2 Exposure Assessment

The process that characterizes the route, duration, intensity, and frequency of contact with a chemical by a receptor is known as the exposure assessment. In this assessment, the receptors of interest are individuals who may reside within a monitoring area, and the principal exposure route of interest is inhalation. For this assessment, both long-term (chronic) and short-term (acute) exposures are evaluated.

- *Chronic assessment* addresses repeated exposure to relatively low levels of pollutants over a prolonged period of time that may result in chronic health effects such as cancer and other diseases
- *Acute assessment* addresses infrequent exposures to relatively high concentrations of pollutants over short periods of time (e.g., the measured maximum concentrations in a 24-hour period) that may result in effects ranging from reversible eye irritation to loss of consciousness, or long term/chronic effects

2.1 Exposure Assumptions

The following assumptions are used in this risk assessment based on the EPA methodology regarding chronic exposure at the monitoring locations:

- A person lives, works, and otherwise stays near a given monitoring location for 24 hours per day, 365 days per year, for a 70-year time period
- The air that the person breathes, both while indoors and outdoors, contains the same concentrations of pollutants measured in the air quality monitoring study.
- Air quality, as reflected by the monitoring results, is assumed to remain relatively constant over the entire 70-year lifetime of a person living in the area

The following assumptions are used in this risk assessment based on the EPA methodology regarding acute noncancer exposure at the monitoring locations:

- A person lives, works, and otherwise stays near a given monitoring location for a time period of up to 1-day
- The air that the person breathes, both while indoors and outdoors, contains the same concentrations of pollutants as monitored in the air quality monitoring study

2.2 Air Monitoring

This health risk assessment utilized data from the ambient air toxics monitoring conducted by GCPH at fixed sites in Garfield County, Colorado from 2008 to 2012. The monitoring sites included Parachute, Rifle, Bell-Melton (referred to as Bell), Battlement Mesa, Rulison, and Brock. Detailed site locations and air monitoring are discussed in the GCPH 2008 to 2011 air quality monitoring reports (GCPH, 2009, 2010a, 2010b, 2012, and 2013). Overall, all six sites were located in close proximity (within 0.5 miles) to oil and gas development activities in Garfield County. The monitoring network consisted of the following four sites per year:

- 2008—Urban sites (Parachute and Rifle) and Rural sites (Brock and Bell)
- 2009 and 2010—Urban sites (Parachute and Rifle) and Rural sites (Rulison and Bell)

- 2011 and 2012—Urban sites (Parachute and Rifle) and Rural sites (Battlement Mesa and Bell)

Overall, the 2008 to 2012 air quality monitoring network consistently included two urban sites (Parachute and Rifle) and one rural site (Bell). Therefore, it is important to note that the site-by-site comparison of the estimated risk from 2008 to 2012 included only three monitoring sites (Bell, Parachute, and Rifle) in this evaluation. The remaining three sites (Brock, Battlement Mesa and Rulison) lacked data for all five years from 2008 to 2012. Furthermore, the Brock air monitoring data were not at all discussed in this evaluation because this site was relocated to Rulison location in January 2009. Again, the Rulison air monitoring site was relocated to Battlement Mesa location in 2011. Therefore, any discussion related to all four monitoring sites includes the following: Bell, Battlement Mesa or Rulison, Parachute, and Rifle.

1.1.2 Data Quality

Organic sampling and analysis conducted by the GCPH was performed using methods that have been approved and recommended by the EPA. Specifically, the SNMOCs were collected with whole-air Summa canisters over a 24-hour period and analyzed via gas chromatography, in accordance with EPA Method TO-12. Likewise, carbonyls were collected on DNPH-coated cartridges and analyzed by liquid chromatography in accordance with EPA Method TO -11a. These methods can be accessed at http://www.epa.gov/ttn/amtic/airtox.html. The laboratory that was used for sample analyses performs analyses nationally for EPA's air toxics program. Thus, data from this study are expected to be of high quality.

The laboratory sends the data to GCPH and the APCD in an Excel file on a monthly basis. The files include not only the analysis results but also the minimum detection levels and quality control check results. These data from 2008 to 2012 were compiled by Mr. Gordon Pierce of the APCD and given to the DCEED in an Excel file for use in the risk assessment.

1.1.3 Data Robustness

For statistical data analyses, the ideal scenario would be to have sampling conducted on an everyday basis. However, due to budget constraints, this typically does not occur. For the GCPH 2008 to 2012 studies, sampling was conducted once every 6th day for the speciated non-methane organic compounds (approximately sixty samples per year) and once every 12th day for the carbonyls (approximately thirty samples per year). While this follows general EPA protocols, the quantity of data is less than ideal for a robust statistical analysis on a one-year basis and can lead to an increased uncertainty.

2.3 Contaminants of Potential Concern

Chronic Contaminants of Potential Concern

All chemicals that were detected at least once in the study period were conservatively retained as chemicals of potential concern (COPCs) for further evaluation. Overall, 90 chemicals were analyzed in the 2008 to 2012 air monitoring studies. Appendices A to E provide the 2008 to 2012 data summary for the 90 chemicals (Tables A1 to A3.1 for

2008; B1 to B3.1 for 2009; Tables C1 to C3.1 for 2010; Tables D1 to D3.1 for 2011; Tables E1 to E3.1 for 2012).

Overall, 90 COPCs that were included inrisk characterization at various monitoring locations as summarized below:

- Twenty three COPCs with available toxicity values (Table 1)—Quantitative risk characterization
- Fifty COPCs (Table 2)—Semi-quantitative risk characterization
    - evaluated using EPA's fractional approach for complex mixture of aliphatic (45) and aromatic (5) petroleum hydrocarbons: 34 aliphatic C_5–C_8 ; 11 aliphatic C_9–C_{18}; and 5 aromatic C_9–C_{16}
- Seventeen COPCs with no toxicity values (Table 3)—Qualitative risk characterization

Acute Contaminants of Potential Concern

For the assessment of acute health risks, COPCs were selected by comparing the maximum detected concentrations with the chronic toxicity value. The selection of acute COPCs for acute risk evaluation from 2008 to 2012 is shown in Table F1 and summarized below:

- For 2008, benzene, 1, 2, 4-trimthylbenzene, and aliphatic hydrocarbons C_5–C_8 were selected. However, only benzene was quantitatively evaluated further for acute health risks because no acute toxicity values were available for 1, 2, 4-trimethylbenzene and aliphatic hydrocarbons C_9–C_{18}. These compounds were qualitatively evaluated by using the available subchronic toxicity values.

- For 2009, benzene, 1, 3-butadiene and formaldehyde were identified as acute COPCs. These COPCs have available acute toxicity values.

- For 2010, 2011, and 2012, no acute COPCs were identified because the maximum detected concentrations were below the chronic toxicity value.

2.4 Exposure Concentration

Analytical data for COPCs were processed to derive exposure concentrations. All samples reported as non-detects were handled statistically in accordance with the ProUCL guidance or were assigned a value of ½ the lowest concentration that the instrument can detect, known as the sample quantitation limit (SQL) or detection limit.

The EPA recommends that the 95% upper confidence limit (UCL) of the arithmetic mean concentration be used as the Exposure Point Concentration (EPC) in calculating exposure and risk. The 95% percent UCL was calculated using the EPA ProUCL version 4.1 software (available at: http://www.epa.gov/nerlesd1/tsc/install.htm) and the GCPH monitoring data (by Mr. Gordon Pierce of the APCD). The EPC values from 2008 to 2012 for the COPCs that were evaluated quantitatively, semi-quantitatively (as fractions), and qualitatively are summarized in Tables and Appendices as noted below: