate all impacts. We have provided a relative rank for each stressor, to help emphasize where the most important impacts may occur.

Adoption of any recommendations of the HIA is at the discretion of the BOCC. We will assist in implementation, if requested by the BOCC, by continuing with stakeholder and professional presentations. We will continue to monitor how this HIA is used, in order to measure its value as a public health tool.

## **ES3 Battlement Mesa Baseline Health Profile**

Several measures of health are best determined by using zip code to define a community. We use the zip codes 81635 and 81636, which are used by the residents of Battlement Mesa, Parachute and surrounding areas. Because these zip codes are shared, Parachute is included along with Battlement Mesa in the descriptions of physical health determinants and some social health determinants. Some of the social health determinant measurements were not available at a zip code level and so we provide descriptions of these at a county level. While the assessments of stressors focus on the impacts to those living within the Battlement Mesa PUD, others living nearby may experience some effects as well. The Battlement Mesa Baseline Health Profile is available in Appendix C.

### ***ES3.1 Vulnerable Populations***

Greater than 45% of the population may be considered to be more vulnerable to certain exposures, based on age. Additional factors, such as pre-existing disease, pregnancy and behaviors such as smoking history, alcohol use, nutrition, and genetic factors can also influence vulnerability to disease. Furthermore, occupational and residential exposures may also contribute to risk of disease. Although these factors can contribute considerably to vulnerability to disease, such information was not available to the HIA team and represents an important information gap that will need to be addressed in the future.

### ***ES3.2 Physical Determinants of Health***

To assess the baseline physical health of the Battlement Mesa/Parachute area, the CSPH team obtained and analyzed inpatient hospital diagnoses, cancer, birth, and death information from the CDPHE for the years 1998-2008. The analysis included health diagnoses, birth outcomes, and causes of death with a known association between disease and the exposures of concern, as well as those for which community members voiced concerns of elevated occurrence of disease. Major categories of disease and death included depression and those involving the nervous system, ear/nose/throat, vascular system and pulmonary system. Major categories of cancer included: Hodgkin lymphoma and non-Hodgkin lymphoma, multiple myeloma, leukemia, melanoma, breast cancer, prostate cancer, bladder cancer, colorectal cancer, and cancer of the adrenal gland. Birth outcomes included low birth weight and preterm delivery. Health for Battlement Mesa/Parachute residents was compared to the health of Colorado residents.

Overall, the citizens of Battlement Mesa appear to be generally healthier than other citizens of Colorado. They experienced fewer hospitalizations and fewer deaths. Battlement Mesa women experienced the same rates of cancer and of negative birth outcomes as other women in Colorado. In Battlement Mesa men, we observed a slightly higher than expected rate of prostate cancer, which we felt is an observation likely due to variability of small numbers or statistical chance (when multiple independent tests are compared, there is a statistical probability that 5 % of the tests will be abnormal by chance alone). No other differences were noted between men in Battlement Mesa when compared with other Colorado men.

### ***ES3.3 Social Determinants of Health***

To evaluate the baseline community health in Battlement Mesa/Parachute, the CSPH team obtained available information regarding sexually transmitted infections, crime, substance abuse, and education. Where information concerning Battlement Mesa was not available, we looked at Garfield County data.

Overall, the incidence of sexually transmitted infections in Garfield County rose during the years 2005- 2008, peaking between 2007 and 2008. Between the years 1992-2005, for adults, violent crime arrests doubled; property arrests fluctuated throughout the period, and increased slightly; and drug violations increased almost ten-fold. In the same time period, for juveniles, violent crime arrests increased; property arrests fluctuated but did not change significantly; and drug violations increased almost ten-fold. Substance abuse information extracted from the GCPH's 2006 assessment on community needs indicates depression, anxiety and stress along with tobacco smoking and alcohol abuse appear to be the top indicators of the burden of mental health and substance abuse, respectively, in Garfield County.

## **ES4 Assessment of Health Impacts**

The HIA team developed a method for assessing and comparing potential health impacts for several areas of concern (stressors) by identifying and defining seven attributes relevant to the importance of potential health effects: direction of potential health effects (i.e., a positive or negative impact on health); the relationship of geography to health effects (i.e. proximity to natural gas development and production activities); the likelihood of health effects occurring as a result of Antero development plans; the presence of people considered especially vulnerable to the effects of the stressor; the estimated duration of exposure; the frequency of exposure when it does occur; and severity of the potential health effect.

To assist in characterizing the relative importance of health effects within this HIA, we assigned a numerical rank to each stressor. The lowest possible rank is 6 and the highest possible rank is 15 (six stressors are assigned values of 1 to 2 or 1 to 3). A negative (-) number indicates that the stressor is likely to produce negative health effects, a positive (+) number indicates that the stressor is likely to produce positive health effects. Some stressors may produce both negative and positive health effects and are therefore given a mixed (+/-) numerical rank. These rankings may be used to help describe the relative importance of each potential health effect within the context of this HIA only. It is important to note that these ranks do not represent a quantitative estimate of risk and have no relevance outside the context of this HIA.

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 HIA.

#### ***ES4.1 Summary of Air Quality Assessment***

The Air Quality Assessment relies upon the Human Health Risk Assessment (Appendix D) to determine the potential for air quality compromise. Plans for drilling throughout the community suggest that all areas within the PUD have the potential to be impacted by local emissions.

The Antero natural gas development plan is likely to change air quality and produce undesirable health impacts in residents living in close proximity throughout the community. Air quality is most likely to be acutely impacted during well pad construction and well completion stages and by truck traffic. Long term compromise of air quality is possible if fugitive emissions from production equipment are not controlled and the impacts to air quality are expected to occur constantly and/or reoccur. Children, older adults, and individuals with respiratory diseases may be more vulnerable to the air contaminants and could experience short-term and/or long-term disease. Health impacts may include respiratory disease, neurological problems, and there may be an increased risk of cancer. Medical attention would be necessary for some of these conditions. Some of these health consequences would not be reversible, and therefore should be considered moderate to high magnitude impacts. Using the numerical ranking scheme, air quality impacts on health are expected to produce a negative rank of -14.5 on a scale of  $\pm 6-15$ .

#### ***ES4.2 Summary of Water and Soil Quality Assessment***

The primary drinking water source for Battlement Mesa is the Colorado River and the intake is upstream of areas potentially impacted by the Antero drilling plan. The primary drinking water source is therefore not likely to be impacted by Antero's Battlement Mesa natural gas development and production plans. The secondary water source is a series of ground water wells located "downhill" from some of the planned well sites. Since the hydrology of the area is not well understood, the likelihood that these wells could be compromised by drilling in the PUD is unclear, but their location suggests that they could be compromised by natural gas development and production activities.(See Appendix D for supporting documentation).

Impact on water quality in Battlement Mesa is not expected to occur frequently and it is unlikely that contamination of drinking water will occur as a result of Antero development plans. However, should water and soil contaminant exposures occur, these changes would produce undesirable health impacts. Areas in close proximity to the development areas would be most likely to show contamination of soil and shallow water. Impacts could be community-wide, should the need for compromised secondary water wells arise. Localized effects of wind erosion and surface run-off may impact children more than adults. Children, older adults, and individuals with pre-existing illnesses may be more vulnerable to water and soil contaminants. Reversal of water quality degradation could take years, and thus any impacts could be enduring. Should exposure occur, health impacts may include cancer, skin and eye irritation, neurological

problems. It is likely that medical attention would be needed for some of these resulting conditions and that some of these health consequences would not be reversible; therefore an impact would be considered moderate to high in magnitude. Using the numerical ranking scheme, compromise to water and soil quality would produce a negative rank of -11.5 on a scale of  $\pm 6-15$ .

### ***ES4.3 Summary of Traffic Assessment***

The traffic assessment relies on estimated average traffic counts provided to us by Antero. While such numbers are somewhat useful for the purpose of this HIA, the estimates may not reflect true numbers of vehicles on any given day. The Garfield County Geographic Information Systems Services is working on a map with the traffic routes Antero anticipates using for their natural gas development and production. This map also will contain information concerning school bus stops in Battlement Mesa, provided to the CSPH team by the Garfield County District 16 transportation office.

When considering safety risks to residents of Battlement Mesa, increased traffic is likely to create negative health impacts. 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. Certain parts of the community will experience a greater impact for the entire duration of the Antero project (i.e., those homes next to CR300/Stone Quarry Road) while others will be impacted by very high volume traffic during the construction of some of the pads (i.e., along River Bluff Road). Because children often walk and ride bicycles and are not as safety conscious, children are considered more vulnerable than most adults to the impacts of traffic. The duration of exposure to increased traffic will likely be long, spanning the entire duration of the development the gas wells, at this time expected to be at least five years. The traffic will be frequent in some cases (River Bluff Road) where it is estimated that several hundred trucks passing a day for several months. Increased traffic is associated with increased risk of traffic accidents. Traffic accidents can cause minor to severe/fatal injuries and as such, there is wide range of potential health impacts. Using the numerical ranking scheme, impact due to traffic produces a negative rank of -13 on a scale of  $\pm 6-15$ .

### ***ES4.4 Summary of Noise, Vibration, and Light Assessment***

Anticipated noise, vibration and light exposures associated with the Antero development within the PUD may produce negative health effects. Of the three, noise is likely to have the most important impact on health. Increased noise is expected to be associated with construction and development phases and with truck traffic on haul routes. While all or most parts of the community may be near 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 residences that are close to haul routes and may experience elevated noise due to truck traffic for the entire development period (five years). Children may be more vulnerable to noise disturbance associated with truck traffic passing by the St. John Elementary School and the

Grand Valley Middle School during school hours. In addition, persons working at home may also be more vulnerable to noise disturbance. The elderly, particularly those with impaired hearing, may also be more vulnerable to noise pollution. Pad development will last several months, while nearby truck traffic may last several years for some residents, and thus, duration of exposure is expected to be medium to long, depending on location. On the other hand, major elevations in noise levels are not expected to occur during normal production phases in the 20 years subsequent to well development. Should well maintenance (workover) be conducted, noise levels are expected to increase during the reworking phase, which can last several days per well. When noise occurs, it is expected to be constant (e.g. diesel generators) and/or frequently reoccurring (e.g. truck traffic), depending upon the source. It is unlikely that noise exposure will cause noise-induced hearing loss or other noise-related health effects. 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 impacts 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, impacts to safety due to noise, vibration, and light increases produces a negative rank of -10.5 on a scale of +/-6-15.

#### ***ES4.5 Summary of Community Wellness Assessment***

Community wellness is difficult to define and more difficult to measure. We describe crime rates, mental health, substance abuse and suicide, occurrence of sexually transmitted infection and enrollment in K-12 education as measures of community wellness. Other factors, such as recreational opportunities and social cohesion do not lend themselves to measurement, but were considered in the assessment. Antero estimates an average of 120-150 persons to be working in Battlement Mesa. This estimate was used to evaluate the impacts on these aspects of community wellness.

Effects on community wellness are expected to be mixed. Positive effects might include less stress over finances, if increased demand for local business benefits the local economy, and increased access to social resources, services and infrastructure that expand to support a growing and changing population. For example, increased school enrollment can lead to more educational opportunity (Jacquet, 2009). Negative effects may include increased substance abuse, crime, sexually transmitted infection, demands on the education system beyond current capacity, interference with recreational activity and decreased social cohesion. Community impacts would be expected to be community wide, affecting the entire geographic extent of the Battlement Mesa PUD. It is possible that the elderly or youth of the community are more vulnerable to impacts on 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 haul routes. We expect the community impacts

to continue for the duration of the development phase of Antero's project (five years). However, because the Antero project is relatively small, it is expected that exposure to factors that impact community wellness will actually be infrequent and unlikely. If impacts do occur, they are anticipated to have low to medium impacts on citizens in the community. The overall magnitude of negative health effects are expected to be low to medium and may be related to distress over changes to the community, to increased availability of illegal substances, and more widespread sexually transmitted infection. The overall magnitude of positive health effects are expected to be low and related to decreased financial stress for some residents and possible increased resources for schools. Given adequate coverage and support offered by social infrastructure, we expect the residents of Battlement Mesa will be able to successfully adjust to the impact on community well-being. Using the numerical ranking scheme, impacts to community wellness produce a mixed rank of  $\pm 11.5$  on a scale of  $\pm 6-15$ .

#### ***ES4.6 Summary of Economic and Employment Assessment***

The economic and employment assessment is based upon Antero's estimate of an average of 120-150 workers, (both direct Antero employees and subcontracted workers) for a 2 rig operation over the five year development period. It is important to note that these numbers represent an estimate of the average number of workers and may not reflect employment on any given day.

The economic and employment changes related to Antero gas development in Battlement Mesa may produce mixed health effects. Positive effects would be related to higher wages for some residents, while negative effects would be related to higher inflation and no wage increase for others. Economic impacts would be experienced community wide and those on fixed incomes would be more vulnerable to the negative effects of inflation. The impacts of increased economic activity are likely to last the duration of the five year development period. The frequency health impact (stress, sleep disturbance) as a result of the economic activity is likely to be infrequent to constant, depending upon the individual circumstances. It is, however, unlikely that there will be large positive or negative economic impacts from the Antero development, given the relatively small economic scale of project and the probability that such impacts will be absorbed into Garfield County as a whole. Health impacts due to changing economic conditions are expected to be of low magnitude. Using the numerical ranking scheme, impacts on the economy and employment produce a mixed rank of  $\pm 10.5$  on a scale of  $\pm 6-15$ .

#### ***ES4.7 Summary of Health Infrastructure Assessment***

The assessment of changes to health infrastructure impacts on health is also based upon Antero's estimate of an average of 120-150 workers, on a two rig operation over the five year development period.

Changes to local health infrastructure associated with an increase in workforce and population in Battlement Mesa and the associated potential increase in health care utilization could have mixed

health impacts on Battlement Mesa community. Positive impacts could occur if the workers are insured and therefore support the existing healthcare system when it is used. On the other hand, if workers are uninsured, their use of medical services could strain the health system. However, like the economic impacts, health care system impacts are anticipated to be small given that Antero estimates an average workforce of 120-150 workers. Health care utilization is likely to be spread into Garfield County, depending upon where the workers live. 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. The potential for increased utilization of the health care services to strain existing services is small unless a large number of workers are uninsured and they all utilize the same services. It is not expected that the extent of such a strain would lead to decreased availability and quality of clinical 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, but are not likely to be large enough to directly impact public health services in Battlement Mesa. Should health services be impacted in Battlement Mesa, the impacts would affect the entire community, and 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 would 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 the 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 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 create a relatively high ranking, 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 project. Any impacts to health as a result of changes to the health care infrastructure are expected to be low. Using the numerical ranking scheme, impacts on the economy and employment produce a mixed rank of  $\pm 10$  on a scale of  $\pm 6-15$ .

#### ***ES4.8 Summary of Accidents and Malfunctions Assessment***

The assessment of accidents and malfunctions relies on a review of past accidents and malfunctions in Garfield County, Colorado from the COGCC incident database and individual cases in other areas. The very nature of accidents and malfunctions makes it difficult to predict whether or how an incident may impact health. Review of several years of COGCC data however, indicates that reportable incidents occur in approximately 6% of wells permitted, state wide, in Garfield County and for Antero's previous operations, as well. Therefore, it is possible to predict that with 200 wells being drilled in Battlement Mesa, there may be approximately 12 incidents that could be considered an accident or malfunction.

When considering the possible health impacts due to an accident or malfunction, the impacts are likely to be negative. Depending upon the size and nature of the incident, health and safety impacts may be felt by those only in close proximity, or throughout the PUD. 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 related 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 impacts 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, impacts to health due to accidents and malfunctions produce a negative rank of -10 on a scale of  $\pm 6-15$ .

## ES5 Recommendations

At the end of each assessment we have provided several recommendations aimed at decreasing negative public health impacts, improving positive ones, and filling information gaps. The summary recommendations that could be acted upon in the near future are listed below, and more long term summary recommendations are listed in the following section.

- **Promote Pollution Prevention:** Require Antero to use best available technology and rapidly adapt new technology, to reduce emissions of air, water and soil pollutants as well as noise reduction and control. Establish a system for short-term odor monitoring and reduction during gas well completion.
- **Protect Public Safety:** Review pipeline system for routes that avoid proximity to homes, schools or other areas used by residents. Require best available technology to avoid accidents and malfunctions and regular inspection of facilities and pipelines. Review emergency response plans and periodically test emergency response system.
- **Address Boomtown Effects:** Develop plans to address temporary and permanent population influx that may affect demand and capacity of social services, schools and other key community facilities and programs. Identify gaps in access to public health or social services and implement monitoring of community health needs.

## ES6 Next Steps and Conclusions

This HIA used the compiled baseline health characteristics of Battlement Mesa, current ambient environmental conditions in Garfield County and Antero's proposed gas development and production plans to evaluate probable and possible health impacts of Antero's project to the residents of Battlement Mesa. Through this process we have attempted to address the concerns of the citizens outlined in the BCC petition.

At the end of each assessment we have provided recommendations aimed at decreasing potential negative health impacts, based upon existing information. However, we also identified numerous gaps in information that limited this evaluation and may limit future evaluations of health in Battlement Mesa. Recommendations intended to address some of these gaps are provided in the HIA. Some of these issues will be addressed in an environmental health monitoring study (EHMS) currently being developed by CSPH investigators. These "next steps" recommendations can be summarized as follows:

- **Establish Baselines:** Improve monitoring of environmental exposures and health effects. Past environmental monitoring (i.e., air, traffic) and public health tracking (e.g., substance abuse, mental health) are insufficient to establish current health impacts among Battlement Mesa/Garfield County residents during gas development and production.
- **Enhance Environmental Monitoring:** Establish monitoring and data systems to conduct ongoing measurement of environmental exposures. Such exposures include 1) pollution of air, water and soil impacts; 2) physical hazards such as traffic, noise, vibration and light, and 3) psychosocial and community changes. Where feasible, tie environmental monitoring to risk-based environmental standards.
- **Improve Health Effects Tracking Systems:** Develop a robust health tracking system for Battlement Mesa/Garfield County so that providers report health conditions potentially related to natural gas development and production to the county health department.
- **Ensure Transparency:** Make exposure and health monitoring data from all public and industry interventions and monitoring available to the Battlement Mesa/Garfield County residents public in a timely manner.
- **Enhance Current Regulations:** Utilize findings of the HIA and future studies to complement ongoing state and local efforts to protect public health.

Because natural gas development and production will continue to grow in Garfield County, other parts of the region and state, as well as other parts of the country, the results of this HIA and the

future EHMS will likely have application beyond the study area and will contribute to filling many knowledge gaps about natural gas development and production and health.

In addition, because the domestic natural gas resource is part of the national policy to increase domestic energy production and reduce greenhouse gas emissions, a high level discussion of the health implications of this policy needs to take place. While municipal, county and state governments have begun to respond to citizen concerns, a national discussion of the benefits and risks associated with this policy is due. As outlined in this HIA, in addition to potential local economic benefits of energy development, there are potential local negative impacts to the physical and social health of the community. It will be important to understand public health implications in the context of national priorities for domestic energy production.