Greater Natural Buttes Supplement to the Draft Environmental Impact Statement

DES 11-23

Vernal Field Office/Utah

Bureau of Land Management

May 2011

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District Office
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Vernal, UT 84078
http://www.blm.gov/ut/st/en/fo/vernal.html

IN REPLY REFER TO:
LLUTG01000
1790
UT-080-07-807

Dear Public Land User:

Enclosed for your review is the Supplement to the Draft Environmental Impact Statement (EIS) for the Greater Natural Buttes Area Gas Development Project, which evaluates air quality impacts of the proposed project in comparison to the new NO_2 and SO_2 1-hour National Ambient Air Quality Standards (NAAQS). It also discloses recent ozone monitoring data for the Uinta Basin. This document supplements the information and analysis contained in the Greater Natural Buttes Draft EIS, which was released for public review and comment in July 2010. The Supplement to the Draft EIS was prepared in response to concerns from the Environmental Protection Agency regarding the new NAAQS standards and the new monitoring data, which were not available when the Draft EIS was being written, but which came out prior to the Draft EIS public comment period.

The Greater Natural Buttes Project Area (GNBPA) encompasses approximately 162,911 acres in an existing gas producing area located in Township 8 South, Ranges 20 through 23 East; Township 9 South, Ranges 20 through 24 East; Township 10 South, Ranges 20 through 23 East; and Township 11 South, Ranges 21 and 22 East (Salt Lake Meridian) in Uintah County, Utah. Under the Proposed Action, up to 3,675 new gas wells would be drilled over a period of 10 years. Additionally, approximately 760 miles of new roads, 820 miles of buried pipelines, 587 miles of surface pipelines, 7 miles of electrical power lines, 2 mancamps, 2 compressor stations, and water disposal facilities would be constructed to support this proposed development. Total new surface disturbance under the Proposed Action would be approximately 12,658 acres, or 8% of the total GNBPA. Three other alternatives were analyzed in detail: the No Action Alternative, the Resource Protection Alternative, and an Optimal Recovery Alternative.

The Supplement to the Draft EIS was prepared pursuant to the National Environmental Policy Act (NEPA), as well as other regulations and statutes, to address possible environmental and socio-economic impacts that could result from implementation of the project. This Supplement to the Draft EIS is not a decision document. Its purpose is to inform the public and the Decision Maker of the air quality impacts associated with implementing the proponent's drilling proposal, to evaluate alternatives to the proposal, and to solicit other agencies and the public for comments.

You may want to refer to the Draft EIS so that you have the full context for this Supplement, including a description of the alternatives, environment, and anticipated impacts. The Draft is available at http://www.blm.gov/ut/st/en/fo/vernal/planning/nepa_/greater_natural_buttes.html.

Written comments on the Supplement will be accepted by fax, email, or letter for 45 days following the publication of the Notice of Availability in the Federal Register by the U.S. Environmental Protection Agency. If you wish to submit comments on this Supplement, we request that you make them as specific as possible, with references to page numbers and chapters of the document. The most useful comments will contain new technical or scientific information, identify data gaps in the impact analysis, or provide technical or scientific rationale for opinions or preferences. Please refer to "Greater Natural Buttes Supplement" in your correspondence. Please provide your comments to:

Bureau of Land Management
Attn: Stephanie Howard
Vernal Field Office
170 South 500 East
Vernal, Utah 84078
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UT_Vernal_Comments@blm.gov

Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you may ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. BLM will not consider anonymous comments. Comments, including names and street addresses of respondents, will be available for public review at the BLM Vernal Field Office from 7:45 a.m. to 4:30 p.m. Monday through Friday, excluding federal holidays. Comments may be published as part of the NEPA document and other related documents. All submissions from organizations or businesses will be made available for public inspection in their entirety. For further information concerning the document, please contact Stephanie Howard at (435) 781-4469.

Sincerely,

Michael G. Stiewig
Vernal Field Office Manager

Enclosures – As Stated

Acronyms and Abbreviations

°F	degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter
AQRV	Air Quality Related Value
AQS	Air Quality System
ARMS	Air Resource Management Strategy
BLM	Bureau of Land Management
CAA	Clean Air Act
CDP	Census Designated Places
CFR	Code of Federal Regulations
CH_4	methane
CMAQ	Community Multiscale Air Quality
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
EIS	environmental impact statement
EO	Executive Order
FLMs	Federal Land Managers
FR	Federal Register
GHG	greenhouse gas
GNBPA	Greater Natural Buttes Project Area
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
hp	horsepower
IPCC	Intergovernmental Panel on Climate Change
km	kilometer
KMG	Kerr-McGee Oil & Gas Onshore LP
MACT	Maximum Achievable Control Technology
MPE	Model Performance Evaluation
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen

NPS	National Park Service
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
ppb	parts per billion
ppm	parts per million
ppmw	parts per million weight
PSD	Prevention of Significant Deterioration
PTE	potential to emit
RfC	Reference Concentrations
ROD	Record of Decision
SAAQS	State Ambient Air Quality Standards
SDEIS	Supplement to the Draft EIS
SI	spark-ignition
SO_2	sulfur dioxide
tpy	tons per year
TSL	Toxic Screening Level
UDAQ	Utah Division of Air Quality
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
UTAG	***Utah Air Resource Advisory Group***
VOC	volatile organic compound
WDEQ	Wyoming Department of Environmental Quality
WRAP	Western Regional Air Partnership

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1.0 Introduction and Background

1.1 Project Location and Background

This section is included in the Draft Environmental Impact Statement (EIS) and is not being amended in this supplement.

1.2 Summary of Proposed Action

This section is included in the Draft EIS and is not being amended in this supplement.

1.3 Purpose and Need

This section is included in the Draft EIS and is not being amended in this supplement.

1.4 Environmental Analysis Process

This section is included in the Draft EIS and is not being amended in this supplement.

1.4.1 Decisions to be Made After the EIS Process

This section is included in the Draft EIS and is not being amended in this supplement.

1.4.2 Supplement to the Draft EIS

In response to comments on the Draft EIS for the Greater Natural Buttes Area Gas Development Project, the Bureau of Land Management (BLM) developed this Supplement to the Draft EIS (SDEIS) to address comments specific to air quality. The comments that provided the basis for the BLM's development of the SDEIS raised issues regarding new information and additional analyses to be included in the document and can be summarized as follows:

- ***Since completion of the air quality impact analysis for this project, United States (U.S.) Environmental Protection Agency (USEPA) established new 1-hour standards for nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). These standards are addressed through additional near-field modeling analyses in this document.***
- ***Monitoring of ozone levels in the Uinta Basin during 2010 and 2011 have revealed concentrations at levels above the National Ambient Air Quality Standards (NAAQS), prompting the BLM to consider additional mitigation measures in the impact analysis.***
- ***The new information and analyses prompted the BLM to re-evaluate potential environmental justice impacts on nearby communities.***

This SDEIS presents additional analysis of near-field impacts to address newly promulgated standards for NO_2 and SO_2 as well as to address comments related to mitigation and environmental justice impacts due to potential air quality impacts. This document is formatted to follow the same outline as the Draft EIS; however, only those sections that are revised or newly added to the document are presented in the SDEIS. For those sections that are referenced in the SDEIS but text has not been included, the reader is referred to the same section number of the Draft EIS.

The SDEIS is being released for public review as a separate document to obtain comment on the revised and newly added sections of the document. The BLM will review public comments, respond to the comments, and make appropriate revisions to the text in the SDEIS. The revised SDEIS will then be incorporated into the Final EIS.

1.5 Legal and Policy Considerations

This section is included in the Draft EIS and is not being amended in this supplement.

1.6 Scoping

This section is included in the Draft EIS and is not being amended in this supplement.

2.0 Proposed Action and Alternatives

This section is included in the Draft EIS and is not being amended in this supplement.

3.0 Affected Environment

This introductory text is included in the Draft EIS and is not being amended in this supplement.

3.1 Air Quality

This section is included in the Draft EIS and is not being amended in this supplement.

3.1.1 Regional Climate

This section is included in the Draft EIS and is not being amended in this supplement.

3.1.2 Air Quality

Air quality in a given location is defined by pollutant concentrations in the atmosphere and is generally expressed in units of parts per million (ppm) or micrograms per cubic meter (µg/m^3). The existing air quality in the proposed development area is in attainment of the NAAQS ***(which are established by the USEPA to protect public health and the environment)*** and State AAQS (SAAQS) or has insufficient data to establish ***attainment status***. Representative ambient background levels of pollutants measured in Uintah and Salt Lake counties in Utah, and Sweetwater County, Wyoming, are shown in **Table 3.1-2**. Data for this table were obtained from the ***USEPA Air Quality System (AQS)*** data archives website. The carbon monoxide (CO) data from Salt Lake County are not representative of the area, but were used to provide a conservative estimate of background levels for estimating impacts on the NAAQS for CO.

Table 3.1-2 Ambient Air Quality Background Values

Pollutant	Averaging Period	Ranking[1]	Year	Concentration (µg/m^3)	County	State
NO_2	***1-hour***	***98th Percentile***	***2010***	***69.6[2]***	***Uintah***	***Utah***
		98th Percentile	***2010***	***58.3[3]***	***Uintah***	***Utah***
	Annual	H	***2010***	***8.0[2]***	***Uintah***	***Utah***
		H	***2010***	***7.2[3]***	***Uintah***	***Utah***
CO	1-hour	H2H	2004	6,210	Salt Lake	Utah
		H2H	2005	6,325	Salt Lake	Utah
		H2H	2006	6,325	Salt Lake	Utah
	8-hour	H2H	2004	3,680	Salt Lake	Utah
		H2H	2005	3,910	Salt Lake	Utah
		H2H	2006	3,450	Salt Lake	Utah
SO_2[4]	***1-hour***	***99th Percentile***	***2007***	***21.7***	***Sweetwater***	***Wyoming***
		99th Percentile	***2008***	***19.7***	***Sweetwater***	***Wyoming***
		99th Percentile	***2009***	***19.0***	***Sweetwater***	***Wyoming***
	3-hour	H2H	***2007***	***16.0***	Sweetwater	Wyoming
		H2H	***2008***	***16.7***	***Sweetwater***	***Wyoming***
		H2H	***2009***	***10.1***	Sweetwater	Wyoming
	24-hour	H2H	***2007***	***5.9***	Sweetwater	Wyoming
		H2H	***2008***	***5.6***	***Sweetwater***	***Wyoming***
		H2H	***2009***	***3.9***	Sweetwater	Wyoming
	Annual	H	***2007***	***1.5***	Sweetwater	Wyoming
		H	***2008***	***1.5***	***Sweetwater***	***Wyoming***
		H	***2009***	***0.8***	Sweetwater	Wyoming
Particulate matter (PM) with an aerodynamic diameter of 10 microns or less (PM_{10})	24-hour	H2H	2004	14.0	Uintah	Utah
		H2H	2005	18.0	Uintah	Utah
		H2H	2006	16.0	Uintah	Utah
	Annual	H	2004	5.0	Uintah	Utah
		H	2005	7.0	Uintah	Utah
		H	2006	7.0	Uintah	Utah
PM with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$)	24-hour	98th percentile	***2010***	***16***.0	***Uintah***	Utah
	Annual	***H***	***2010***	***6.0***	***Uintah***	***Utah***

Table 3.1-2 Ambient Air Quality Background Values

Pollutant	Averaging Period	Ranking[1]	Year	Concentration ($\mu g/m^3$)	County	State
Ozone	*8-hour*	*H4H*	*2010*	*117.0*[2,5]	*Uintah*	*Utah*
		H4H	*2010*	*98.0*[3,5]	*Uintah*	*Utah*

[1] H = Highest value recorded; H2H = High Second High (second highest value from the highest receptor site); H4H = High Fourth High (fourth highest value from the highest receptor site).
[2] Ouray Monitoring Station Data (USEPA AQS Database).
[3] Redwash Monitoring Station Data (USEPA AQS Database).
[4] Wamsutter Monitoring Station Data (USEPA AQS Database).
[5] Ozone is measured in parts per billion (ppb).

Figure 3.1-2 shows the maximum daily 8-hour average ozone concentrations recorded at the Ouray and Redwash monitoring stations from July 30, 2009, to August 31, 2010. These data show winter ozone levels above 75 ppb NAAQS; however, summer 8-hour daily maximum values do not exceed 75 ppb. This winter ozone pattern is similar to ozone monitoring observations made in other oil and gas fields including the Upper Green River Basin and Jonah-Pinedale Anticline (Schnell et al. 2009). The current scientific consensus is that the photochemical processes that form tropospheric ozone in the presence of NO_2 and free radical volatile organics are heightened by increased concentrations of ozone precursors from the stagnant winter atmospheric conditions and increased solar radiation reflected from the winter snow cover (Schnell et al. 2009). However, this is an area of ongoing scientific research.

3.1.3 Regulatory Framework

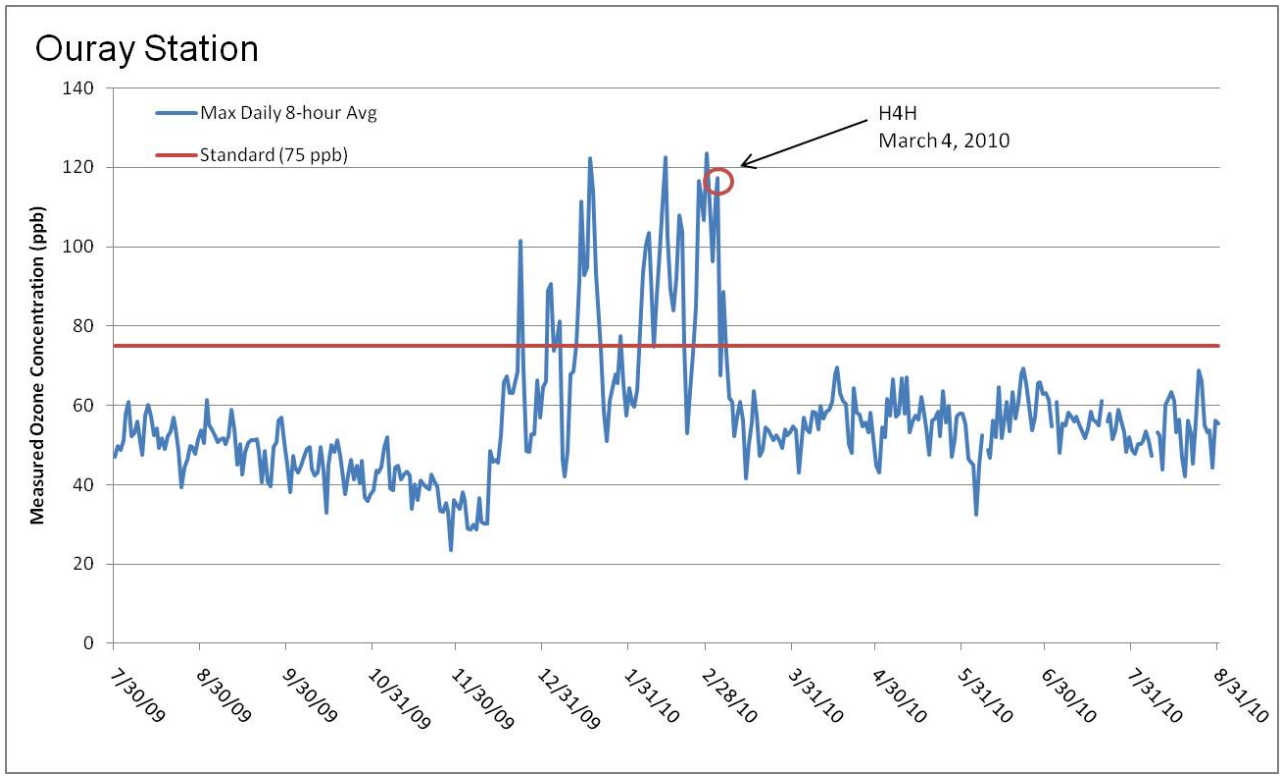
This section is included in the Draft EIS and is not being amended in this supplement.

3.1.3.1 National Ambient Air Quality Standards

The Federal ***Clean Air Act (***CAA***)*** require***s*** all states to control air pollution emission sources so that NAAQS are met and maintained. In addition to these requirements, the National Park Service (NPS) Organic Act requires the NPS to protect the natural resources of the lands it manages from the adverse effects of air pollution.

The NAAQS establishes maximum acceptable concentrations for oxides of nitrogen (NO_2/NO_X), CO, SO_2, PM_{10}, $PM_{2.5}$, ozone, and lead. Given the extremely low levels of lead emissions from project sources, the lead standards are not addressed in this analysis. These pollutants are known as criteria pollutants. The NAAQS are established by the USEPA and are outlined in 40 ***Code of Federal Regulations (***CFR***)*** 50. These standards represent the maximum allowable atmospheric concentrations that may occur without jeopardizing public health and welfare, and include a reasonable margin of safety to protect the more sensitive individuals in the population. The NAAQS represent maximum acceptable concentrations that generally may not be exceeded more than once per year; the annual standards may never be exceeded. An area that does not meet the NAAQS is designated as a nonattainment area on a pollutant-by-pollutant basis.

The USEPA established a 1-hour NO_2 NAAQS of 100 ppb (188 $\mu g/m^3$) on January 22, 2010 (75 Federal Register [FR] 6474-65370, February 9, 2010), supplementing the existing annual NO_2 NAAQS. Further, the USEPA established a 1-hour SO_2 NAAQS of 75 ppb (197 $\mu g/m^3$) on June 2, 2010 (FR 35520-35603, June 22, 2010). At the same time, USEPA revoked the existing 24-hour and annual primary SO_2 standards. The NO_2 and SO_2 standards became effective on April 12 and August 23, 2010, respectively. Compliance with the standard is attained for 1-hour NO_2 when the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour concentrations does not exceed the standard within an area. For 1-hour SO_2, the standard is attained when the 3-year average of the 99th percentile



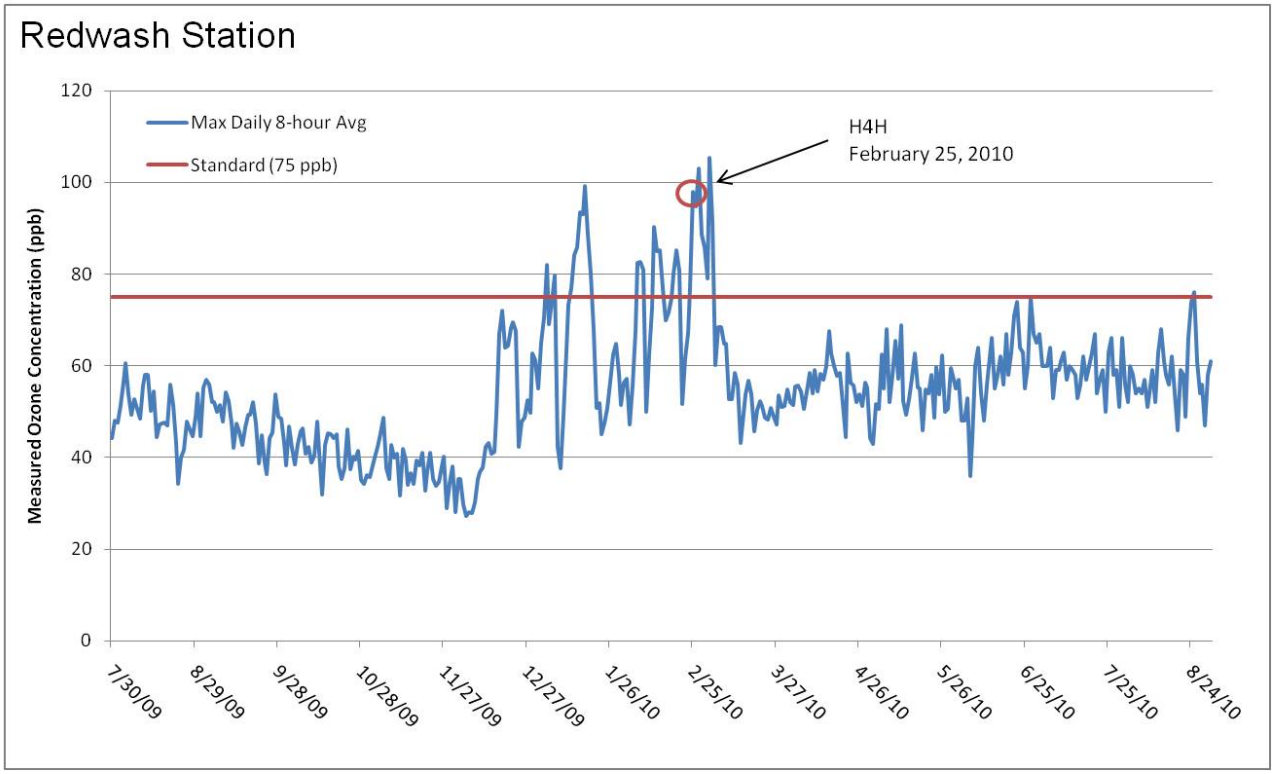


Figure 3.1-2 Ouray and Redwash Ozone Monitoring Data

of the annual distribution of daily maximum 1-hour concentrations does not exceed the standard within an area. Applicable state and federal criteria are presented in Table 3.1-3.

Table 3.1-3 *Applicable* Ambient Air Quality Standards

Pollutant	Averaging Period	Ambient Air Quality Standards[1]			
		National	Wyoming	Utah	Colorado
NO_2 (µg/m^3)	***1-hour[2]***	***188***	***--[3]***	***188***	***--[3]***
	Annual[4]	100	100	100	100
CO (µg/m^3)	1-hour[5]	40,000	40,000	40,000	40,000
	8-hour[5]	10,000	10,000	10,000	10,000
SO_2 (µg/m^3)	***1-hour[6]***	***197***	***--[3]***	***197***	***--[3]***
	3-hour[5,7]	1,300	1,300	1,300	1,300
	24-hour[5,7]	***--[8]***	260	365	365
	Annual[4]	***--[8]***	60	80	80
PM_{10} (µg/m^3)	24-hour[9]	150	150	150	150
	Annual[4]	--[10]	50	50	50
$PM_{2.5}$ (µg/m^3)	24-hour[11]	35	35	35	35
	Annual[12]	15	15	15	15
Ozone (pp***b***)	8-hour[13]	***75***	***75***	***75***	***75***

[1] Sources: USEPA 2009, Wyoming Department of Environmental Quality (WDEQ) 2008, and Colorado Department of Public Health and Environment 2007.
[2] Three-year average of the 98th percentile of the daily maximum 1-hour average.
[3] No state standard has been incorporated into the State Implementation Plan.
[4] Never to be exceeded.
[5] Not to be exceeded more than once per year.
[6] Three-year average of the 99th percentile of daily maximum 1-hour average.
[7] Secondary standard only.
[8] The 24-hour and annual SO_2 NAAQS have been revoked and replaced with the 1-hour standard (75 FR 35520-35603, June 22, 2010).
[9] Not to be exceeded more than once per year on average over 3 years.
[10] The annual PM_{10} NAAQS of 50 µg/m^3 was revoked by USEPA on September 21, 2006. See FR Volume 71, Number 200, October 17, 2006.
[11] Three-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed the standard.
[12] Three-year average of the weighted annual mean concentrations from single or multiple community-oriented monitors must not exceed this standard.
[13] Three-year average of the fourth highest daily maximum 8-hour average measured at each monitor within an area over each year must not exceed this standard.

3.1.3.2 Prevention of Significant Deterioration

Prevention of Significant Deterioration (PSD***)*** regulations***, which*** restrict the degree of ambient air quality deterioration allowed ***in areas that meet the NAAQS,*** apply to proposed new or modified major stationary sources located in an attainment area that have the potential to emit criteria pollutants in excess of predetermined de minimis values (40 CFR Part 51). Increments for criteria pollutants are based on the PSD classification of the area. Class I area status is assigned to federally protected wilderness areas and allows the lowest amount of permissible deterioration. Class I areas allow the lowest amount of air quality increment consumption, while Class II designations allow higher increment consumption. There are no designated Class III or heavy industrial use areas.

As defined in 40 CFR 51, a source is a major stationary source if it:

1. Can be classified in one of the 28 named source categories listed in Section 169 of the CAA and it emits or has the potential to emit ***(PTE)*** 100 tons per year (tpy) or more of any pollutant regulated by the Act; or
2. Is any other stationary source that emits or has the ***PTE*** 250 tpy or more of any pollutants regulated by the CAA (USEPA 1990).

Compressor stations and other upstream oil and gas sources are not listed as one of the 28 named source types in Section 169 of the Act; therefore, 250 tpy is the threshold for major source status.

In addition to more stringent PSD increments, Class I areas are protected by Federal Land Managers (FLMs) by management of air quality related values (AQRVs) such as visibility and acid deposition. Though not a regulatory program under PSD, FLMs review the issuance of a PSD permit for any impacts that exceed guideline thresholds for these parameters. The air quality impacts in the area must meet the NAAQS, which apply nationwide. The nearest Class I area is Arches National Park about 80 miles south of the ***Greater Natural Buttes Project Area (***GNBPA***)***. See **Table 3.1-4** for a complete list of Class I and Class II areas considered in the air quality analysis.

Table 3.1-4 Class I and Sensitive Class II Areas of Concern for Air Quality Impact Analysis

NPS Class I Areas
Arches National Park
Black Canyon of the Gunnison National Park
Canyonlands National Park
Capitol Reef National Park
Mesa Verde National Park
***U.S. Forest Service (*USFS*)* Class I Areas**
Eagles Nest Wilderness Area
Flat Tops Wilderness Area
La Garita Wilderness Area
Maroon Bells-Snowmass Wilderness Area
Mount Zirkel Wilderness Area
Weminuche Wilderness Area
West Elk Wilderness Area
NPS Class II Areas
Colorado National Monument
Dinosaur National Monument
USFS Class II Areas
Flaming Gorge National Recreation Area
High Uintah Wilderness Area
Holy Cross Wilderness Area
Hunter/Frying Pan Wilderness Area
Raggeds Wilderness Area
***U.S. Fish and Wildlife Service (*USFWS*)* Class II Areas**
Browns Park National Wildlife Refuge

Allowable deterioration to air quality can be expressed as the incremental increase to ambient concentrations of criteria pollutants, or PSD increment. Modeled air concentrations of NO_2, SO_2, and PM_{10} predicted at near-field receptors that result from the emissions due to project sources are compared with the convenient threshold of allowable PSD increments. This comparison to PSD Class II increments ***is solely for informational purposes and*** does not represent a regulatory PSD increment consumption analysis because the focus of this study is the Proposed Action and alternatives under ***the National Environmental Policy Act (***NEPA***)***, not increment-affecting sources, which are not evaluated for regulatory purposes under NEPA. The allowable PSD increments for ***Class I and*** Class II areas are given in **Table 3.1-5**.

Table 3.1-5 PSD Increments for Class I and Class II Areas

PSD Class	Pollutant	Allowable Increment ($\mu g/m^3$)		
		Annual Arithmetic Mean	24-hour Maximum	3-hour Maximum
Class I	NO_2	2.5	-	-
	SO_2	2	5	25
	PM_{10}	4	8	-
Class II	NO_2	25	-	-
	SO_2	20	91	512
	PM_{10}	17	30	-

On June 3, 2010, the USEPA issued the final rule that "tailors" the applicability of PSD regarding USEPA and/or permitting authorities to implement PSD permitting requirements for greenhouse gases (GHGs) (75 FR 31514). The "Tailoring Rule" took effect on January 2, 2011, for new or modified sources that have the PTE or net increase in emissions more than 75,000 tpy of carbon dioxide (CO_2) equivalents (CO_2e) and would be considered major for other PSD pollutants. On or after July 1, 2011, this rule will apply to any new source with the PTE 100,000 tpy CO_2e and exceeds the major source threshold of any GHG on a mass basis regardless of the PTE of other PSD pollutants. Further, modifications at an existing major source that results in a net emissions increase of 75,000 tpy CO_2e also will be reviewed under the PSD rules.

This EIS does not evaluate permitting requirements under the CAA; however, if a major source were to be proposed during the course of development of any alternatives, emissions from that source would need to be evaluated regarding the applicability of the PSD program based on GHG emissions, as well as the standard criteria air pollutant emissions. Under the current project design, including compressor stations that are the largest sources of GHGs, none of the proposed sources would trigger PSD review under the Tailoring Rule.

3.1.3.3 Nonattainment New Source Review

This section is included in the Draft EIS and is not being amended in this supplement.

3.1.3.4 Conformity for General Federal Actions

This section is included in the Draft EIS and is not being amended in this supplement.

3.1.3.5 New Source Performance Standards

This section is included in the Draft EIS and is not being amended in this supplement.

3.1.3.6 National Emission Standards for Hazardous Air Pollutants

Under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs), the USEPA promulgated ***Maximum Achievable Control Technology (***MACT***)*** standards pursuant to Section 112 of the 1990 CAA Amendments and these rules are provided in 40 CFR 63. The MACT standards that potentially would be applicable to the proposed project include:

- Subpart A – General Provisions;
- Subpart HH – Oil and Natural Gas Production Facilities;
- Subpart YYYY – Stationary Combustion Turbines; and
- Subpart ZZZZ – Stationary Reciprocating Internal Combustion Engines

Subpart A – General Provisions

The general provisions for all sources affected by a MACT standard are promulgated under Subpart A. Each of the promulgated standards contains a detailed list of Subpart A ***provisions*** that ***are*** applicable to the affected facility. The critical sections of Subpart A are summarized in Section 63.6, specifically including paragraph 63.6(e), which provides operation and maintenance requirements.

Subpart HH – Oil and Natural Gas Production Facilities

In the January 3, 2007, Federal Register ***(72 FR pp. 26-43)***, the USEPA amend***ed*** 40 CFR 63, Subpart HH to include area sources rather than just major sources of ***hazardous air pollutants (***HAPs***)***. An affected source under this final rule is each tri-ethylene glycol dehydration unit located at an area source oil and natural gas production facility. ***The USEPA is reviewing the Subpart HH rules and is under a consent decree schedule to issue a final rule revising Subpart HH, or a determination that revisions are not necessary, by November 30, 2011.***

Subpart YYYY – Stationary Combustion Turbines

The USEPA published the final stationary combustion turbine MACT rule in the Federal Register on March 5, 2004. New lean premix and diffusion flame gas- and oil-fired turbines at major HAP facilities are required to limit formaldehyde emissions to 91 ppb volume dry at 15 percent oxygen. On April 7, 2004, the USEPA published two proposed rules affecting natural gas-fired lean premix combustion turbines and three other subcategories. On August 18, 2004, USEPA issued a final rule to stay of the effectiveness for two categories of stationary combustion turbines: lean pre-mix gas-fired turbines and diffusion flame gas-fired turbines.

Subpart ZZZZ – Stationary Reciprocating Internal Combustion Engines

On January 18, 2008, the USEPA published in the Federal Register finalized rules to amend 40 CFR 63, Subpart ZZZZ. An affected source under this amended Subpart is any existing, new, or reconstructed stationary reciprocating internal combustion engine with a site-rating of more than 25 brake horsepower, which are located at either a major source or area source of HAPs.

On August 20, 2010, the USEPA published further revisions to this rule (71 FR 51570 et. seq.) to address emissions from existing stationary spark-ignition (SI) engines less than or equal to 500 horsepower (hp) at major sources and all existing stationary SI engines located at area sources.

3.1.3.7 Carbon Dioxide and Other Greenhouse Gases

Ongoing scientific research has identified the potential impacts of anthropogenic (man-made) GHG emissions and changes in biological carbon sequestration due to land management activities on global climate. Through complex interactions on a regional and global scale, these GHG emissions and net losses of biological carbon sinks cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy

radiated by the earth back into space. Although GHG levels have varied for millennia, recent industrialization and burning of fossil carbon sources have caused CO_2e concentrations to increase dramatically, and are likely to contribute to overall global climatic changes. The Intergovernmental Panel on Climate Change (IPCC) recently concluded that warming of the climate system is unequivocal and most of the observed increase in globally average temperatures since the mid-20th century very likely is due to the observed increase in anthropogenic GHG concentrations (IPCC 2007).

Global mean surface temperatures increased nearly 1.8 ***degrees Fahrenheit (***°F***)*** from 1890 to 2006. Models indicate that average temperature changes are likely to be greater in the Northern Hemisphere. Northern latitudes (above 24°N) have exhibited temperature increases of nearly 2.1°F since 1900, with nearly a 1.8°F increase since 1970. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHGs are likely to accelerate the rate of climate change.

In 2001, the IPCC projected that by the year 2100, global average surface temperatures could increase by 2.5 to 10.4°F above 1990 levels. The National Academy of Sciences (2010) has confirmed these projections, but also has indicated that there are uncertainties regarding how climate change may affect different regions. Computer model predictions indicate that increases in temperature would not be equally distributed, but are likely to be accentuated at higher latitudes. Warming during the winter months is expected to be greater than during the summer, and increases in daily minimum temperatures are more likely than increases in daily maximum temperatures. Although large-scale spatial shifts in precipitation distribution may occur, these changes are more uncertain and difficult to predict.

As with any field of scientific study, there are uncertainties associated with the science of climate change; however, this does not imply that scientists do not have confidence in many aspects of climate change science. Some aspects of the science are known with virtual certainty because they are based on well-known physical laws and documented trends (USEPA 2010***a***).

Several activities contribute to the phenomena of climate change, including emissions of GHGs (especially CO_2 and methane [CH_4]) from fossil fuel development, large wildfires, activities using combustion engines, changes to the natural carbon cycle, and changes to radiative forces and reflectivity (albedo). It is important to note that GHGs will have a sustained climatic impact over different temporal scales. For example, recent emissions of CO_2 may influence climate for 100 years.

It may be difficult to discern whether climate change is already affecting resources globally, let alone those in the vicinity of the proposed project. In most cases, there is little information about potential or projected effects of global climate change on resources. It is important to note that projected changes are likely to occur over several decades to a century. Therefore, many of the projected changes associated with climate change may not be measurably discernible within the reasonably foreseeable future. Existing climate prediction models are global in nature; therefore, they are not at the appropriate scale to ***provide a credible*** estimate of climate change ***impacts in*** the ***project*** vicinity.

The analysis of the Regional Climate Impacts prepared by the U.S. Global Change Research Program (USGCRP) (2009) suggests that recent warming in the region was among the most rapid nationally. They conclude that this warming is causing decline in spring snowpack and reducing flow in the Colorado River. Their projections of future climate change indicate that further strong warming will reduce precipitation, which in turn will strain regional water supplies, increase the risk of wildfires and invasive species, and degrade recreational opportunities.

Past records and future projections predict an overall increase in regional temperatures, which would cover the development area. As has been observed at many sites to date, the observed increase is largely the result of the warmer nights, and effectively higher average daily minimum temperatures at many of the sites in the region. The USGCRP (2009) projects a region-wide decrease in precipitation, although with substantial variability in interannual conditions. For eastern Utah, the projections range

from approximately 5 percent decrease in annual precipitation to decreases as high as 40 percent of annual precipitation.

In *Massachusetts v. EPA*, the U.S. Supreme Court (April 7, 2007) held that CO_2 satisfies the definition of "air pollutant" and that USEPA has authority to regulate emissions of CO_2 and other GHGs from new motor vehicles under the CAA. The Supreme Court remanded the case to the USEPA to determine whether such motor vehicle emissions contribute to global climate change, and thereby endanger public health or welfare.

On October 30, 2009, the USEPA promulgated the final mandatory reporting rule for GHGs under 40 CFR Part 98, which requires a wide range of sources to record and report selected GHG emissions including CO_2, CH_4, nitrous oxide (N_2O), and some halogenated compounds. A CO_2e value is calculated for combined emissions of these gases based on their comparative global warming potential. This rule applies to sources that emit 25,000 tpy or more CO_2e. Further, the USEPA issued the final reporting GHG requirements for petroleum and natural gas production on November 30, 2010 (40 CFR Part 98, Subpart W) (75 FR 74458). The rule specifically identifies monitoring and reporting requirements for natural gas systems including combustion units (Subpart C) as well as on-shore gas production, storage, processing, and transmission (Subpart W).

Applicable USEPA rules do not require any controls or establish any ***emission limits*** related to GHG emissions or impacts. Therefore, there is no requirement at this time that would affect development of the proposed project under ***this*** rule, other than the ***requirement for the operator to develop a monitoring plan and maintain*** recordkeeping and reporting of GHG emissions.

3.2 Cultural Resources and Native American Traditional Values

This section is included in the Draft EIS and is not being amended in this supplement.

3.3 Geology

This section is included in the Draft EIS and is not being amended in this supplement.

3.4 Land Use

This section is included in the Draft EIS and is not being amended in this supplement.

3.5 Paleontology

This section is included in the Draft EIS and is not being amended in this supplement.

3.6 Range Resources

This section is included in the Draft EIS and is not being amended in this supplement.

3.7 Recreation

This section is included in the Draft EIS and is not being amended in this supplement.

3.8 Socioeconomics and Environmental Justice

3.8.1 Study Area for Socioeconomics

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.2 Background on the Role of Oil and Gas Development in the Region

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.3 Local Population

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.4 Local Economy and Labor Force

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.5 Specific Economic Sectors

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.6 Community Facilities and Services

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.7 Public Expenditures and Revenues

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.8 Population and Employment Projections

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.9 Community Social Conditions

This section is included in the Draft EIS and is not being amended in this supplement.

3.8.10 Environmental Justice

Environmental justice is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (USEPA 1998a). Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, tasks "each Federal agency [to] make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Implementation of EO 12898 for NEPA by agency directive involves the following steps (BLM 2002):

- ***Identification of the presence of minority and low-income populations and Indian Tribes in areas that may be affected by the action under consideration.***
- ***Determination of whether the action under consideration would have adverse human health, environmental, or other effects on any population.***

- ***Determine of whether such environmental, human health, or other effects would be disproportionately high and adverse on minority or low-income populations or Indian Tribes.***
- ***Providing opportunities for effective community participation in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of public meetings, crucial documents, and notices (USEPA 1998a).***

Table 3.8-32 shows the proportions of low-income, minority, and Tribal populations in selected communities in Duchesne and Uintah counties. Data for the State of Utah are shown for comparison. The table includes the main communities in each county near the GNBPA, including the Fort Duchesne Census Designated Place (CDP), Randlett CDP, and Whiterocks CDP. The three CDPs are boundary-defined places within the Uintah and Ouray Reservation enumerated by the U.S. Census Bureau in 2000. All three are located in western Uintah County and are approximately 18, 10, and 28 linear miles, respectively, from the northwest corner of the GNBPA. Fort Duchesne is the headquarters location of the Ute Tribe.

Table 3.8-32 Poverty and Minority Population Characteristics of Selected Communities, 2000

Population	Percent of Total Population in Poverty	Minority as Percent of Total Population[1]	Percent American Indian
Duchesne County	16.8	***11.2***	5.4
Duchesne City	12.4	***5.0***	0.7
Roosevelt	22.1	***14.9***	8.1
Uintah County	14.5	***14.1***	***10.3***
Vernal	14.8	***8.2***	***3.1***
Naples	***6.7***	***4.1***	***0.8***
Ballard	***8.5***	***5.7***	***3.9***
Uintah and Ouray Reservation	20.2	***20.0***	***16.4***
Fort Duchesne CDP[2]	54.6	***94.8***	90.2
Randlett CDP	54.5	***96.4***	93.3
Whiterocks CDP	70.9	***94.4***	93.8
State of Utah	9.4	***14.7***	1.3

[1] ***The total minority population comprises all persons of a minority racial identity plus persons of Hispanic-origin identity not already included because of race.***
[2] ***Unincorporated communities with boundaries defined for purposes of enumeration during the decennial census.***
Source: U.S. Census Bureau 2000a,***b***.

The BLM standard for identifying a low-income population is the poverty level used by the U.S. Census Bureau. The standard for identifying minority populations is either: 1) the minority population of the affected area exceeds 50 percent, or 2) the minority population percentage of the affected area is "meaningfully greater" than the minority population percentage in the general population or other appropriate unit of geographic analysis. For environmental justice compliance, the relevant minority population is the total minority population comprising all persons of a minority racial identity plus persons of Hispanic-origin identity (BLM 2002).

Resident populations with a poverty rate over 50 percent exist in ***the*** Fort Duchesne, Randlett, and Whiterocks ***CDPs***. Elsewhere in Duchesne and Uintah counties, the poverty rate varies from ***6.7*** percent to 22.1 percent, compared to 9.4 percent in the state overall. Fort Duchesne, Randlett, and Whiterocks ***also*** are minority communities***, each having populations*** more than 90 percent minority***, principally*** American Indian. ***The***

concentration of the American Indian population in the three CDPs is consistent with a 1994 survey of the Ute Tribe members in which 64 percent of the respondents living on the reservation reported their residence in Whiterocks, 16 percent in Fort Duchesne, and 8 percent in Randlett. The remaining survey respondents cited places of residence not enumerated by the U.S. Census Bureau (Duchesne County 2005). The minority population percentages elsewhere in Duchesne and Uintah counties, including rural areas near the three CDPs, are not meaningfully higher than the state average (Table 3.8-32).

In summary, economic and demographic data from the 2000 Census indicates several concentrations of minority and/or low-income populations residing northwest of the GNBPA meeting the BLM standard for consideration of potential environmental justice issues.

3.9 Soils

This section is included in the Draft EIS and is not being amended in this supplement.

3.10 Transportation and Access

This section is included in the Draft EIS and is not being amended in this supplement.

3.11 Vegetation Resources

This section is included in the Draft EIS and is not being amended in this supplement.

3.12 Visual Resources

This section is included in the Draft EIS and is not being amended in this supplement.

3.13 Water Resources

This section is included in the Draft EIS and is not being amended in this supplement.

3.14 Wilderness Characteristics

This section is included in the Draft EIS and is not being amended in this supplement.

3.15 Wildlife and Fisheries Resources

This section is included in the Draft EIS and is not being amended in this supplement.

4.0 Environmental Impacts

This introductory section is included in the Draft EIS and is not being amended in this supplement.

4.1 Air Quality

The purpose of the air quality analysis was to assess local and regional air quality impacts from current and future reasonably foreseeable development in the Uinta Basin Region, in conjunction with the proposed project. The general approach was to develop an emissions inventory for a “project base year” (defined below) to tabulate emissions and conduct modeling.

The air quality analysis incorporated the planned development and a prepared set of emissions data for project modeling, including project development alternatives and reasonably foreseeable development as discussed below. Those emissions data were incorporated into the modeling system for the project base year, and used to predict potential impacts on visibility, acid deposition, and air quality, including ozone. The analysis identifies potential impacts on resources evaluated, and characterizes the major source or source groups that contribute to those impacts.

The 2006 emissions data was used as the basis for comparing emissions and impacts for the base year. This selection was made to coincide with the 2006 Western Regional Air Partnership (WRAP) Phase III emissions inventory for the Uinta and Piceance basins, which was developed by a collection of government and industry stakeholders for ozone modeling in the same area. As such, these data serve as the best available data for base year emissions and comparisons.

Emissions of criteria pollutants and source characteristics for the proposed project alternatives were based on project data provided by ***Kerr-McGee Oil and Gas Onshore LP (***KMG***)***. To support the modeling effort, emissions scenarios were developed for the base year and 3 forecast years and included reasonably foreseeable development, the proposed project, and maximum production. Emissions inventories were developed for each of the following scenarios:

- 2006 Baseline – 2006 base year actual emissions;
- 2018 Projected Baseline – 2018 projected emissions without the proposed project;
- 2017 Proposed Action Alternative – 2018 Projected Baseline emissions with project emissions from the proposed alternative in 2017; and
- 2026 Optimal Recovery Alternative – 2018 Projected Baseline emissions with project emissions from the maximum recovery development alternative in 2026.

The 2018 Projected Baseline essentially is the No Action Alternative, but also includes non-project emissions. The Resource Protection Alternative focuses on minimizing land disturbance for the installation and operation of wells and other support facilities. From an air emissions perspective, ambient impacts from the Resource Protection Alternative are well-characterized by the impacts from the Proposed Action. For that reason, the Resource Protection Alternative was not modeled as a separate evaluation.

The 2018 Projected Baseline was used as the baseline for the Optimal Recovery Alternative, though peak production under this alternative is anticipated in 2026. This approach provides a consistent basis of comparison between the alternatives and reduces uncertainty in baseline emissions from projecting development beyond the WRAP inventory time horizon.

GHGs are produced and emitted by various sources during phases of oil and gas exploration, well development, and production. The primary sources of GHGs associated with oil and gas exploration and production are CO_2, N_2O, and CH_4. In addition, volatile organic compounds (VOCs) are a typical source of emissions associated with oil and gas exploration and production. Under specific environmental conditions, N_2O and VOCs form ozone, which also is considered a GHG.

Climate change analyses are comprised of several factors including, but not limited to, GHGs, land use management practices, and the albedo effect. While emissions from oil and gas activities may contribute to the

effects of climate change to some extent, it currently is not possible to associate any of these particular actions with the creation of any specific climate-related environmental effects. The tools necessary to quantify climatic impacts presently are unavailable. As a consequence, impact assessment of specific effects of anthropogenic activities cannot be determined. Additionally, specific levels of significance have not yet been established. Therefore, climate change analysis for the purpose of this document ***focuses on*** accounting and disclosing of GHG emissions that may contribute to climate change ***(see Section 3.1.3.7 for text acknowledging related potential impacts)***.

Emissions Data Development

Emissions data for the Proposed Action and the Optimal Recovery Alternative were developed from available emission factors, analytical data, applicable ***applicant-committed environmental protection measures (Appendix A)***, applicant-provided equipment specifications, and anticipated activity levels. Emission rates were developed for the criteria pollutants and for selected HAPs. A summary of criteria pollutant emissions from stationary sources in the Uinta Basin is provided in **Table 4.1-1**, and the project-related increases in the major components of HAPs for the Proposed Action and Optimal Recovery Alternative are provided in **Table 4.1-2**. Emissions for a full list of HAPs were reviewed, but only those with the greatest emissions in relation to health effects were evaluated. A summary of emission calculation methods for each source type and pollutant is shown in **Table 4.1-3**.

Table 4.1-1 Summary of Criteria Pollutant Emissions for Each Scenario

Criteria Pollutant	Emissions (tpy)					
	2006 Baseline	2018 Projected Baseline	2017 Proposed Action		2026 Optimal Recovery Alternative	
			Project	Total	Project	Total
NO_X	10,754	10,138	2,***213***	12,***351***	4,946	15,084
CO	7,800	9,732	1,**300**	**11,032**	2,994	12,726
SO_2	391	30	25	55	78	108
PM_{10}	592	565	***1,011***	1,***576***	2,658	3,223
VOC	70,226	184,262	6,***617***	190,***879***	24,976	209,238

Source: Air Quality Technical Support Document (**Appendix G**).

Table 4.1-2 Summary of Potential Increases in Emissions of HAPs for Project-related Alternatives

Pollutant	Potential HAP Increase (tpy)	
	Proposed Action Alternative	Optimal Recovery Alternative
Benzene	67.***0***	255.2
Toluene	17***2.4***	662.1
Ethyl Benzene	12.7	48.5
Xylenes	18***5.7***	714.1
Formaldehyde	7***1.3***	156.5
n-Hexane	19***4.9***	748.5

Source: Air Quality Technical Support Document (**Appendix G**).

Table 4.1-3 Summary of Emissions Calculation Methods by Source Type and Pollutant

Source Type	Pollutant	Emissions Calculation Methodology
Drill Rig Engines	NO_X	40 CFR 1039.101
	CO	***Tier 2 – Near-field Impact Analysis***
	VOC	***Tier 4 – Near-field Impact Analysis and Regional Emissions***
	$PM/PM_{10}/PM_{2.5}$	
	SO_2	Mass balance of fuel sulfur (15 ppm weight [ppmw] fuel sulfur)
	HAP	National Mobile Inventory Model Database (USEPA 2005)
Drill Rig Boilers	All	USEPA AP-42 Volume I: Stationary Sources *Chapter 1.3* (USEPA 1998***b***)
Drilling and Completion Traffic	NO_X	USEPA AP-42 Volume II: Mobile Sources (USEPA 1995a)
	CO	
	VOC	
	$PM_{10}/PM_{2.5}$	USEPA AP-42 Volume I *Chapter 13.2.2* (USEPA 2006) and USEPA AP-42 Volume II: Mobile Sources (USEPA 1995a)
	SO_2	USEPA AP-42 Volume II: Mobile Sources (USEPA 1995a)
Condensate Flashing	VOC	American Petroleum Institute E&P Tanks v2.0 based on Analysis of Condensate
	HAP	
Separator Heaters	NO_X	USEPA AP-42 Volume I: Stationary Sources *Chapter 1.4* (USEPA 1998***c***)
	CO	
	VOC	
	$PM/PM_{10}/PM_{2.5}$	
	SO_2	Mass balance of fuel sulfur [20 ppmw fuel sulfur]
	HAP	USEPA AP-42 Volume I: Stationary Sources *Chapter 1.4* (USEPA 1998***c***)
Production Well Fugitives	VOC	USEPA Protocol for Equipment Leak Estimates (USEPA 1995b)
	HAP	Mass fraction of VOC based on Analysis of Condensate
Production Traffic	NO_X	USEPA AP-42 Volume II: Mobile Sources (USEPA 1995a)
	CO	
	VOC	
	$PM_{10}/PM_{2.5}$	USEPA AP-42 Volume I *Chapter 13.2.2* (USEPA 2006) and USEPA AP-42 Volume II: Mobile Sources (USEPA 1995a)
	SO_2	USEPA AP-42 Volume II: Mobile Sources (USEPA 1995a)
Produced Water Tank Batteries	VOC	TANKS 4.09 based on Analysis of Condensate
	HAP	Mass Fraction of VOC based on Analysis of Condensate
Gas-fired Compression Engines	NO_X	Engine Manufacturer Specifications
	CO	
	VOC	
	$PM_{10}/PM_{2.5}$	USEPA AP-42 Volume I: Stationary Sources *Chapter 3.2* (USEPA 2000)
	SO_2	Mass balance of fuel sulfur [20 ppmw fuel sulfur]
	HAP	USEPA AP-42 Volume I: Stationary Sources *Chapter 3.2* (USEPA 2000)

Source: Air Quality Technical Support Document (**Appendix G**).

The air quality model AERMOD was used to evaluate impacts on air quality in the near-field. Several scenarios, including various well spacing and drill density plans, were evaluated to determine their projected impacts on the near-field. A square mile area was used to characterize the scenario sources arrangement, and impacts were calculated within that area and at the boundary of the square mile area. For drilling operations, it was assumed that ***up to four*** drill rig***s*** would operate in this area at any one time. ***Annual impacts from drilling operations were based on the assumption that 64 wells could be drilled in a square mile to accommodate the proposed 10-acre downhole spacing.*** For operations, the source arrangement depicted wells located on a 10-, 20-, and 40-acre spacing. For compression, a single compressor station was sited in the area and impacts were calculated in the near-field.

The CALPUFF modeling system was used to estimate impacts on visibility (regional haze), air quality, and acid deposition in areas 50 kilometers (km) or more from the development area. The Models-3 Community Multiscale Air Quality (CMAQ) model was used to evaluate impacts on ambient air ozone in the region.

An inventory of actual emissions developed specifically for this analysis were input to the AERMOD and CALPUFF models to analyze compliance with the NAAQS and evaluate impacts to regional haze, acid deposition, and acid neutralizing capacity at sensitive lakes in Class I areas. Comparison of impacts to PSD increments is provided for informational purposes only; this study does not represent a PSD increment-consumption analysis. The inventory for the CMAQ ozone modeling utilized actual project base year emissions along with emissions from other sources (i.e., electric generation, motor vehicles, and biogenics).

The CAA lists HAPs that could be emitted during project operations: primarily BTEX (benzene, toluene, ethyl benzene, and xylene) from the well dehydrators and formaldehyde from the pipeline compressor engines. Control of these and other HAPs would be achieved through compliance with applicable MACT standards. HAP emissions for each activity were developed on a per unit basis and were based on approved emissions factors, mass balance, or process simulation, where appropriate. Site-specific supporting information such as operation schedules, equipment specification, and physical and chemical properties of fuel and materials were used to develop the emissions inventory for the various alternatives. Where site-specific information was not available, the analysis used published references or assumptions based on professional experience as described in the Technical Support Document (**Appendix G**).

NESHAP and MACT regulations for oil and natural gas production facilities include provisions for ethylene glycol dehydrators and vents, storage vessels with flash emissions, and ancillary equipment. Under these provisions, any source that emits or has the potential to emit 10 tpy or more of any HAP is considered a major source; would require an operating permit under Title V of the CAA; and must install and operate control equipment to control air emissions. Under these same provisions, glycol dehydration units emitting less than 1 tpy benzene are considered “small,” and would not require controls under MACT rules.

Ambient air concentrations of HAPs were determined based on these emissions rates using the same AERMOD model scenarios used for near-field criteria pollutant analysis. These ambient concentrations were compared to the USEPA Toxic Screening Levels (TSLs) to determine if any adverse impact would be predicted from project-related source emissions.

Based on the minimal content of hydrogen sulfide (H_2S) in the natural gas found in the GNBPA, potential H_2S impacts would be negligible. However, should H_2S be encountered, operations on federal or Indian leases would be regulated by Onshore Oil and Gas Order No. 6 (Hydrogen Sulfide Operations). This order requires monitoring of H_2S beginning at levels of 10 ppm at each drilling well (40 CFR part 63, subpart HH §63.760[b][1] through [4]; and 40 CFR part 63, subpart A of the General Provisions, effective June 17, 1999). Should H_2S levels increase, specific drilling and production equipment, along with drilling and public protection plans, would be required ***under Onshore Order No. 6 in zones where H_2S can reasonably be expected to be present at concentrations of 100 ppm or more***.

The analysis was based on several conservative assumptions, including:

- Maximum measured and/or estimated background criteria air pollutant concentrations were assumed to occur at all locations in the region throughout the life of the project.
- All existing emissions sources were assumed to operate at their reasonably foreseeable emission rates simultaneously throughout the life of the project. Given the number of sources included in this analysis, the probability of such a scenario actually occurring over an entire year (or even 24 hours) is small. While this assumption is typically used in modeling analyses, the resulting predicted impacts would be overstated.

- For the near-field modeling, total predicted short-term air pollutant impact concentrations were assumed to be the sum of the first maximum background concentration, plus the maximum modeled concentrations, which actually would occur under very different meteorological conditions and would not be likely to coincide.
- The HAP analyses assumed all existing equipment would continue to operate simultaneously at the assumed emission levels continuously throughout the life of the project. ***Since no data are available to characterize HAP concentrations in the vicinity of the GNBPA, no background HAP concentrations were assumed for near-field modeling.***

4.1.1 No Action Alternative

On BLM-administered lands, current management plans would continue to guide oil and natural gas exploration and development activity. Air quality effects for the No Action Alternative would include an increase in air pollutant emissions resulting from drill and development projects previously approved.

Emissions for the No Action Alternative are represented by the 2018 Projected Baseline, specifically including the WRAP III data for the Uinta and Piceance basins, and the WRAP II data for other basins.

4.1.1.1 Impacts on Air Quality

The USEPA dispersion model AERMOD was used to predict maximum potential near-field air quality impacts from existing emission sources, which would continue to operate under the No Action Alternative. As of October 2007, there were 1,102 undrilled wells within the GNBPA that have been described in approved NEPA decision documents or identified in the ***Utah Division of Oil, Gas, and Mining*** database. The analysis results identify predicted air pollutant concentrations in the vicinity of ***producing*** wells ***(drill rigs),*** compressor engines***, and related oil and gas facilities***. ***Specific modeling scenarios for the near-field impact analysis are discussed in more detail in Appendix G.***

CALPUFF modeling was used to predict impacts at distant ***receptors*** (greater than 50 km from the GNBPA), mandatory federal PSD Class I areas for comparison with applicable air quality standards, PSD increments, HAP exposures, visibility standards, and atmospheric deposition (**Appendix G**).

Because this alternative includes wells that have not yet been drilled, there would be construction-related air quality impacts. Construction emissions would occur during road and well pad construction, well drilling, and well completion testing. In addition, particulate matter ($PM_{2.5}$ and PM_{10}) concentrations likely would increase during construction. Potential SO_2 emissions would be generated by drilling rigs and other diesel engines used during rig-up, drilling, and completion operations (sulfur being a trace element in diesel fuel). Maximum air pollutant emissions from each well would be temporary (i.e., occurring only during the construction period), would occur in isolation, and would not significantly interact with adjacent well locations. Since construction emissions would be temporary, PSD increments are not applicable.

The maximum impacts of criteria pollutants in the near-field for this alternative are presented in Table 4.1-4.

Table 4.1-4 Air Quality Impacts for Criteria Air Pollutants in the Near-field, No Action Alternative

Pollutant	Standard	Modeled Impact (µg/m^3)	Background Concentration (µg/m^3)	Total Impact (µg/m^3)	NAAQS / SAAQS (µg/m^3)
NO_2	***1-hour[1]***	***217.7***	***69.6***	***287.3***	***188***
	Annual[1]	***7.7***	***8.0***	***15.7***	100
CO	1-hour[1]	***399***	6,325	6,***724***	40,000
	8-hour[1]	***251***	3,910	4,***161***	10,000

Table 4.1-4 Air Quality Impacts for Criteria Air Pollutants in the Near-field, No Action Alternative

Pollutant	Standard	Modeled Impact ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	NAAQS / SAAQS ($\mu g/m^3$)
SO_2	***1-hour[2]***	***2.6***	***21.7***	***24.3***	***196***
	3-hour[2]	***1.9***	***16.7***	***18.6***	1,300
	24-hour[2]	***0.9***	***5.9***	***6.8***	365
	Annual[2]	***0.1***	***1.5***	***1.6***	80
PM_{10}	24-hour[3]	***4.5***	18.***0***	**22.5**	150
$PM_{2.5}$	24-hour[1]	***4.5***	***16.0***	***20.5***	35
	Annual[1]	***0.8***	***6.0***	***6.8***	15

Source: Air Quality Technical Support Document (**Appendix G**).

Near-field modeling was conducted to determine the impacts from simultaneous operation of drill rigs on adjacent pads spaced at intervals from 400 meters to 800 meters. This modeling showed that such simultaneous operation of drill rigs on adjacent pads could cause an exceedance of the NAAQS for 1-hour NO_2 regardless of the space between rigs. However, compliance with the NAAQS for 1-hour NO_2 is based on the 98th percentile of the daily 1-hour maxima for each of 3 consecutive years. Because the duration of this drilling scenario is limited, the drilling activity likely would not coincide with the 8 highest impact days in 1 year. Also, because drill rigs move to different locations during the course of development, it is not possible that the same level of drilling would occur for 3 consecutive years at the same location. Therefore, although the project has been modeled to exceed the 1-hour NO_2 standard, the project may not result in a violation of the standard under this method of operation. Compliance with the NAAQS was obtained for all other scenarios and pollutant/averaging periods.

As shown in Figure 4.1-1, the extent of these impacts is limited, with peak impacts occurring immediately adjacent to the drill rig and rapidly decreasing to approach background levels.

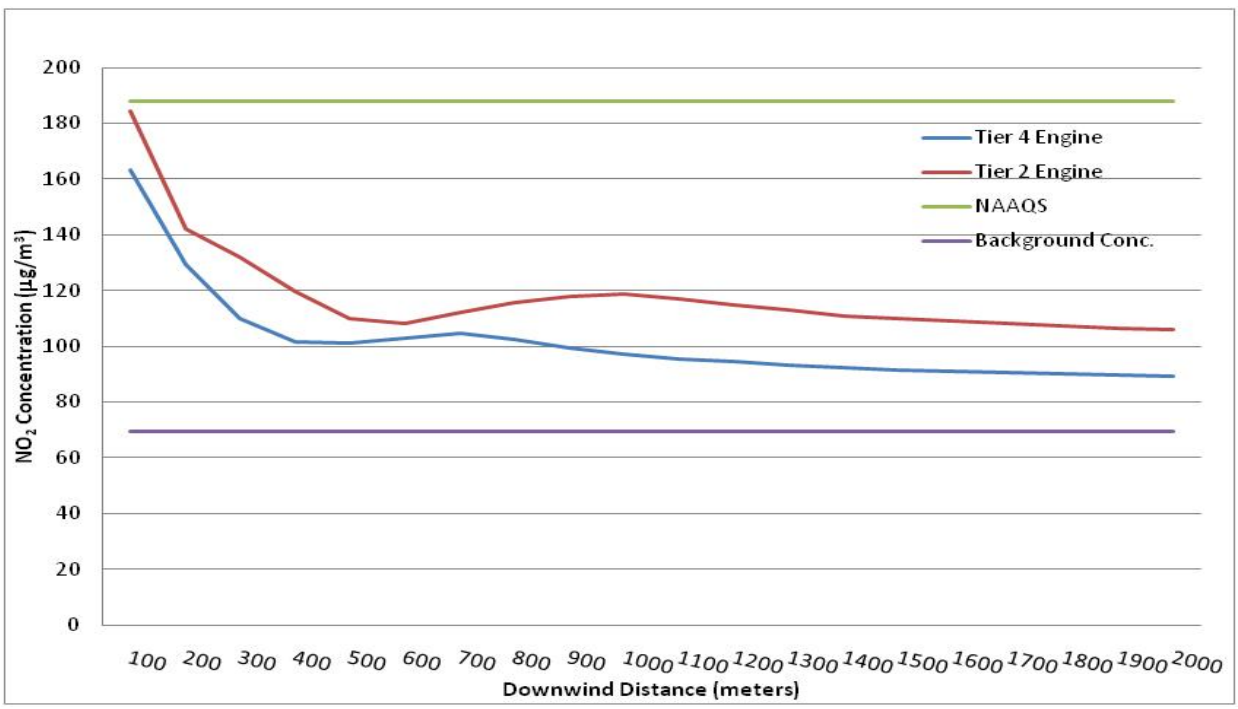


Figure 4.1-1 Modeled 1-hour NO_2 Impact for Well Drilling as a Function of Downwind Distance for Tier 2 and Tier 4 Engines at a Single Drill Rig

Comparison of modeled HAP concentrations against USEPA TSLs and Reference Concentrations (RfC) indicates no adverse impacts from emissions of HAPs from project sources. The maximum concentrations are predicted from the 10-acre production scenario (64 operating wells per section) for all pollutants. These results are shown in Table 4.1-5.

Table 4.1-5 Air Quality Impacts for HAPs in the Near-field, No Action Alternative

Pollutant/Averaging Period	Concentration per Production Well Density ($\mu g/m^3$)			Non-Carcinogenic RfC[1] ($\mu g/m^3$)	TSL[2] ($\mu g/m^3$)
	10-Acre Spacing	20-Acre Spacing	40-Acre Spacing		
Benzene					
24-hour	5.25	4.14	2.99	-	53.3
Annual	1.55	1.22	0.71	30	-
Ethylbenzene					
24-hour	0.32	0.26	0.18	-	14,473
Annual	0.17	0.13	0.08	1,000	-
Formaldehyde					
24-hour	3.89	3.76	3.76	-	37
Annual	0.85	0.64	0.50	9.8	-
n-Hexane					
24-hour	14.85	11.70	8.45	-	5,875
Annual	4.47	3.52	2.05	700	-
Toluene					
24-hour	12.17	9.59	6.93	-	2,512
Annual	3.63	2.86	1.67	5,000	-
Xylene					
24-hour	9.08	7.15	5.16	-	14,473
Annual	2.68	2.11	1.23	100	-

[1] USEPA Air Toxics Database, Table 1 (USEPA 2010b).

[2] Utah Division of Air Quality (UDAQ) Air Toxic Modeling Guidance for TSLs (UDAQ 2007).

Source: Air Quality Technical Support Document (Appendix G).

4.1.1.2 Impacts at Class I and II Areas – Acid Deposition

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.1.3 Impacts at Class I and II Areas – Visibility

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.1.4 Impacts on Ambient Ozone Levels

The CMAQ modeling system was used to estimate impacts on ambient air ozone levels from the emissions for 2006, representative of the base year operations. Results from that modeling effort were compared to actual monitored levels in the region (though not directly in the GNBPA). A formal Model Performance Evaluation

(MPE) was conducted for 2006, which was used to evaluate the performance of the model with actual conditions, and to provide an adjustment of modeled impacts for future development scenarios. The MPE showed that the modeling system meets the USEPA-established criteria for acceptable model accuracy and error statistics at the existing monitoring stations within the modeling domain. The lack of concurrent ***monitored ozone*** data ***for 2006*** prevents validation and calibration of the model results; however, the model does provide a means to compare the relative change in ambient ozone concentration between the project alternatives and baseline air quality.

The CMAQ modeling system was used to model impacts for 2018 for the projected No Action Alternative, the Proposed Action, and the Optimal Recovery Alternative. The results were used to show the expected change in ozone levels at receptors in the region resulting from each of the alternatives as well as the cumulative impact from expected development. The model results showed no impacts above the current ozone standard of 75 ppb for the fourth highest annual level in the Uinta Basin for the No Action Alternative.

As shown in Section 3.1.2 and Figure 3.1-2, ozone levels monitored at the Ouray and Redwash monitoring stations in the Uinta Basin, showed numerous days during the winter of 2010 with 8-hour concentrations above 75 ppb, the current ozone level that forms the basis for the standard. However, the 8-hour average ozone levels monitored during the summer were below the 75 ppb level, which is consistent with the modeling results. The ability of current photochemical models to replicate winter ozone formation has not been established. Therefore, the comparison of modeled values to isolated winter values is not appropriate.

The No Action Alternative would involve continued development in the GNBPA as disclosed in approved NEPA decision documents. Given a continued level of NO_X and VOC emissions, and the current levels of ozone observed in the winter, there likely would be continued observations of winter ozone concentrations above the NAAQS resulting from this alternative.

4.1.1.5 Summary of GHG Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.2 Proposed Action Alternative

4.1.2.1 Impacts on Air Quality

Construction emissions would occur during road and well pad construction, well drilling, and well completion testing. Potential SO_2 emissions would be generated by drilling rigs and other diesel engines used during rig-up, drilling, and completion operations (sulfur being a trace element in diesel fuel). Maximum air pollutant emissions from each well would be temporary (i.e., occurring only during the construction period), would occur in isolation, and would not significantly interact with adjacent well locations. Since construction emissions would be temporary, PSD increments are not applicable.

The highest near-field impacts for the Proposed Action would occur during drilling and completion activities ***and the maximum production scenario. These impacts*** would be the same as the near-field impacts for the No Action Alternative (**Table 4.1-4**). The AERMOD modeling to assess near-field impacts used the same hypothetical drilling and production arrangement for all ***project alternatives***. Therefore, near-field impacts ***for the Proposed Action would be*** the same ***as the No Action Alternative, provided that drill rigs are not simultaneously operated at closer than 40-acre surface spacing***.

The regulated HAPs listed in Section 112 of the CAA that contribute the highest levels of emissions for the proposed project are benzene, toluene, ethylbenzene, xylenes, formaldehyde, and n-hexane. Emissions of the remaining HAPs are orders of magnitude smaller. Increases in HAPs due to the Proposed Action Alternative are shown in **Table 4.1-2**. ***The AERMOD modeling used to assess ambient air concentrations for the Proposed Action Alternative was the same as used to assess the No Action. As shown in Table 4.1-5,***

the ambient air concentrations of HAPs would not exceed the USEPA RfCs or TSLs, so no adverse impacts from HAPs are predicted.

4.1.2.2 Impacts at Class I and II Areas – Acid Deposition

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.2.3 Impacts at Class I and II Areas – Visibility

The CALPUFF model system was used to evaluate impacts on visibility at the Class I areas and at the listed sensitive Class II areas. **Table 4.1-7** provides results of the CALPUFF visibility analysis for the Proposed Action for both Class I and Class II areas. Only the areas with the highest impacts in each group are presented on this table; impacts for all areas analyzed are provided in **Appendix G**. These data were developed from the Method 6 approach using annual average background visibility conditions. The results showed that there are no days with a contribution to visibility impacts greater than 10 percent in extinction at listed Class I areas, indicating that the Proposed Action would not contribute to an impact on visibility at these sites.

The modeling results at the listed sensitive Class II areas showed project-related impacts above 1.0 dv (eighth highest, Method 6) at Dinosaur National Monument and Flaming Gorge National Recreation Area. The results predicted 102 days greater than 1.0 dv at Flaming Gorge and 32 days greater than 1.0 dv at Dinosaur National Monument. Modeled results for all other Class II areas showed that impacts would be less than 1.0 dv using Method 6.

The Utah BLM has proposed an Air Resource Management Strategy (ARMS), which includes a goal of providing greater certainty and transparency for agencies, project proponents, and the public regarding the conduct and review of air quality and AQRV impact analyses in the NEPA process, and the application of mitigation. Regional visibility impacts will be evaluated by a photochemical grid model through the ARMS, and the BLM will identify reasonable mitigation, control measures, and design features to address adverse air quality or AQRV impacts.

Given the level of emissions from the Proposed Action that would act as precursors to visibility impairment (primarily NO_X and SO_2 emissions, with less effect from PM emissions), it is likely that any mitigation that would reduce ozone levels, if it incorporates NO_X emissions reductions, also would reduce impacts on visibility levels at nearby sensitive areas. Furthermore, mitigation activities that would control particulate emissions from construction (e.g., fugitive emissions from traffic on roadways) also would lead to improvements in visibility at these same areas.

The primary contributors to cumulative impacts on visibility from the regional sources vary with the location of each area evaluated and the nature of the sources that affect receptors in that area. For areas that are already modeled as being impacted for the No Action Alternative, the cumulative effects of the Proposed Action would be greater in some areas and negligible in others.

4.1.2.4 Impacts on Ambient Ozone Levels

Impacts on ambient air ozone were evaluated using the CMAQ model system. As noted above, the modeling system meets the USEPA-established criteria for acceptable model accuracy and error statistics at the existing monitoring stations in the region. Increases in the fourth-highest ozone levels above baseline were modeled at 2.4 ppb for the Proposed Action Alternative ***for the summer months***. No ozone concentrations in excess of the 75 ppb standard were modeled in the GNBPA ***for that period***.

As noted in Section 4.1.1.4, there have been several occurrences of 8-hour ozone levels above 75 ppb during the winter months. Due to limitations of the model, this analysis does not address winter ozone levels. It is anticipated that the Proposed Action would add approximately 2,213 tpy of NO_X and

Table 4.1-7 CALPUFF Modeled Results for Regional Haze, Proposed Action

Area	All Sources (Project + Non-Project)				Project Sources				Non-Project Sources			
	Days > than		MAX% Δ B_{ext}	8th Highest % Δ B_{ext}	Days > than		MAX% Δ B_{ext}	8th Highest % Δ B_{ext}	Days > than		MAX% Δ B_{ext}	8th Highest % Δ B_{ext}
	5% Δ B_{ext}	10% Δ B_{ext}			5% Δ B_{ext}	10% Δ B_{ext}			5% Δ B_{ext}	10% Δ B_{ext}		
Class I Areas												
Arches National Park	359	311	118.47	82.29	0	0	2.56	1.30	359	311	118.47	81.84
Canyonlands National Park	328	236	106.52	68.85	0	0	1.98	1.12	328	236	106.50	68.85
Flat Tops Wilderness Area	365	348	55.02	45.70	0	0	1.86	1.01	365	348	54.72	45.58
Class II Areas												
Dinosaur National Monument	365	364	166.24	131.74	73	32	30.54	16.60	365	363	147.81	123.53
Flaming Gorge National Recreation Area	365	365	280.99	240.99	150	102	41.89	32.57	365	365	256.70	221.14

Source: Air Quality Technical Support Document (**Appendix G**).

6,617 tpy of VOC emissions (representing increases of 22 and 4 percent, respectively) to the regional air quality emission levels. Given this level of emissions and the current levels of ozone in the winter, there likely would be an incremental increase in regional ozone levels resulting from the Proposed Action.

4.1.2.5 Summary of GHG Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.2.6 Mitigation and Mitigation Effectiveness

The short-term near-field analysis was conducted to determine how various rig spacing scenarios affect predicted exceedances of the 1-hour NO_2 NAAQS in the near-field during drilling and completion operations. This modeling exercise assumed four drill rigs at various spacing intervals between 400 meters and 800 meters between rigs. This modeling predicted a near-field 1-hour NO_2 standard exceedance at distances less than 200 meters from the drill rig location for all spacing scenarios modeled. Based on this predicted 1-hour NO_2 exceedance and in view of the fact that these emission sources would be mobile, temporary, and operated at least 1 mile from any populated area, the BLM proposes two mitigation options:

AIR-1: ***The proponent would employ measures to mitigate the modeled exceedance of the 1-hour NO_2 standard during drilling operations by employing effective public health buffer zones out to 200 meters from the nearest emission source. Examples of an effective public health protection buffer zone include demarcation of a public access exclusion zone by signage at intervals of every 250 feet that is visible from a distance of 125 feet during daylight hours and a physical buffer such as active surveillance to ensure the property is not accessible by the public during drilling operations.***

AIR-2: ***The proponent may demonstrate compliance with the 1-hour NO_2 NAAQS with appropriate and accepted near-field modeling. As part of this demonstration, the proponent may propose alternative mitigation that could include but is not limited to natural-gas fired drill rigs, installation of NO_X controls, time/use restrictions, and/or drill rig spacing.***

Details of the mitigation measure and, if necessary, compliance demonstration modeling would be submitted by the applicant and enforced as a condition of the BLM-issued Application for Permit to Drill.

Monitored ozone exceedances in the Uinta Basin are cause for concern and potentially could result in a nonattainment designation for the region. In view of this, and unless otherwise specified, the applicant has committed to employ the following measures at the outset of the proposed project as part of an "Ozone Action Plan" to mitigate additional adverse ozone impacts:

- ***Low emission glycol dehydrators at all existing and new compressor stations and production wells.***
- ***Electric compression, where feasible (approximately 50 percent of the compression hp to be electrically driven).***
- ***Emission controls having a control efficiency of 95 percent on existing condensate tanks with a potential to emit of greater 20 tpy, and on new condensate tanks with a potential to emit of 5 tpy VOCs.***
- ***Low-bleed pneumatic devices would be installed at all new compressor stations and production facilities. Within 6 months after of the Record of Decision (ROD), all existing high-***

bleed pneumatic devices would be replaced with low bleed pneumatic devices. High-bleed devices may be allowed to remain in service for critical safety and/or process reasons.

- ***Green completions for all well completion activities.***
- ***Tier II drill rig engines by 2012, with phase-in of Tier IV engines or equivalent emission reduction technology as soon as possible thereafter, but no later than 2018***
- ***A natural gas or liquid natural gas drilling rig engine pilot project would be implemented as soon as operationally feasible, but no later than 1 year after the ROD. This pilot project would ascertain emission reduction benefits, operating experience and, if successful, may result in more natural gas or liquid natural gas engine use in the Uinta Basin.***
- ***Lean burn natural gas-fired stationary compressor engines or equipment with equivalent emission rates.***
- ***Catalyst on all natural gas-fired compressor engines to reduce the emissions of CO and VOCs.***
- ***Dry seals on new centrifugal compressors.***
- ***An annual inspection and maintenance program to reduce VOC emissions, including:***
  - ***Performing inspections of thief hatch seals and Enardo pressure relief valves to ensure proper operations.***
  - ***Reviewing gathering system pressures to evaluate any areas where gathering pressure may be reduced, resulting in lower flash losses from the condensate storage tanks.***

Additionally, the applicant commits to developing a project-specific adaptive management strategy, to be informed by periodic emission inventory updates. Implementation of this strategy and associated application of "enhanced" ozone mitigation measures would be required once the proposed project is initiated if: 1) USEPA designates the area "nonattainment" for ozone; 2) there is a monitored ozone standard exceedance; 3) the ARMS modeling shows that additional mitigation is needed to prevent future ozone exceedances; or 4) the ARMS group establishes industry-wide mitigation requirements through ongoing modeling. If implementation of this adaptive management strategy is triggered, the applicant commits to working with the BLM to analyze project-specific "enhanced" mitigation measures and employ them within 1 year. The measures to be considered could include, but would not be limited to, the following:

- ***Reducing the total number of drill rigs.***
- ***Installing Tier IV or better drill rig engines.***
- ***Seasonally reducing or ceasing drilling during specified periods.***
- ***Using only lower-emitting drill and completion rig engines during specified time periods.***
- ***Using natural gas-fired drill and completion rig engines.***
- ***Replacing internal combustion engines with gas turbines for natural gas compression.***
- ***Using electric drill rig or compression engines.***
- ***Centralizing gathering facilities.***
- ***Limiting blowdowns or restricting them during specified periods.***
- ***Installing plunger lift systems with smart automation.***
- ***Employing a monthly Forward Looking Infrared, or FLIR, program to reduce VOCs.***
- ***Enhancing a direct inspection and maintenance program.***

- ***Employing tank load out vapor recovery.***
- ***Employing enhanced VOC emission controls with 95 percent control efficiency on additional production equipment having a potential to emit of greater than 5 tpy.***

In addition to the commitments discussed above, the applicant commits to complying with applicable air pollution control rules and regulations.

The high ozone levels reported in the Uinta Basin in the winter of 2010 prompted the BLM to begin developing an adaptive management strategy for Uinta Basin operations to address ozone levels in excess of the NAAQS with the goal that this and other oil and gas development projects in the basin under BLM jurisdiction would not contribute to ozone exceedances.

Air quality issues are being addressed on a Utah-wide basis through the Utah Air Resource Technical Advisory Group (UTAG) and the BLM's ARMS. The adaptive management strategy outlined below has been designed to develop an ozone action plan to address ozone levels in the Uinta Basin associated with oil and gas operations. The adaptive management strategy would consist of the following elements:

- ***Refine air quality modeling predictions;***
- ***Develop a Uinta Basin ozone action plan; and***
- ***Implement a regional ozone action plan.***

The first two elements of this strategy are being implemented by the BLM and other agency stakeholders, independent of the decision to be made regarding further development in the GNBPA. Regional operators may participate in these initial planning steps, thereby having the opportunity to contribute to the outcome of the process. The third element would require specific action by KMG and other oil and gas operators in the GNBPA following the approval of the ROD. All three elements are described in more detail in the following paragraphs.

<u>Refine Air Quality Modeling Predictions</u>. The ARMS adaptive management strategy involves conducting a regional photochemical modeling analysis to compare and evaluate the effect of different mitigation activities on the ozone levels in the Uinta Basin. This modeling would be conducted in consultation with appropriate federal, Tribal, and state stakeholders as well as with regional oil and gas operators. The aim of the modeling effort would be to compare the effect of changes in VOC and NO_X emissions, under various control strategies, to model-predicted change in ozone levels. Separate comparisons may be made for winter and summer periods. An updated emissions inventory, observed ozone levels within the basin, and corresponding meteorological data would be used. Modeling results would provide an estimate of ozone region-wide and depict spatially the effectiveness of different emission controls on ozone formation in the Uinta Basin. The BLM would isolate the project-specific incremental ozone increases from the ARMS modeling immediately following completion of the region-wide modeling effort.

The updated air quality modeling analysis utilizing the new inventory and monitored data would be performed within 2 years of signing the ROD. This would be accomplished by isolating project-specific impacts from the ARMS regional scale air quality modeling study, if available. The modeling would consider the current emission inventory data, to be updated periodically, current operating practices, applicant committed mitigation, and any applicable Best Available Control Technology requirements in place at the time the modeling is conducted. The BLM, in consultation with appropriate federal, state, and Tribal stakeholders, would evaluate the modeling results and identify any needed additional reductions in ozone precursor emissions.

As soon as possible following evaluation of the modeling results, the BLM and appropriate stakeholders would use their respective authorities to implement any needed emission control mitigation measures and/or operating limitations necessary to ensure continued compliance with applicable ambient air quality standards for ozone. Absent an effective technology to implement, reductions in the pace of development may be utilized to ensure ambient air quality standards are met.

Develop an Ozone Action Plan. Based on the results of the photochemical modeling study, the BLM would develop an ozone action plan that would describe mitigation to be enacted to address observed ozone levels above the NAAQS. The plan would be developed in consultation with appropriate federal, Tribal, and state stakeholders. Regional oil and gas operators also may participate in the development of the plan. Specific criteria would be identified within the plan for determining when additional mitigation would be initiated and which measures would be recommended. Criteria also would be specified for when the use of additional mitigation could be suspended based on observed ozone concentrations. Potential mitigation strategies are included in the list of "enhanced mitigation measures" presented above.

Implement an Ozone Action Plan. The BLM would evaluate monitored ozone ambient air quality data at sites in the Uinta Basin to determine when to implement the ozone action plan. Monitoring data would be obtained, summarized, and reviewed on an ongoing basis following quality assurance review of each data set. Based on the data review and the criteria set forth in the ozone action plan, the BLM, in consultation with the appropriate federal, Tribal, and state stakeholders, would determine when to trigger implementation of the plan. Following issuance of the ROD for this project, KMG and other operators in the GNBPA would be required to participate in the implementation of the BLM-approved ozone action plan within the GNBPA.

The applicant, in consultation with the BLM and appropriate federal, Tribal, and state stakeholders would employ "enhanced mitigation measures" as warranted through the Ozone Action Plan within 1 year of a nonattainment designation or monitored ozone standard exceedance.

The BLM would ensure that appropriate ambient air monitoring is occurring in the Uinta Basin. The BLM and/or the operator, in consultation with the UTAG, would establish monitoring sites in the event that additional monitored data is necessary. These monitors would conform to USEPA monitoring protocols (40 CFR Parts 50 and 58), with emphasis on obtaining measurements that contribute to the formation of secondarily formed pollutants such as $PM_{2.5}$ and ozone, to ensure that monitoring data are valid and useful in calibrating the model and determining control strategies.

4.1.2.7 Residual Impacts

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.3 Resource Protection Alternative

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.4 Optimal Recovery Alternative

4.1.4.1 Impacts on Air Quality

Maximum potential air quality impacts from emission sources under the Optimal Recovery Alternative include impacts from sources that would continue to operate under the No Action Alternative. There would be more emissions sources under the Optimal Recovery Alternative than the Proposed Action (**Table 4.1-1**).

The highest near-field impacts for the Optimal Recovery Alternative would occur during drilling and completion activities and maximum production alternatives and would be the same as the near-field impacts for the No Action Alternative (Table 4.1-4). The same maximum hypothetical drilling and

production arrangement for an individual square mile was used for the AERMOD modeling to assess near-field impacts for all project alternatives. Therefore, near-field impacts for this alternative would be the same as the other alternatives provided that drill rigs are not simultaneously operated at closer than 40-acre surface spacing.

Increases in HAPs due to the Optimal Recovery Alternative are shown in Table 4.1-2. As shown in Table 4.1-5, the ambient air concentrations of HAPs would not exceed the USEPA RfCs or TSLs, so no adverse impacts from HAPs are predicted.

In the far-field analysis, the maximum 24-hour PM_{10} impact at Class I areas would be 0.24 µg/m^3 at Arches National Park, and the annual average PM_{10} impact would be 0.02 µg/m^3. Impacts from SO_2 and NO_X emissions would be below 0.013 µg/m^3. At sensitive Class II areas, the maximum impacts would be at Flaming Gorge National Recreation Area for all criteria air pollutants. The maximum particulate impact on a 24-hour average would be 7.36 µg/m^3 and the annual PM_{10} impact would be 1.38 µg/m^3. The maximum annual average NO_X impact would be 0.94 µg/m^3. Impacts from all other criteria pollutants would be less than 1.0 µg/m^3. When added to the background concentrations, all impacts from all sources would be below the established NAAQS for criteria pollutants.

4.1.4.2 Impacts at Class I and II areas – Acid Deposition

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.4.3 Impacts on Visibility

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.4.4 Impacts on Ambient Ozone Levels

Impacts on ambient air ozone were evaluated using the CMAQ model system. Increases in the fourth-highest ozone levels were modeled at 4.9 ppb for the Optimal Recovery Alternative. Ozone concentrations were simulated to remain below the 75 ppb ozone standard based on the 2005 meteorological data set. The model results showed ozone concentration up to 79 ppb for limited areas adjacent to the GNBPA ***during summer months*** based on the 2006 meteorological data set. The result indicates that there would be a potential to exceed the NAAQS for ozone in areas adjacent to the GNBPA.

As noted in Section 4.1.1.4, there have been several occurrences of 8-hour ozone levels above 75 ppb during the winter months. Due to limitations of the model, this analysis does not address winter ozone levels. It is anticipated that the Optimal Recovery Alternative would add approximately 4,946 tpy of NO_X and 24,976 tpy of VOC emissions (representing increases of 49 and 14 percent, respectively) to the regional air quality emission levels. Given this level of emissions and the current levels of ozone in the winter, there likely would be an increase in regional ozone levels resulting from this alternative.

4.1.4.5 Summary of GHG Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.4.6 Mitigation and Mitigation Effectiveness

Modeling results for the Optimal Recovery Alternative showed compliance with all ambient air quality standards except potential exceedances of the ozone standard at scattered locations. The projected impacts are up to 79 ppb, but the limitations on the model must be considered before imposing mitigation measures. Given the level of the predicted ozone impacts, and the fact that all other ambient air quality standards would be attained, specification of monitoring or mitigation measures is not proposed at this time. However, the BLM would implement an adaptive management strategy to ensure that the proposed project remains in compliance with the NAAQS and would not contribute to ozone exceedances. This strategy***, as well as specific***

measures for mitigation of air quality impacts, is described in more detail in Section 4.1.2.6 under the Proposed Action.

4.1.4.7 Residual Impacts

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.5 Relationship Between Local Short-term Uses of the Human Environment and Maintenance and Enhancement of Long-term Productivity

This section is included in the Draft EIS and is not being amended in this supplement.

4.1.6 Irreversible/Irretrievable Commitment of Resources

This section is included in the Draft EIS and is not being amended in this supplement.

4.2 Cultural Resources and Native American Traditional Values

This section is included in the Draft EIS and is not being amended in this supplement.

4.3 Geology

This section is included in the Draft EIS and is not being amended in this supplement.

4.4 Land Use

This section is included in the Draft EIS and is not being amended in this supplement.

4.5 Paleontology

This section is included in the Draft EIS and is not being amended in this supplement.

4.6 Range Resources

This section is included in the Draft EIS and is not being amended in this supplement.

4.7 Recreation

This section is included in the Draft EIS and is not being amended in this supplement.

4.8 Socioeconomics and Environmental Justice

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.1 No Action Alternative

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.1.1 Impacts on Socioeconomics and Environmental Justice

This section is included in the Draft EIS and is not being amended in this supplement.

Employment, Income, and Population

This section is included in the Draft EIS and is not being amended in this supplement.

Grazing

This section is included in the Draft EIS and is not being amended in this supplement.

Recreational Use and Tourism

This section is included in the Draft EIS and is not being amended in this supplement.

Community Facilities and Services

This section is included in the Draft EIS and is not being amended in this supplement.

Public Expenditures and Revenues

This section is included in the Draft EIS and is not being amended in this supplement.

Community Social Conditions

This section is included in the Draft EIS and is not being amended in this supplement.

Environmental Justice

Continuing production and some additional development activity is foreseen within the GNBPA under the No Action Alternative. The GNBPA encompasses a vast, largely unpopulated and undeveloped area in south-central Uintah County, characterized by substantial existing oil and gas development. The latter includes many producing wells, gathering lines, resource roads, and field compression and water disposal facilities. A few residents live on scattered farms and ranches in the general vicinity of the GNBPA, on the Ouray National Wildlife Refuge, and a small cluster of residences are located in Ouray, site of the former Reservation agency. Randlett CDP, with a population of 224 in 2000, is the nearest community of any substantial size to the GNBPA, located approximately 10 linear miles to the northwest. The Fort Duchesne and Whiterocks CDPs, the two other identified communities warranting consideration under the environmental justice criteria, are even more distant from the GNBPA.

The spatial separation between these communities and the GNBPA, combined with other factors, supports a determination of no environmental justice effects under the No Action Alternative. The other factors include no adverse environmental impacts of concern extending outside the GNBPA and avoidance of these communities by the primary highway access routes from the oil and gas industry's major service centers and staging areas in Vernal and Naples.

Results of near-field air quality modeling indicate temporary, short-term exceedances of the 1-hour NO_2 standard could occur under a scenario of multiple drilling rigs operating within a single section in

the extreme northwest corner of the GNBPA. However, the concentrations of pollutants would dissipate within 200 meters of the source to below the NAAQS within the GNBPA boundary. These near-field effects are described in Section 3.1.2. Therefore, the likelihood of adverse environmental effects of concern for environmental justice extending beyond the GNBPA is not anticipated. The BLM notes that ozone exceedances have been observed at monitoring stations in the Uinta Basin near Ouray and Redwash. These impacts are regional in scale and would not disproportionately impact communities with low-income or minority populations.

Finally, the Ute Tribe would receive royalty revenues on current and future oil and gas production from Tribal minerals under the No Action Alternative that may be used to further the Tribe's economic development and diversification goals.

4.8.2 Proposed Action Alternative

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.2.1 Impacts on Socioeconomics and Environmental Justice

This section is included in the Draft EIS and is not being amended in this supplement.

Employment, Income, and Population

This section is included in the Draft EIS and is not being amended in this supplement.

Grazing

This section is included in the Draft EIS and is not being amended in this supplement.

Recreational Use and Tourism

This section is included in the Draft EIS and is not being amended in this supplement.

Community Facilities and Services

This section is included in the Draft EIS and is not being amended in this supplement.

Public Expenditures and Revenues

This section is included in the Draft EIS and is not being amended in this supplement.

Community Social Conditions

This section is included in the Draft EIS and is not being amended in this supplement.

Environmental Justice

Although the Proposed Action would increase levels of future natural gas development and production activities within the GNBPA, the fact that it is an infill development would not alter the fundamental spatial, economic, and demographic relationships used to assess potential economic justice effects with respect to the three minority and low-income communities; the Whiterocks, Fort Duchesne, and Randlett CDPs. Although additional well pads would be developed in the GNBPA, the Proposed Action would not reduce the distances or alter the intervening land uses that effectively buffer those three communities from existing and future gas development. The volume of truck traffic accessing the GNBPA would increase under the Proposed Action and residents living along the travel corridors would experience increases in traffic and traffic-related effects. However, the bulk of the truck traffic would occur on existing public highway access routes that avoid the three identified communities. Similar to that discussed under the No Action Alternative, near-field modeling does not

predict air quality impacts from the Proposed Action beyond the GNBPA boundary; therefore, adverse impacts for environmental justice are not anticipated.

Potential growth-related social and economic impacts associated with the Proposed Action would be higher and continue over a longer duration than under the No Action Alternative. Such impacts would have both beneficial and adverse dimensions, most of which would be focused in the Vernal and Naples area. Disproportionately high and adverse effects would not be anticipated in the three potentially affected minority and low-income communities.

The Ute Tribe would realize higher royalties on oil and gas production from Tribal mineral interests under the Proposed Action Alternative than under the No Action Alternative.

The spatial separation between these minority and low-income communities and the GNBPA, and the absence of adverse environmental effects, supports a determination of no environmental justice effects for the Proposed Action. Even were such environmental effects identified, prevailing wind patterns, the reliance on existing highway routes, and distribution of the population along the routes would preclude a determination of disproportionately high effects to potentially affected minority and low-income populations.

4.8.2.2 Mitigation and Mitigation Effectiveness

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.2.3 Residual Effects

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.3 Resource Protection Alternative

4.8.3.1 Impacts on Socioeconomics and Environmental Justice

This section is included in the Draft EIS and is not being amended in this supplement.

Environmental Justice

Under the Resource Protection Alternative, the same total number of wells would be drilled as under the Proposed Action, but on fewer new well pads. The lower number of well pads would leave unaffected the fundamental spatial, economic, and demographic relationships used to assess potential economic justice effects with respect to the three minority and low-income communities (i.e., the Whiterocks, Fort Duchesne, and Randlett CDPs).

Potential growth-related social and economic impacts associated with the Resource Protection Alternative would be higher and continue over a longer duration than under the No Action Alternative. Such impacts would have both beneficial and adverse dimensions, most of which would be focused in the Vernal and Naples area. Disproportionately high and adverse effects would not be anticipated in the three potentially affected minority and low-income communities.

The Ute Tribe would realize higher royalties on oil and gas production from Tribal mineral interests under the Resource Protection Alternative than under the No Action Alternative.

The spatial separation between these minority and low-income communities and the GNBPA, and the absence of significant adverse environmental effects, supports a determination of no environmental justice effects for the Resource Protection Alternative. Even were environmental effects identified, prevailing wind patterns, the reliance on existing highway routes, and distribution of the population along the routes would preclude a determination of disproportionately high effects to potentially

affected minority and low-income populations. Similar to that discussed under the No Action Alternative, near-field modeling does not predict impacts from the Resource Protection Alternative beyond the boundary of the GNBPA. Therefore, adverse air quality impacts for environmental justice are not anticipated.

4.8.3.2 Mitigation and Mitigation Effectiveness

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.3.3 Residual Effects

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.4 Optimal Recovery Alternative

4.8.4.1 Impacts on Socioeconomics and Environmental Justice

This section is included in the Draft EIS and is not being amended in this supplement.

Employment, Income, and Population

This section is included in the Draft EIS and is not being amended in this supplement.

Grazing

This section is included in the Draft EIS and is not being amended in this supplement.

Recreational Use and Tourism

This section is included in the Draft EIS and is not being amended in this supplement.

Community Facilities and Services

This section is included in the Draft EIS and is not being amended in this supplement.

Public Expenditures and Revenues

This section is included in the Draft EIS and is not being amended in this supplement.

Community Social Conditions

This section is included in the Draft EIS and is not being amended in this supplement.

Environmental Justice

Under the Optimal Recovery Alternative, substantially more wells would be drilled than under the Proposed Action, and these wells would be developed on many more new well pads over a longer duration. However, the higher number of wells and well pads would not alter the fundamental spatial, economic, and demographic relationships used to assess potential Environmental justice effects with respect to the three minority and low-income communities: Whiterocks, Fort Duchesne, and Randlett CDPs.

The spatial separation between these communities and the GNBPA, and the absence of significant adverse environmental effects, supports a determination of no environmental justice effects for the Optimal Recovery Alternative. Even were environmental effects identified, prevailing wind patterns, the reliance on existing highway routes, and distribution population along the routes would preclude a

determination of disproportionately high effects to potentially affected minority and low-income populations.

The Ute Tribe would realize substantially higher royalties on oil and gas production from Tribal mineral interests under the Optimal Recovery Alternative than under the No Action Alternative.

Potential growth-related social and economic impacts associated with the Optimal Recovery Alternative would be much higher and continue over a longer duration than under the No Action Alternative. Such impacts would have both beneficial and adverse dimensions. Although most impacts would be focused in and around the Vernal and Naples area, more growth-related development and land use changes would occur outside the existing urbanized area. However, such effects would not be anticipated to accrue disproportionately to the three potentially affected minority and low-income communities. Similar to that discussed under the No Action Alternative, near-field modeling does not predict impacts from the Optimal Recovery Alternative beyond the GNBPA boundary. Therefore, adverse air quality impacts for environmental justice are not anticipated.

4.8.4.2 Mitigation and Mitigation Effectiveness

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.4.3 Residual Effects

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.5 Relationship Between Local Short-term Uses of the Human Environment and Maintenance and Enhancement of Long-term Productivity

This section is included in the Draft EIS and is not being amended in this supplement.

4.8.6 Irreversible/Irretrievable Commitment of Resources

This section is included in the Draft EIS and is not being amended in this supplement.

4.9 Soils

This section is included in the Draft EIS and is not being amended in this supplement.

4.10 Transportation and Access

This section is included in the Draft EIS and is not being amended in this supplement.

4.11 Vegetation

This section is included in the Draft EIS and is not being amended in this supplement.

4.12 Visual Resources

This section is included in the Draft EIS and is not being amended in this supplement.

4.13 Water Resources

This section is included in the Draft EIS and is not being amended in this supplement.

4.14 Wilderness Characteristics

This section is included in the Draft EIS and is not being amended in this supplement.

4.15 Wildlife and Fisheries Resources

This section is included in the Draft EIS and is not being amended in this supplement.

5.0 Cumulative Impacts

This section is included in the Draft EIS and is not being amended in this supplement.

6.0 Consultation and Coordination

This section is included in the Draft EIS and is not being amended in this supplement.

7.0 Glossary

This section is included in the Draft EIS and is not being amended in this supplement.

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Appendix A
Applicant-Committed Environmental Protection Measures

Appendix A

Applicant-Committed Environmental Protection Measures

Topic(s)	Applicant-Committed Measures
Surface Disturbance	KMG would utilize shared well pads to the extent possible, in consideration of technical, environmental, and economic viability, to minimize the amount of total surface disturbance in the GNBPA.
Surface Disturbance	KMG would develop a Transportation Plan that will detail the procedures intended to minimize construction of roads needed to implement Project activities. KMG's Transportation Plan would include construction procedures to prevent/minimize sedimentation that may result from road and/or pad construction. KMG would submit the plan to the BLM prior to the initiation of Project activities.
Surface Disturbance	Each new produced water disposal well would be located on existing production locations.
Surface Disturbance	KMG would evaluate deepening existing wells to accomplish Mesaverde-only completions before twinning an existing well.
Surface Disturbance	KMG would strive to continually improve the development processes in order in minimize the surface impact where practical.
Cultural Resources	A Class III archeological survey has been conducted on all federal and/or tribal lands in the GNBPA. All personnel would refrain from collecting artifacts and from disturbing any significant cultural resources in the area. KMG would be responsible for informing all persons in the area who are associated with this Project that they may be subject to prosecution for knowingly disturbing historic or archaeological sites or for collecting artifacts. All vehicular traffic, personnel movement, construction, and restoration activities would be confined to the areas examined, as referenced in the archaeological report, and to the existing roadways and/or evaluated access routes. If historic or archaeological materials were to be uncovered during construction, KMG would immediately stop surface disturbing activities that might further disturb such materials and contact the appropriate AO.
Paleontological Resources	KMG would conduct a paleontological survey on all of its federal, state, and tribal locations. All personnel would refrain from collecting fossils and from disturbing any significant fossil in the GNBPA. If fossils were to be uncovered during construction, KMG would immediately stop surface disturbing activities that might further disturb such materials and contact the appropriate AO.
Vegetation / Noxious and Invasive Species	KMG would develop a Pesticide/Herbicide Use Plan for submission to the BLM and State of Utah prior to the initiation of Project activities.
Vegetation / Noxious and Invasive Species	In accordance with the procedures described in its Pesticide/ Herbicide Use Plan, KMG would monitor for the growth of invasive species resulting from surface disturbance caused by Project activities and would control weeds caused by Project activities.
Vegetation / Noxious and Invasive Species	KMG would use its best efforts to control noxious weeds along access road authorizations, pipeline route authorizations, well sites, or other proposed facilities by spraying or mechanical removal. A list of noxious weeds would be obtained from the BLM or the appropriate County Extension Office. On BLM-administered land, a Pesticide Use Proposal would be submitted and approved prior to the application of herbicides or other pesticides or possibly hazardous chemicals.

Appendix A (Continued)

Topic(s)	Applicant-Committed Measures
Sedimentation, Erosion, and Stormwater Runoff	KMG would employ industry best management practices ***(BMPs)*** to control stormwater runoff, including appropriate measures to prevent disturbed sediments from reaching the White River drainage during precipitation events.
Raptors	KMG would adhere to seasonal and spatial buffers applicable to occupied raptor nests in the GNBPA in consideration of guidelines developed by the Utah Division of Wildlife Resources and the USFWS.
Migratory Birds	KMG would install bird-excluding devices that prevent the perching and entry of migratory birds on or into its new fired vessel exhaust stacks. In addition, KMG completed retrofitting approximately 1,014 existing exhaust stacks in 2007.
Sage Grouse Protection	KMG would utilize low-profile tanks in areas where sage grouse leks are determined to be active to minimize the opportunities for raptor perching.
Sage Grouse Protection	No surface-disturbing activities would be allowed year-round within ¼-mile of active Sage-grouse leks.
Pipeline Construction	KMG would utilize the applicable USFWS' BMPs for work in Utah streams where pipelines or roads cross a stream. Additionally, KMG would utilize BLM Hydraulic Considerations for Pipeline Crossings of Stream Channels (prepared by the Utah State Office BLM, Salt Lake City, Utah).
Water Use	KMG would attempt to maximize the use of produced water for completion purposes.
Water Quality/ Soils	KMG would position two 15-foot emergency response spill trailers in areas in or near the GNBPA to respond to accidental spills or releases. At least one of the trailers would be located at a drilling site near the White River, if necessary. Each trailer would be equipped with 300 feet of 10-inch Techniboom, tow bridles, and anchor sets. In addition, the trailers contain sorbent pads, sorbent booms, flash lights, life jackets, Tyvek suits and other safety equipment. KMG has conducted training sessions that included two days of instruction and field exercises with 15 field employees. The training was conducted by the Texas Engineering Extension Service Emergency Services Training Institute.
Air Quality	KMG would use water or other BLM-approved dust suppression during drilling and completion operations for dust abatement on access roads, as needed. KMG would use water or other BLM-approved dust suppression in high traffic areas during production operations for dust abatement, as needed.
Air Quality	KMG employees would comply with speed limits on unpaved county roads used for access and would use safe vehicle speeds on other access unpaved roads.
Air Quality	KMG would ***install low-emission dehydration units.***
Air Quality	***KMG would install electric compression, where feasible (approximately 50 percent of the compression horsepower [hp] to be electrically driven).***
Air Quality	KMG would install ***controls on new condensate storage*** tanks with the potential to emit more than 20 tpy VOCs.
Air Quality	KMG would install low-bleed pneumatic ***controllers on all new equipment***.

Appendix A (Continued)

Topic(s)	Applicant-Committed Measures
Air Quality	***KMG would use "green completion" BMPs ("green completion" indicates the use of additional surface equipment including special gas-liquid-sand separator straps and additional tankage allowing the well to immediately be connected to a sales line, significantly reducing emissions associated with flow back operations).***
Air Quality	KMG would phase in the use of Tier 2 drill rig engines ***(90 percent by 2010 and 100 percent by 2012)***.
Air Quality	***For engines greater than 500 hp, KMG would install lean-burn engines or engines equipped to achieve comparable emission reductions.***
Air Quality	***KMG would install and optimize artificial lift.***
Air Quality	***In the event monitoring shows the fourth high to exceed the NAAQS for ozone of 75 ppb, KMG would institute the following:*** • ***Install controls on existing condensate storage tanks with potential VOC emissions greater than 20 tons per year;*** • ***Within 3 years, retrofit or replace any remaining high-bleed pneumatic devices on existing equipment;*** • ***Perform annual inspections on thief hatch seal and Enardo pressure relief valves to ensure proper operation;*** • ***Conduct annual review of gathering system pressures to evaluate any areas where gathering pressure may be reduced, resulting in lower flashing losses from the condensate storage tanks; and*** • ***Periodically evaluate well-site automation systems to reduce vehicle tail pipe emissions at individual well sites.***
Air Quality	***KMG would jointly support (with other active oil and gas industry operators, oil and gas industry vendors, and non-industry emission source contributors) activities undertaken by a BLM/Industry Work Group that may include:*** ***Modeling:*** • ***Model calibration with monitored and meteorological data;*** • ***Source apportionment sensitivities;*** • ***Ozone precursor sensitivities; and*** • ***Mitigation control sensitivities.*** ***Industry Wide Emission Control Strategy:*** • ***In the event that monitoring shows the fourth high after 2 years exceeds the ambient standard of 75 ppb for ozone in two successive years, KMG would initiate additional emission controls as warranted through the development of an air mitigation strategy plan developed by a BLM/Industry Work Group.***

Topic(s)	Applicant-Committed Measures
Air Quality	***KMG would implement the following Ozone Awareness and Outreach Plan:*** ***Mobile Sources:*** • ***Refuel vehicles in the evening hours: Employees and contractors would be encouraged to refuel their vehicle fleet during the cooler evening hours;*** • ***Refuel activities: Operators would not overfill fuel tanks and would ensure that fuel caps are properly installed;*** • ***Minimize vehicle engine idling: Employees and contractors would minimize vehicle idling when practicable, resulting in the emission of reduced ozone precursors;*** • ***Minimize vehicle miles traveled: Employees and contractors would plan ahead to consolidate trips and minimize miles traveled between various drilling, production, and compression sites;*** • ***Double-up vehicle occupancy: Employees and contractors would maximize vehicle occupancy whenever possible to reduce the number of vehicles in operation and to eliminate redundant trips; and*** • ***Review vehicle maintenance: KMG would review fleet maintenance prior to summer weather to ensure that vehicles operate as efficiently as possible, reducing combustion emissions.*** ***Training and Outreach:*** • ***Staff Awareness: KMG would conduct annual training for regional staff to ensure increased ozone awareness;*** • ***Industry Awareness: KMG would participate in forums sharing BMPs for oil and gas sources. Technology and work practices can change dramatically with greater understanding of the creation of ozone. Sharing BMPs would educate all industry partners and facilitates the transfer of technology between industry partners.***
Wilderness Characteristics	KMG would not disturb the surface for ***p***roject***-related*** activities in NENW Section 22, T10S-R23E.
Wildlife	**Installation of raptor perch deterrents.** In order to minimize potential of electrocution mortality of raptors, KMG would utilize methods and designs described in *Suggested Practices for Raptor Protection on Power Lines* (APLIC 2006) and in *Mitigating Bird Collisions with Power Lines* (APLIC 1994) during construction, operation, and maintenance of power lines.
Surface Disturbance	**Burying of distribution pipelines and/or flow lines in or adjacent to access roads.** KMG would evaluate burying pipelines after site-specific evaluation of surface and subsurface conditions with consideration to the materials that would be transported through the pipelines. KMG proposes to bury approximately 10 miles of pipelines transporting produced water and 25 miles of gas-transportation pipelines. In areas where there is sufficient soil to excavate and after consultation with the BLM AO, KMG would consider burying well gathering lines adjacent to access roads.[1]

Appendix A (Continued)

Topic(s)	Applicant-Committed Measures
Transportation	**Centralizing production facilities.** Project wells would utilize centralized compression facilities. The proposed use of telemetry would reduce the frequency of well visits and therefore decrease vehicle traffic within the GNBPA, one objective of combining production facilities.
Surface Disturbance	**Drilling multiple wells from a single pad.** KMG would carefully evaluate drilling multiple wells from a single pad on an ongoing basis and has included the potential to use multiple wells from a shared pad in the GNBPA to the extent that KMG determines technically and economically viable.[2]
Wildlife	**Wildlife monitoring.** KMG would enter into discussions with the BLM to determine how, when and for what species wildlife monitoring may be implemented. KMG would participate in industry groups and projects to support efforts to reduce impacts to wildlife that may result from oil and gas activities in the GNBPA. KMG would enter into discussions with the BLM to mutually investigate possibilities for voluntary offsite mitigation measures for wildlife habitat enhancement after evaluation of the effectiveness of onsite mitigation, including ***BMPs***.
Public Safety Wildlife	**Seasonal restriction of public vehicle access.** KMG would construct fences to surround its proposed evaporation ponds to prevent the public or animals from accessing these facilities. In consultation with the BLM AO, KMG would comply with applicable OSHA requirements by taking measures such as installing “warning” signs at locations where public access could result in potential safety issues.
Transportation	Most of the unpaved roads within the GNBPA are claimed as Class “B” and “D” roads by Uintah County and are, therefore, public roads. The remaining roads in the GNBPA are short, dead end roads used to access well pads. These roads would not be considered “through” roads by the public, rendering their use by the public unlikely.
Visual Resources	**Avoiding placement of production facilities on hilltops and ridgelines.** KMG would utilize low-profile tanks in the portions of the GNBPA visible from the White River where the river can be viewed from the location, such as ridgelines, or would utilize topographic features, to the extent available, to prevent viewing the tanks from the White River.
Visual Resources	**Screening facilities from view.** KMG would utilize topographic features, to the extent available, and utilize screening or other design measures, to the extent practical, to prevent stationary permanent equipment from being viewed from the White River. KMG would develop methods for screening facilities on a site-specific basis.
Surface Disturbance	**Use of common utility or right-of-way corridors.** KMG would locate gathering lines adjacent to access roads. KMG would locate larger pipelines adjacent to roads or within existing utility corridors.
Floodplains	Exempting existing pipelines and projects previously approved, KMG would bury gas pipelines associated with new and future construction within 100-year floodplains.

Appendix A (Continued)

Topic(s)	Applicant-Committed Measures
Noxious and Invasive Weeds	KMG would conduct pre-disturbance weed inventories to identify locations of noxious and invasive weed species.
Sedimentation, Erosion, and Stormwater Runoff	KMG will implement Reasonable and Prudent Practices for Stabilization (RAPPS) and develop Storm Water Pollution Prevention Plans (SWPPPs) for individual new construction sites associated with compressor stations, processing plants, and pipeline projects that disturb more than 5 acres.
Surface Disturbance	KMG would not construct new mancamps within 0.5 mile of floodplains (including the floodplain) of major drainages (Sand Wash, Cottonwood Wash, Bitter Creek, White River, Green River); and within occupied Threatened and Endangered Plant habitat. This mitigation measure would be applied only if there is a demonstrated need (i.e., only if other mitigations do not adequately mitigate impacts).
Threatened and Endangered Fish	KMG would adhere to the following mitigation regarding protection of threatened and endangered fish: 1. Limit pumping to off-channel locations – ones that do not connect to the river during high spring flows. 2. If the pump head is located in the river channel where larval fish are known to occur, the following measures apply: a. Pumps will not be situated in low-flow or no-flow area as these habitats tend to concentrate larval fishes; b. Limit the amount of pumping, to the greatest extent possible, during that period of the year when larval fish may be present (see above); and c. Limit the amount of pumping, to the greatest extent possible, during the pre-dawn hours as larval drift studies indicate that this is a period of greatest daily activity. 3. Screen all pump intakes with ¼" mesh material. 4. Report any fish impinged on the intake screen to the Service (801.975.3330) and the: Utah Division of Wildlife Resources Northeastern Region 152 East 100 North Vernal, UT 84078 Phone: (435) 781-9453

[1] The disturbance associated with these buried gas gathering and water pipelines is considered in the analysis as new disturbance.
[2] For the purpose of the EIS analysis, all wells in the Proposed Action Alternative and the Optimal Recovery Alternative are assumed to be drilled vertically.

Appendix G
Air Quality Technical Support Document

Greater Natural Buttes
Air Quality Technical Support Document

Vernal Field Office/Utah

Bureau of Land Management

May 2011

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1.0 Introduction and Background

Kerr-McGee Oil & Gas Onshore LP (KMG), a wholly owned subsidiary of Anadarko Petroleum Corporation, proposes to conduct infill drilling to develop the hydrocarbon resources underlying oil and gas leases owned, at least in part, by KMG within the Greater Natural Buttes Project Area (GNBPA) in Uintah County, Utah. KMG plans to explore and develop all potentially productive subsurface formations underlying the GNBPA. KMG is the designated operator or owns contractual leasehold rights for more than 85 percent of the lands within the GNBPA boundary. The oil and gas leases were issued by the Bureau of Land Management (BLM), State of Utah, Bureau of Indian Affairs (BIA), and private owners.

The BLM is analyzing the environmental impacts of the proposed project by preparing an Environmental Impact Statement (EIS) as required by the National Environmental Policy Act (NEPA). In support of NEPA ***requirements***, this document presents a technical analysis of air quality issues related to development of the resources within the GNBPA. The purpose of this analysis is to provide the details of the air quality technical data and assumptions that were used to develop the air quality review and evaluation of impacts as required under NEPA.

In response to comments on the Draft EIS, a supplemental air quality analysis was conducted in December 2010. This analysis addresses potential air quality impacts from the project relative to new National Ambient Air Quality Standards (NAAQS) promulgated in 2010 subsequent to the analysis conducted for the Draft EIS. Further, additional analysis was conducted to determine ambient air concentrations of selected hazardous air pollutants (HAPs). The supplemental analysis also discloses additional air quality monitoring data collected in 2010 from stations near the GNBPA.

1.1 Project Description

KMG proposes to drill and produce natural gas supplies in the GNBPA shown in **Figure 1-1**. This project area consists of approximately 162,911 acres in an existing gas producing area located in T8S/R20-23E, T9S/R20-24E, T10S/R20-23E, and T11S/R21-22E in Uintah County, Utah. The GNBPA encompasses 88,565 acres of federal land administered by the BLM; 39,399 acres of land owned by the Northern Ute Tribe and administered by the BIA; 32,755 acres of land owned by the State of Utah; and 2,192 acres of privately owned land.

KMG's proposed development plan, referred to in this document as the Proposed Action, is to drill additional wells at an average rate of approximately 358 wells per year over a period of about 10 years or until the resource base is fully developed, with a maximum total of 3,675 wellbores. The total number of wells drilled during the life of the project or during any particular year would depend largely on factors outside of KMG's control such as permit approvals, production success, engineering technology, economic factors, commodity prices, rig availability, and lease stipulations. The productive life of each well is estimated to be 30 to 50 years.

Infill drilling would be performed on 40-acre and 20-acre surface spacing throughout the GNBPA (i.e., 16 to 32 surface well pads per square mile, respectively). KMG defines a 40-acre well pad as the first well pad located in a 40-acre quarter-quarter of a square mile section of land. A 20-acre pad is defined as the second well pad located in a 40-acre quarter-quarter section. Downhole well spacing would be based on reservoir engineering evaluation on an on-going basis and would be site-dependent, potentially ranging from 16 wells per section (40-acre spacing) to 64 wells per section (10-acre spacing). In areas where the gas resources in the reservoirs warrant a downhole spacing of less than 20 acres based on reservoir engineering evaluation, KMG would test and attempt to utilize directional drilling technology to drill from nearby 20-acre or 40-acre pads, if such is technically and economically viable. In general, the surface density of the KMG well pads would not exceed 32 pads per section. This equates to an average spacing between pads of approximately 285 meters (m), a distance that is incorporated into air modeling procedures described in this document.

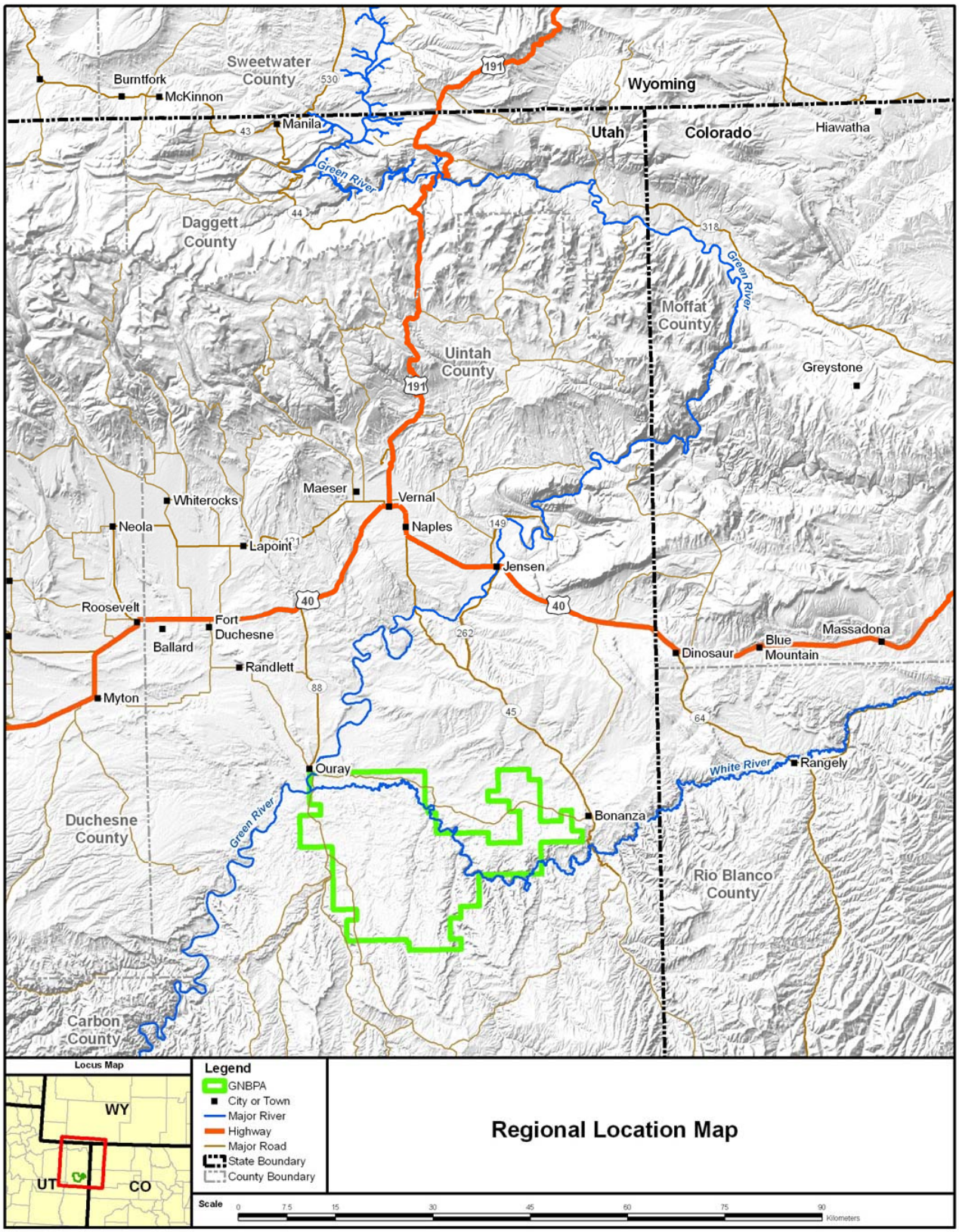


Figure 1-1 Location of GNBPA

KMG has committed to ***a number of*** environmental protection measures to reduce emissions of criteria and HAPs from the proposed project. ***Those measures that were quantified in the modeling analysis*** are summarized in **Table 1-1**.

Table 1-1 Applicant-committed Environmental Protection Measures *Considered in Modeling*

Source Type	Proposed Control	***Considerations in Modeling* Analysis**
Natural Gas Fired Engines	For engines ***greater than 500 horsepower (hp)***, install lean burn engines ***or engines equipped to achieve comparable emissions reduction.***	All stationary engines considered for the project are greater than 500 hp, and therefore will be considered lean burn. ***KMG provided manufacturer specified emission rates for compression engines.***
	Install catalyst on all natural gas fired ***compression.***	***Because*** all ***compression*** engines ***considered in the analysis*** are lean burn, the analysis ***assumes*** the use of oxidation catalysts for carbon monoxide (CO) and volatile organic compound (VOC) reduction. Non-selective catalytic reduction is appropriate for rich burn engines only and therefore is not considered.
	Install approximately 50 percent electric compression***, where feasible.***	The analysis considers 57 percent of the compression to be electric based on information on compression to be installed as provided by KMG.
Non-road Diesel Engines	Phase in Tier 2 drill rig engines ***(90 percent by 2010 and 100 percent*** by 2012***).***[1]	***The use of both Tier 2 and Tier 4 engines was considered in the near-field impact analysis. The far-field and regional analyses were specific to a project year past the implementation of Tier 4 engines. Therefore, the far-field analysis only considered the use of Tier 4 engines.***
Dehydrators	Install ***low-***emission dehydrat***ion units.***	***Consistent with low emission dehydrators, venting emissions were not considered; however, combustion emissions from production heaters were included in the analysis.***
Pneumatics	Install low-bleed pneumatic ***controllers on all new equipment.***	The fugitive emission calculations consider low-bleed pneumatics. ***The projected future baseline emissions considered the replacement of existing pneumatic controllers with low-bleed pneumatics.***
Condensate Tanks	Install controls on new condensate tanks with potential to emit VOC greater than 20 tons per year (tpy)	The analysis considers controls on tanks greater than 20 tpy VOC.
Completions	Use “green completion” ***best management practices.***	No VOC from completions and “green completions” assumed for greenhouse gas analysis.

[1] The implementation of Tier 2 engine standards as specified in 40 Code of Federal Regulations (CFR) 89.112 supersedes this Applicant-committed Environmental Protection Measure.

1.2 Overview of Modeling Approach

This section is included in the Draft EIS and is not being amended in this supplement.

1.3 Development of Emissions Inventories and Pollutants of Interest

This section is included in the Draft EIS and is not being amended in this supplement.

1.4 Assessment Approach

This section is included in the Draft EIS and is not being amended in this supplement.

2.0 Study Area and Background for Air Quality Analyses

This section is included in the Draft EIS and is not being amended in this supplement.

2.1 Regional Setting for Air Quality

This section is included in the Draft EIS and is not being amended in this supplement.

2.2 Recent Development in the Region

This section is included in the Draft EIS and is not being amended in this supplement.

2.3 Background Air Quality

Air quality in a given location is defined by pollutant concentrations in the atmosphere and generally is expressed in units of parts per million (ppm) or micrograms per cubic meter (µg/m^3). The existing air quality in the proposed development area is compliant with both the NAAQS and ***State AAQS (***SAAQS***)*** or has insufficient data to establish compliance. Representative ambient background levels of pollutants measured in Uintah and Salt Lake counties, Utah, and Sweetwater County, Wyoming, are shown in **Table 2-2**. Data for this table ***were*** obtained from the ***United States (U.S.) Environmental Protection Agency (USEPA) Air Quality System (AQS)*** website.

Table 2-2 Background Ambient Air Quality Data

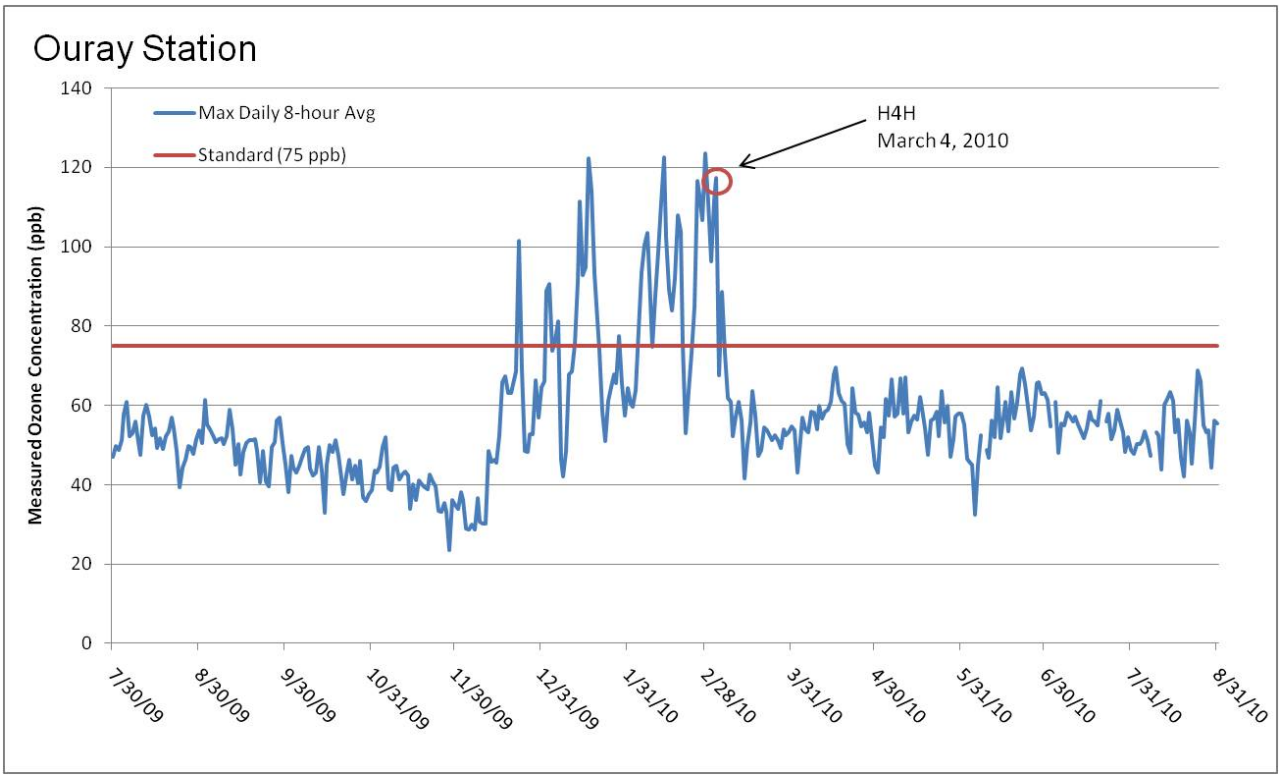
Pollutant	Averaging Period	Ranking[1]	Year	Concentration (µg/m^3)	County	State
Nitrogen Dioxide (NO_2)	***1-hour***	***98th Percentile***	***2010***	***69.6***[2]	***Uintah***	***Utah***
		98th Percentile	***2010***	***58.3***[3]	***Uintah***	***Utah***
			AQIA[4]	***69.6***	***Uintah***	***Utah***
	Annual	H	***2010***	***8.0***[2]	***Uintah***	***Utah***
		H	***2010***	***7.2***[3]	***Uintah***	***Utah***
			AQIA	***8.0***	***Uintah***	***Utah***
CO	1-hour	H2H	2004	6,210	Salt Lake	Utah
		H2H	2005	6,325	Salt Lake	Utah
		H2H	2006	6,325	Salt Lake	Utah
			AQIA	6,325	Salt Lake	Utah
	8-hour	H2H	2004	3,680	Salt Lake	Utah
		H2H	2005	3,910	Salt Lake	Utah
		H2H	2006	3,450	Salt Lake	Utah
			AQIA	3,910	Salt Lake	Utah
Sulfur Dioxide (SO_2)[5]	***1-hour***	***99th Percentile***	***2007***	***21.7***	***Sweetwater***	***Wyoming***
		99th Percentile	***2008***	***19.7***	***Sweetwater***	***Wyoming***
		99th Percentile	***2009***	***19.0***	***Sweetwater***	***Wyoming***
			AQIA	***21.7***	***Sweetwater***	***Wyoming***
	3-hour	H2H	200***7***	***16.0***	Sweetwater	Wyoming
		H2H	200***8***	1***6***.7	Sweetwater	Wyoming
		H2H	***2009***	***10.1***	***Sweetwater***	***Wyoming***
			AQIA	***16.7***	Sweetwater	Wyoming

Table 2-2 Background Ambient Air Quality Data

Pollutant	Averaging Period	Ranking[1]	Year	Concentration ($\mu g/m^3$)	County	State
SO_2[5] (Continued)	24-hour	H2H	200***7***	***5.9***	Sweetwater	Wyoming
		H2H	200***8***	5.***6***	Sweetwater	Wyoming
		H2H	***2009***	***3.9***	***Sweetwater***	***Wyoming***
			AQIA	***5.9***	Sweetwater	Wyoming
	Annual	H	200***7***	***1.5***	Sweetwater	Wyoming
		H	200***8***	***1.5***	Sweetwater	Wyoming
		H	***2009***	***0.8***	***Sweetwater***	***Wyoming***
			AQIA	***1.5***	Sweetwater	Wyoming
PM with an aerodynamic diameter of 10 microns or less (PM_{10})	24-hour	H2H	2004	14.0	Uintah	Utah
		H2H	2005	18.0	Uintah	Utah
		H2H	2006	16.0	Uintah	Utah
			AQIA	18.0	Uintah	Utah
	Annual	H	2004	5.0	Uintah	Utah
		H	2005	7.0	Uintah	Utah
		H	2006	7.0	Uintah	Utah
			AQIA	7.0	Uintah	Utah
PM with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$)[3]	24-hour	98th percentile	***2010***	***16.0***	Uintah	Utah
			AQIA	***16.0***	Uintah	Utah
	Annual	***H***	***2010***	***6.0***	***Uintah***	***Utah***
			AQIA	***6.0***	***Uintah***	***Utah***
Ozone	***8-hour***	***H4H***	***2010***	***117***[2,6]	***Uintah***	***Utah***
			2010	***98***[3,6]	***Uintah***	***Utah***
			AQIA	***117***	***Uintah***	***Utah***

[1] H = Highest value recorded; H2H = High Second High (second highest value from the highest receptor site)***; H4H = High Fourth High (fourth highest value from the highest receptor site)***.
[2] ***Ouray Monitoring Station Data (USEPA AQS Database).***
[3] ***Redwash Monitoring Station Data (USEPA AQS Database).***
[4] AQIA = Air Quality Impact Assessment (representative of ambient background). The AQIA selected for each averaging period for a specific pollutant is the maximum ranked value from ***the*** period.
[5] ***Wamsutter Monitoring Station Data (USEPA AQS Database).***
[6] ***Ozone is measured in parts per billion (ppb).***

The USEPA collected ozone and NO_2 data at monitoring stations near Ouray and Redwash monitoring stations from July 30, 2009, to August 31, 2010. These data for a single year show monitored 8-hour ambient concentrations of ozone that are above the 75 ppb NAAQS; however, compliance with the NAAQS for ozone is established by the 3-year average of the fourth highest daily 8-hour maximum ozone reading. The data also indicate a seasonal variation in which the high values occur exclusively during the December to March winter period. As shown in Figure 2-2, the summer 8-hour daily maximum values at either station do not exceed 75 ppb.



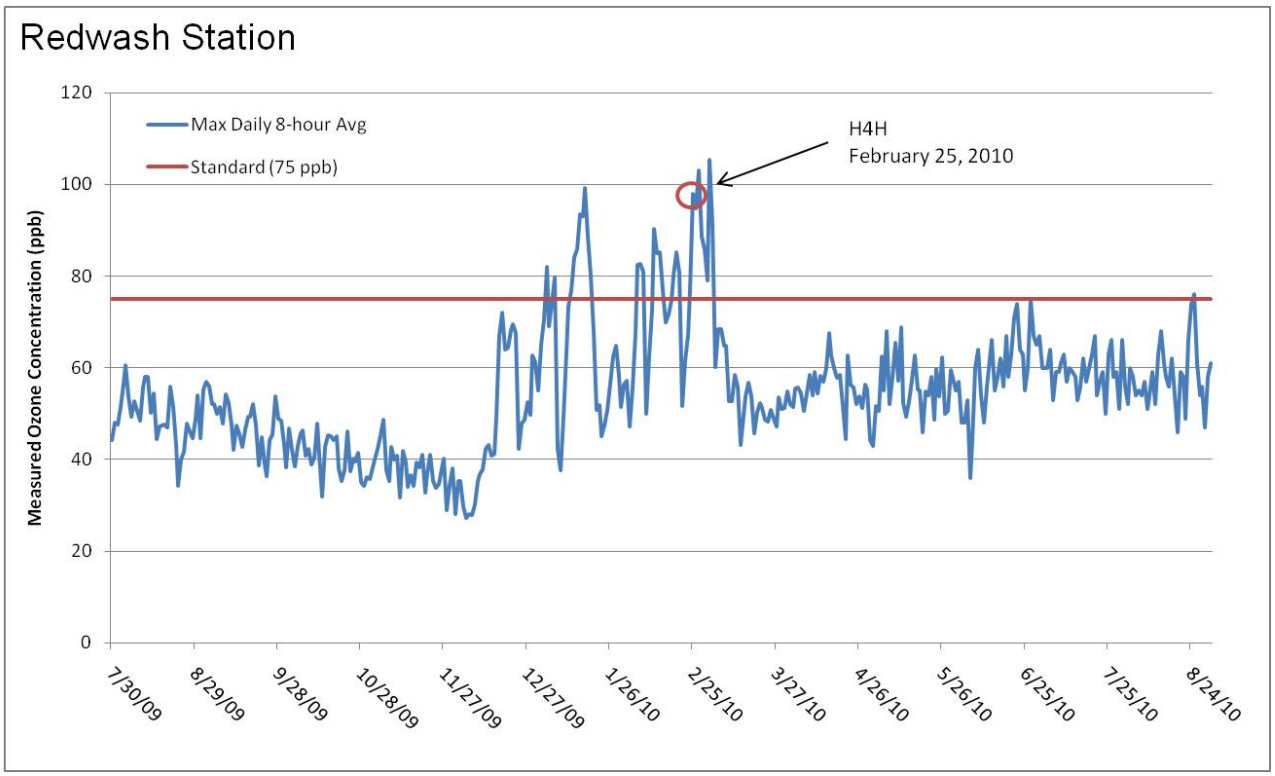


Figure 2-2 Ouray and Redwash Ozone Monitoring Data

2.4 Standards and Evaluation

The ***Clean Air Act (***CAA***)*** of 1970 (42 United States Code 7401) as amended in 1977 and 1990 is the basic federal statute governing air pollution. Provisions of the CAA that potentially are relevant to the GNBPA are listed and discussed below:

- NAAQS;
- ***Prevention of Significant Deterioration (***PSD***)***;
- Nonattainment New Source Review;
- Conformity Regulations;
- New Source Performance Standards; and
- National Emissions Standards for Hazardous Air Pollutants.

2.4.1 National Ambient Air Quality Standards

The federal CAA amendments of the 1990s require all states to control air pollution emissions sources so that NAAQS are met and maintained. The NAAQS establishes maximum acceptable concentrations for nitrogen (NO_2/NO_X), CO, SO_2, PM_{10}, $PM_{2.5}$, ozone, and lead. Given the extremely low levels of lead emissions from project sources, the lead standards were not addressed in this analysis. These pollutants are known as criteria pollutants. The NAAQS are established by USEPA and are outlined in 40 CFR 50. These standards represent the maximum allowable atmospheric concentrations that may occur without jeopardizing public health and welfare, and include a reasonable margin of safety to protect the more sensitive individuals in a population. The NAAQS represent maximum acceptable concentrations that generally may not be exceeded more than once per year; the annual standards may never be exceeded. An area that does not meet the NAAQS is designated as a nonattainment area on a pollutant-by-pollutant basis.

The USEPA announced a 1-hour NO_2 NAAQS of 100 ppb (188 µg/m^3) in the Federal Register (FR) on January 22, 2010, which was finalized on February 9, 2010 (75 FR 6474-6537). Further, the USEPA announced a 1-hour SO_2 NAAQS of 75 ppb (197 µg/m^3) on June 2, 2010, which was finalized on June 22, 2010 (FR 35520-35603). The NO_2 and SO_2 standards became effective on April 12 and August 23, 2010, respectively. Compliance with the standard is attained for 1-hour NO_2 when the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour concentrations does not exceed the standard within an area. For 1-hour SO_2, the standard is attained when the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour concentrations does not exceed the standard within an area. The State of Utah has adopted the NAAQS as the SAAQS; however, Wyoming and Colorado have not incorporated these new standards into the State Implementation Plan. Applicable federal and state criteria are presented in **Table 2-3**.

Table 2-3 Applicable Ambient Air Quality Standards

Pollutant	Averaging Period	Ambient Air Quality Standards[1]			
		National	Wyoming	Utah	Colorado
NO_2 ***(µg/m^3)***	***1-hour[2]***	***188***	***--[3]***	***188***	***--[3]***
	Annual[4]	100	100	100	100
CO ***(µg/m^3)***	1-hour[5]	40,000	40,000	40,000	40,000
	8-hour[5]	10,000	10,000	10,000	10,000
SO_2 ***(µg/m^3)***	***1-hour[6]***	***197***	***--[3]***	***197***	***--[3]***
	3-hour[5,7]	1,300	1,300	1,300	1,300
	24-hour[5,7]	365	260	365	365
	Annual[4]	80	60	80	80

Table 2-3 Applicable Ambient Air Quality Standards

Pollutant	Averaging Period	Ambient Air Quality Standards[1]			
		National	Wyoming	Utah	Colorado
PM_{10} ***(µg/m³)***	24-hour[8]	150	150	150	150
	Annual[4]	--[9]	50	50	50
$PM_{2.5}$ ***(µg/m³)***	24-hour[10]	35	35	35	35
	Annual[11]	15	15	15	15
Ozone ***(ppb)***	8-hour[12]	75	75	75	75

1 Sources: USEPA 2009, Wyoming Department of Environmental Quality 2008, and Colorado Department of Public Health and Environment 2007.
2 ***Three-year average of the 98th percentile of the daily maximum 1-hour average.***
3 ***No state standard has been incorporated into the State Implementation Plan.***
4 ***Never to be exceeded.***
5 ***Not to be exceeded more than once per year.***
6 Three-year average of the ***99th percentile of daily maximum 1-hour average.***
7 ***Secondary standard only.***
8 ***Not to be exceeded more than once per year.***
9 ***The annual PM_{10} NAAQS of 50 µg/m³ was revoked by USEPA on September 21, 2006. See FR Volume 71, Number 200, October 17, 2006.***
10 ***Three-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed the standard.***
11 ***Three-year average of the weighted annual mean concentrations from single or multiple community-oriented monitors must not exceed this standard.***
12 ***Three-year average of the fourth highest daily maximum 8-hour average measured at each monitor within an area over each year must not exceed this standard.***

2.4.2 Prevention of Significant Deterioration

PSD regulations restrict the degree of ambient air quality deterioration allowed and apply to proposed new or modified major stationary sources located in an attainment area that have the potential to emit criteria pollutants in excess of predetermined de minimis values (40 CFR 51). Increments for criteria pollutants are based on the PSD classification of the area. Class I area status is assigned to federally protected wilderness areas and allows the lowest amount of permissible deterioration. This designation essentially precludes development near these areas. Class II areas are designed to allow for moderate, controlled growth, and Class III areas allow for heavy industrial use.

As defined in 40 CFR 51, a source is considered a major stationary source if it:

- Can be classified in one of 28 named source categories listed in Section 169 of the CAA and it emits or has the potential to emit 100 tpy of any pollutant regulated by the Act; or
- Is any other stationary source that emits or has the potential to emit 250 tpy or more of any pollutants regulated by the CAA (USEPA 1990).

Compressor stations and other upstream oil and gas sources are not listed as one of the 28 named source types in Section 169 of the Act; therefore, 250 tpy is the threshold for major source status.

Federal PSD Class I areas, which include certain national wilderness areas, national memorial parks, and national parks, are afforded the highest level of protection. Ambient air criteria that apply within Class I areas are more stringent than those that apply to other areas. In addition to more stringent ambient air increments, Class I areas also are protected by the regulation of ***air quality related values*** within their borders. FLMs are responsible for the management of PSD Class I areas. **Table 2-4** provides a list of federal Class I and sensitive Class II areas considered in this analysis.

Table 2-4 Class I and Sensitive Class II Areas of Concern for Air Quality Impact Analysis

National Park Service (NPS) Class I Areas
Arches National Park
Black Canyon of the Gunnison National Park
Canyonlands National Park
Capitol Reef National Park
Mesa Verde National Park
***U.S. Forest Service (*USFS*)* Class I Areas**
Eagles Nest Wilderness Area
Flat Tops Wilderness Area
La Garita Wilderness Area
Maroon Bells-Snowmass Wilderness Area
Mount Zirkel Wilderness Area
Weminuche Wilderness Area
West Elk Wilderness Area
NPS Class II Areas
Colorado National Monument
Dinosaur National Monument
USFS Class II Areas
Flaming Gorge National Recreation Area
High Uintah Wilderness Area
Holy Cross Wilderness Area
Hunter/Frying Pan Wilderness Area
Raggeds Wilderness Area
U.S. Fish and Wildlife Service Class II Areas
Browns Park National Wildlife Refuge

Allowable deterioration to air quality can be expressed as the incremental increase to ambient concentration of criteria pollutants, or PSD increment. Modeled air concentration of NO_2, SO_2, and PM_{10} predicted at near-field receptors that result from project emissions were compared to the threshold of allowable PSD increments. This comparison to PSD Class II increments did not represent a regulatory PSD increment consumption analysis because the focus of this study was the Proposed Action and alternatives under NEPA, not increment-affecting sources that were not relevant under NEPA. The allowable PSD increments for Class II areas also are given in **Table 2-5**.

Table 2-5 PSD Increments for Class I and Class II Areas

PSD Class	Pollutant	Allowable Increment ($\mu g/m^3$)		
		Annual Arithmetic Mean	**24-hour Maximum**	**3-hour Maximum**
Class I	NO_2	2.5	-	-
	SO_2	2	5	25
	PM_{10}	4	8	-
Class II	NO_2	25	-	-
	SO_2	20	91	512
	PM_{10}	17	30	-

On June 3, 2010, the USEPA issued the final rule that "tailors" the applicability of PSD requiring USEPA and/or permitting authorities to implement PSD permitting requirements for greenhouse gases (GHGs) (75 FR 31514). The "Tailoring Rule" takes effect on January 21, 2011, for new or modified

sources that have the potential to emit (PTE) or net increase in emissions more than 75,000 tpy of carbon dioxide (CO_2) equivalents (CO_2e) and would be considered major for other PSD pollutants. On or after July 1, 2011, this rule will apply to any new source with the PTE of 100,000 tpy CO_2e and exceeds the major source threshold of any GHG on a mass basis regardless of the PTE of other PSD pollutants. Further, modification at an existing major source that results in a net emissions increase of 75,000 tpy CO_2e also will be reviewed under the PSD rules.

2.4.3 Nonattainment New Source Review

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.4 Conformity for General Federal Actions

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.5 New Source Performance Standards

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.6 National Emission Standards for Hazardous Air Pollutants

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.6.1 Subpart A – General Provisions

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.6.2 Subpart HH – Oil and Natural Gas Production Facilities

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.6.3 Subpart YYYY – Stationary Combustion Turbines

This section is included in the Draft EIS and is not being amended in this supplement.

2.4.6.4 Subpart ZZZZ – Stationary Reciprocating Internal Combustion Engines

On January 18, 2008, the USEPA published finalized rules in the Federal Register to amend 40 CFR 63 Subpart ZZZZ. An affected source under this amended Subpart is any existing, new, or reconstructed stationary reciprocating internal combustion engine with a site-rating of more than 25 brake hp (bhp), located at either a major source or area source of HAP.

On August 20, 2010, the USEPA published further revisions to this rule (71 FR 51570 et. seq) to address emissions from existing stationary spark-ignition (SI) engines less than or equal to 500 hp at major sources and all existing stationary SI engines located at area sources.

2.5 Carbon Dioxide and Other Greenhouse Gases

In *Massachusetts v. EPA*, the U.S. Supreme Court (April 7, 2007) held that CO_2 satisfies the definition of "air pollutant" and that USEPA has authority to regulate emissions of CO_2 and other GHG from new motor vehicles under the CAA. The Supreme Court remanded the case to USEPA to determine whether such motor vehicle emissions contribute to global climate change, and thereby endanger public health or welfare. The ruling, however, did not require the USEPA to create any emission control standards or ambient air quality standards for GHG.

CO_2 and other GHG are naturally occurring gases in the atmosphere whose status as a pollutant is not related to their toxicity, but to the added long-term impacts they may have on climate because of their increased

incremental levels in the earth's atmosphere. Because they are non-toxic and non-hazardous at normal ambient concentrations, CO_2 and other naturally occurring GHG are, therefore, not regulated under the major environmental regulatory programs that primarily address toxic and hazardous substances.

On October 30, 2009, the USEPA promulgated the final mandatory reporting rule for GHGs under 40 CFR Part 98, which requires a wide range of sources to record and report selected GHG emissions including CO_2, methane, nitrous oxide, and some halogenated compounds. A CO_2e value is calculated for combined emissions of these gases based on their comparative global warming potential. This rule applies to sources that emit 25,000 tpy or more CO_2e. Further, the USEPA issued the final reporting GHG requirements for petroleum and natural gas production on November 30, 2010 (40 CFR Part 98 Subpart W) (75 FR 74458). The rule specifically identifies monitoring and reporting requirements for natural gas systems including combustion units (Subpart C) as well as on-shore gas production, storage, processing, and transmission (Subpart W).

The rule does not require any controls or establish any ***emission limits*** related to GHG emissions. Therefore, there is no requirement at this time that would affect development of the proposed project under ***this*** rule, other than the ***requirement for the operator to develop a monitoring plan and maintain*** recordkeeping, and reporting of GHG emissions. Chapter 6.0 provides a detailed GHG emission calculation for the Proposed Action and Optimal Recovery Alternative.

3.0 Emissions Data

This section is included in the Draft EIS and is not being amended in this supplement.

3.1 Current and Projected Baseline Emissions Input Procedures

This section is included in the Draft EIS and is not being amended in this supplement.

3.2 Determination of Cumulative Impacts

This section is included in the Draft EIS and is not being amended in this supplement.

3.3 Construction Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

3.4 Drilling Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

3.4.1 Emissions from Drill Rig Operation

Based on data provided by KMG, each rig was assumed to be driven by up to three Caterpillar G3512LE diesel-fired engines or equivalent. These engines would run in tandem with only two of the engines operating at a time. Further, drilling would be concluded at each well by the operation of a workover rig equipped with a Caterpillar C13 engine or equivalent to complete the well.

Although the peak production year would occur after the compliance date for Tier 4 engines, KMG has only committed to the use of Tier 2 engines. The regional emissions inventory for the analysis only considered the use of Tier 4 engines because this inventory is used to determine regional impacts to ambient air quality in a specific projected year that is well past the Tier 4 compliance date for all alternatives. The near-field modeling analysis must consider the use of both Tier 2 and Tier 4 engines in the field because drilling would commence prior to the Tier 4 compliance date. Therefore, emissions estimates were calculated using emissions factors of NO_X, CO, PM_{10}, $PM_{2.5}$, and VOCs for both Tier 2 and Tier 4 engine standards from Table 1 of 40 CFR 1089.101 to meet the needs for both action alternatives.

The emission factor for SO_2 was derived using **Equation 3-1** assuming 15 ppm ***weight (ppmw)*** of sulfur in the fuel per fuel sulfur standards in 40 CFR 89. HAP emission factors were taken from the National Mobile Inventory Model database (USEPA 2005a). Emissions from the drill rig engine for each well drilled are calculated using **Equation 3-2** and shown in **Table 3-20**.

Equation 3-1 Calculation of SO_2 Emission Factor Based on Fuel Sulfur

$$EF_{SO2} = \frac{15\ lb\ S}{10^6\ lb\ fuel}\ x\ \frac{6.8\ lb\ fuel}{gal}\ x\ \frac{gal}{140{,}000\ Btu}\ x\ \frac{7{,}000\ Btu}{hp-hr}\ x\ \frac{64.06\ lb\ SO_2}{32.06\ lb\ S}\ x\ \frac{453.6\ g}{lb} = 4.6x10^{-3}\ g/hp-hr$$

Equation 3-2 Calculation of Criteria Pollutant Emissions from Diesel Fired Drill Rig Engines

$$E(tons\ /\ well) = EF(g\ /\ hp\ -\ hr)\ x\ \frac{hp}{rig}\ x\ \frac{days}{well}\ x\ \frac{24\ rig\ -\ hour}{day}\ x\ LoadFactor\ \ x\ \frac{lb}{453.6\ g}\ x\ \frac{ton}{2000\ lb}$$

Table 3-20 Pollutant Emissions from Rig Engines per Well Drilled

Drill Rig Engine Emissions								
Rig Size = 1,476 hp								
Annual Utilization = 0.67 (2 of 3 engines)								
Daily Load Factor = 0.65								
Overall Load Factor = 0.43 (for 24-hour and annual emissions); 1.00 for hourly emissions								
Duration = 15 days/well; 24 hours/day								
	Tier 2				*Tier 4*			
	Emission	*Emission Rate*			*Emission*	*Emission Rate*		
	Factor	*Hourly*	*24-hour*	*Annual*	*Factor*	*Hourly*	*24-hour*	*Annual*
Pollutant	*(g/hp-hr)*	*(lb/hr)*	*(lb/hr)*	*(tons/well)*	*(g/hp-hr)*	*(lb/hr)*	*(lb/hr)*	*(tons/well)*
NO_X	*4.8*	*15.6*	*10.2*	*3.7*	*2.6*	*8.5*	*5.5*	*2.0*
CO	*2.6*	*8.5*	*5.5*	*2.0*	*2.6*	*8.5*	*5.5*	*2.0*
SO_2	*0.0046*	*0.02*	*0.001*	*0.004*	*0.0046*	*0.02*	*0.001*	*0.004*
$PM_{10/2.5}$	*0.15*	*0.5*	*0.3*	*0.1*	*0.015*	*0.05*	*0.03*	*0.01*
VOC	*0.14*	*0.5*	*0.3*	*0.1*	*0.14*	*0.5*	*0.3*	*0.1*
Benzene	*2.9E-03*	*9.3E-03*	*6.0E-03*	*2.2E-03*	*2.9E-03*	*9.3E-03*	*6.0E-03*	*2.2E-03*
Toluene	*2.1E-03*	*6.8E-03*	*4.4E-03*	*1.6E-03*	*2.1E-03*	*6.8E-03*	*4.4E-03*	*1.6E-03*
Ethylbenzene	*4.3E-04*	*1.4E-03*	*9.2E-04*	*3.3E-04*	*4.3E-04*	*1.4E-03*	*9.2E-04*	*3.3E-04*
Xylene	*1.5E-03*	*4.8E-03*	*3.1E-03*	*1.1E-03*	*1.5E-03*	*4.8E-03*	*3.1E-03*	*1.1E-03*
Formaldehyde	*1.7E-02*	*5.4E-02*	*3.5E-02*	*1.3E-02*	*1.7E-02*	*5.4E-02*	*3.5E-02*	*1.3E-02*
n-Hexane	*2.2E-04*	*7.3E-04*	*4.7E-04*	*1.7E-04*	*2.2E-04*	*7.3E-04*	*4.7E-04*	*1.7E-04*
Completion Rig Engine Emissions								
Rig Size = 475 hp								
Annual Utilization = 1.00 (1 of 1 engine)								
Daily Load Factor = 0.65								
Overall Load Factor = 0.65 (for 24-hour and annual emissions); 1.00 for hourly emissions								
Duration = 3 days/well; 12 hours/day								
	Tier 2				*Tier 4*			
	Emission	*Emission Rate*			*Emission*	*Emission Rate*		
	Factor	*Hourly*	*24-hour*	*Annual*	*Factor*	*Hourly*	*24-hour*	*Annual*
Pollutant	*(g/hp-hr)*	*(lb/hr)*	*(lb/hr)*	*(tons/well)*	*(g/hp-hr)*	*(lb/hr)*	*(lb/hr)*	*(tons/well)*
NO_X	*4.8*	*5.0*	*3.3*	*0.06*	*2.6*	*2.7*	*1.8*	*0.03*
CO	*2.6*	*2.7*	*1.8*	*0.03*	*2.6*	*2.7*	*1.8*	*0.03*
SO_2	*0.005*	*0.005*	*0.003*	*0.00006*	*0.005*	*0.003*	*0.00006*	*0.005*
$PM_{10/2.5}$	*0.15*	*0.2*	*0.1*	*0.0018*	*0.015*	*0.0016*	*0.010*	*0.00018*
VOC	*0.14*	*0.2*	*0.1*	*0.0017*	*0.14*	*0.2*	*0.1*	*0.0017*
Benzene	*2.9E-03*	*3.0E-03*	*1.9E-03*	*3.5E-05*	*2.9E-03*	*3.0E-03*	*1.9E-03*	*3.5E-05*
Toluene	*2.1E-03*	*2.2E-03*	*1.4E-03*	*2.6E-05*	*2.1E-03*	*2.2E-03*	*1.4E-03*	*2.6E-05*
Ethylbenzene	*4.3E-04*	*4.5E-04*	*3.0E-04*	*5.3E-06*	*4.3E-04*	*4.5E-04*	*3.0E-04*	*5.3E-06*
Xylene	*1.5E-03*	*1.6E-03*	*1.0E-03*	*1.8E-05*	*1.5E-03*	*1.6E-03*	*1.0E-03*	*1.8E-05*
Formaldehyde	*1.7E-02*	*1.7E-02*	*1.1E-02*	*2.0E-04*	*1.7E-02*	*1.7E-02*	*1.1E-02*	*2.0 E-04*
n-Hexane	*2.2E-04*	*2.3E-04*	*1.5E-04*	*2.7E-06*	*2.2E-04*	*2.3E-04*	*1.5E-04*	*2.7E-06*

Each rig would be equipped with a diesel-fired boiler to provide heat and steam during cold periods. It was assumed that the boilers would run at 2.8 million British thermal units (MMBtu)/hr per boiler (20.***0*** gal/hr based on ***140***,000 Btu/gal) and operate 4,380 hr/yr. Emissions factors were taken from AP-42, Table 1.3-1 and Table 1.3-9 for distillate oil fired boilers (USEPA 1998). Emissions per rig are the product of the emission factor, fuel use, and operating time. ***SO_2 emissions are based on the use of diesel fuel with 15 ppmw sulfur content. Because*** each rig was estimated to drill 2 wells per month, the emissions per well drilled equal

the annual emissions per rig divided by 24 wells per rig. A summary of emissions from rig boilers is provided in **Table 3-21**.

Table 3-21 Pollutant Emissions from Rig Boilers per Well Drilled

Design Firing Rate = 2.8 MMBtu/hr				
= 20.0 gallons/hour[1]				
Annual Operating Hours = 4,380				
	Emission Factor	*Emission Rate*		
		Hourly	*Annual*	
Pollutant	*(lb/10³ gal)*	*(lb/hr-rig)*	*(tpy/rig)*	*(tons/well)*
NO_X	*18.0*	*0.4*	*0.8*	*0.03*
CO	*5.0*	*0.1*	*0.2*	*0.009*
SO_2	*0.2*	*0.004*	*0.009*	*0.0004*
PM_{10} ($PM_{2.5}$)	*2.0*	*0.04*	*0.09*	*0.004*
VOC	*0.34*	*0.007*	*0.01*	*0.0006*
Benzene	*2.1E-04*	*4.3E-06*	*9.4E-06*	*3.9E-07*
Toluene	*6.2E-03*	*1.2E-04*	*2.7E-04*	*1.1E-05*
Ethylbenzene	*6.4E-05*	*1.3E-06*	*2.8E-06*	*1.2E-07*
Xylene	*1.1E-04*	*2.2E-06*	*4.8E-06*	*2.0E-07*
Formaldehyde	*3.3E-02*	*6.6E-04*	*1.4E-03*	*6.0E-05*
n-Hexane	*No data*	*No data*	*No data*	*No data*

[1] Based on 140,000 Btu per gallon.

3.4.2 Criteria Pollutant Emissions from Drilling and Completion Traffic

This section is included in the Draft EIS and is not being amended in this supplement.

3.4.3 Drilling Emissions Summary

The emissions of criteria pollutants and HAP per well installed are summarized in **Table 3-26**. Note that when $PM_{2.5}$ emission factors were unavailable, PM_{10} was used as a surrogate. ***Annual emissions are presented for both Tier 2 and Tier 4 engines. The regional emissions inventory uses Tier 4 emissions because development under the project alternatives would occur after the Tier 4 implementation date. The near-field modeling uses both Tier 2 and Tier 4 emissions to evaluate impacts from both options.***

Table 3-26 Summary of Pollutant Emissions for Well Installation

	Criteria Pollutant Emissions (tons/well)					
Activity	*NO_X*	*CO*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*VOC*
Tier 2 Engines						
Drill Rig	*3.7*	*2.0*	*0.004*	*0.1*	*0.1*	*0.1*
Completion Rig	*0.06*	*0.03*	*0.00006*	*0.0002*	*0.0002*	*0.002*
Rig Boiler	*0.03*	*0.009*	*0.0004*	*0.004*	*0.004*	*0.0006*
Drill Road Traffic	*-*	*-*	*-*	*0.9*	*0.1*	*-*
Completion Road Traffic	*-*	*-*	*-*	*0.7*	*0.1*	*-*
Rig Hauling Traffic	*-*	*-*	*-*	*0.05*	*0.007*	*-*
Hauling Tailpipe	*0.05*	*0.2*	*0.002*	*-*	*-*	*0.04*
Total	*3.8*	*2.2*	*0.005*	*1.7*	*0.4*	*0.1*
Tier 4 Engines						
Drill Rig	*2.0*	*2.0*	*0.004*	*0.01*	*0.01*	*0.1*
Completion Rig	*0.03*	*0.03*	*0.00006*	*0.0002*	*0.0002*	*0.002*

Table 3-26 Summary of Pollutant Emissions for Well Installation

Activity	Criteria Pollutant Emissions (tons/well)					
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
Rig Boiler	0.03	0.009	0.0004	0.004	0.004	0.0006
Drill Road Traffic	-	-	-	0.9	0.1	-
Completion Road Traffic	-	-	-	0.7	0.1	-
Rig Hauling Traffic	-	-	-	0.05	0.007	-
Hauling Tailpipe	0.05	0.2	0.002	-	-	0.04
Total	2.1	2.2	0.006	1.6	0.3	0.1
	Hazardous Air Pollutant Emissions (tons/well)					
Activity	Benzene	Toluene	Ethylbenzne	Xylene	Formaldehyde	n-Hexane
Tier 2 and Tier 4 Engines						
Drill Rig	232E-03	1.6E-03	3.3E-04	1.1E-03	1.3E-02	1.7E-04
Completion Rig	3.5E-05	2.6E-05	5.3E-06	1.8E-05	2.0E-04	2.7E-06
Rig Boiler	3.9E-07	1.1E-05	1.2E-07	2.0E-07	6.0E-05	No data
Total	2.2E-03	1.6E-03	3.4E-04	1.1E-03	1.3E-02	1.7E-04

3.5 Production Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

3.6 Operation Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

3.7 Modeling Inventory Development for Project Alternatives

Sections 3.3 through 3.6 describe the annual emissions for each alternative per activity. However, the additional emissions from each project alternative must be calculated for the peak production year activity and spatially distributed throughout the GNBPA for modeling. The peak production year for the Proposed Action would be 2017, and for the Optimal Recovery Alternative it would be 2026. For the project alternatives, it was assumed that all wells proposed are operating at normal capacity excluding the final year of wells drilled. The wells drilled were assumed to be operating for part of the year and producing condensate at a higher rate. This reflects the last ongoing year of drilling emissions and the maximum operational emissions.

Under the Proposed Action, it was assumed that a fleet of ***15*** rigs would be operating, drilling an average of two producing wells per month, while the Optimal Recovery drilling would require *28* rigs drilling at the same rate. It was assumed that 3 percent of these wells would be dry, resulting in additional drilling emissions.

As described earlier, total emissions for production and drilling activity were the product of the proposed activity level and the emissions per activity. Finally, these emissions were spatially distributed for each alternative to specific township, range, and section based on the predicted activity in each section. The emissions per section for each alternative are summarized in **Appendix C**. These emissions are in addition to the compression emissions shown in **Tables 3-43** and **3-44**. Location of compression emissions are summarized in Chapter 4.0. **Tables 3-47** through **3-50** summarize the total project emissions (criteria pollutant and HAP) for each alternative, based on the summary of emissions provided in **Tables 3-26**, **3-35**, **3-37**, **3-39**, **3-44**, and **3-45**.

For the analysis conducted for the Draft EIS, it was assumed that a fleet of 14 rigs would operate under the Proposed Action. For this Supplement to the Draft EIS, the number of operating rigs was increased to 15 for the Proposed Action. This adjustment was due to a small change to the drilling schedule for

this alternative. Consequently, the increase in the number of operating rigs resulted in a decrease in the number of producing wells in the inventory as well as a material increase in NO_X and CO. The NO_X increased 142.1 tpy (6.8 percent), while CO increased 144.4 tpy (12.5 percent). The change in other criteria pollutants and HAPs were inconsequential.

Table 3-47 Summary of Criteria Pollutant Emissions for the Proposed Action

Activity	Scenario Description			2017 Annual Emissions (tpy)					
	Project	2017	2018	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
Drilling Activities									
Wellbores Drilled (Producing)	3,675	360	0	755.5	782.0	2.0	589.9	94.4	53.3
Wellbores Drilled (Non-producing)	91	11	0	23.1	23.9	0.1	10.1	1.7	1.7
Total Drilling Emissions[1]				778.6	805.9	2.0	600.0	96.1	54.9
Production and Operation Activities									
Producing Wells (above baseline)	3,675	3,315	3,675	394.2	354.9	14.2	384.2	83.2	6,309.4
Compression Engines				958.3	127.3	8.0	23.7	23.7	222.0
Water Tank Batteries Operating	2	2	2	0.0	0.0	0.0	0.0	0.0	9.6
Water Injection Facilities Operating	15	13	15	81.6	11.4	0.9	2.6	2.6	21.3
Total Production and Operating Emissions[1]				1,434.1	493.7	23.0	410.6	109.5	6,562.3
Total Project Emissions[1]				2,212.7	1,299.6	25.0	1,010.6	205.7	6,617.3

[1] **Totals may vary slightly due to rounding.**

Table 3-48 Summary of Criteria Pollutant Emissions for Optimal Recovery Alternative

Activity	Scenario Description			2026 Annual Emissions (tpy)					
	Project	2026	2027	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
Drilling Activities									
Wellbores Drilled (Producing)	13,446	672	0	1,230.2	1,279.6	3.4	1,100.0	175.3	89.8
Wellbores Drilled (Non-producing)	384	20	0	36.6	38.1	0.1	18.4	3.0	2.7
Total Drilling Emissions				1,266.8	1,317.7	3.5	1,118.5	178.3	92.5
Production and Operation Activities									
Producing Wells (above baseline)	13,446	12,774	13,446	1,519.1	1,367.7	54.8	1,480.6	320.6	24,312.6
Compression Engines				2,015.1	288.6	18.0	53.5	53.5	500.0
Water Tank Batteries Operating	5	5	5	0.0	0.0	0.0	0.0	0.0	33.6
Water Injection Facilities Operating	25	23	25	144.4	20.2	1.5	3.7	3.7	37.7
Total Production and Operating Emissions				3,678.6	1,676.6	74.3	1,691.3	531.3	24,883.9
Total Project Emissions				4,945.9	2,994.4	77.8	2,656.6	556.4	24,976.3

Table 3-49 Summary of Hazardous Air Pollutant Emissions for the Proposed Action

Activity	Scenario Description			2017 Annual Emissions (tpy)					
	Project	2017	2018	Benzene	Toluene	Ethyl Benzene	Xylene	Formaldehyde	n-Hexane
Drilling Activities									
Wellbores Drilled (Producing)	3,675	***360***	0	0.***8***	0.6	0.1	0.***4***	***4.6***	0.***06***
Wellbores Drilled (Non-producing)	91	***11***	0	0.02	0.02	0.***004***	0.01	0.1	0.002
Total Drilling Emissions[1]				**0.*8***	**0.6**	**0.1**	**0.*4***	***4.8***	**0.*06***
Production and Operation Activities									
Producing Wells (above baseline)	3,675	3,***315***	3,675	65.***3***	17***1.0***	12.***5***	18***4.9***	0.3	19***2.9***
Compression Engines				0.5	0.5	0.04	0.2	59.4	1.2
Water Tank Batteries Operating	2	2	2	0.2	0.2	0.***009***	0.1	***0.0***	0.5
Water Injection Facilities Operating	15	13	15	0.06	0.***05***	0.005	0.02	6.8	0.1
Total Production and Operating Emissions[1]				**66.*1***	**17*1.8***	**12.*5***	**18*5.3***	**66.*5***	**19*4.8***
Total Project Emissions[1]				**67.*0***	**17*2.4***	**12.7**	**18*5.7***	**7*1.3***	**19*4.9***

[1] Totals may vary slightly due to rounding.

Table 3-50 Summary of Hazardous Air Pollutant Emissions for Optimal Recovery Alternative

Activity	Scenario Description			2026 Annual Emissions (tpy)					
	Project	2026	2027	Benzene	Toluene	Ethyl Benzene	Xylene	Formaldehyde	n-Hexane
Drilling Activities									
Wellbores Drilled (Producing)	13,446	672	0	1.3	1.1	0.2	0.7	7.5	0.1
Wellbores Drilled (Non-producing)	384	20	0	0.04	0.04	0.006	0.02	0.2	0.003
Total Drilling Emissions				1.3	1.2	0.2	0.7	8.7	0.1
Production and Operation Activities									
Producing Wells (above baseline)	13,446	12,774	13,446	251.8	658.9	48.1	712.5	1.1	743.5
Compression Engines (bhp)		167,540		1.1	1.0	0.1	0.5	135.6	2.9
Water Tank Batteries Operating	5	5	5	0.8	0.8	0.003	0.5	-	1.8
Water Injection Facilities Operating	25	23	25	0.1	0.09	0.009	0.04	12.1	0.3
Total Production and Operating Emissions				253.9	660.9	48.3	713.5	148.8	748.4
Total Project Emissions				255.2	662.1	48.5	714.1	156.5	748.5

4.0 Modeling Procedures

This section is included in the Draft EIS and is not being amended in this supplement.

4.1 CALPUFF Modeling

This section is included in the Draft EIS and is not being amended in this supplement.

4.2 CMAQ Ozone Modeling

This section is included in the Draft EIS and is not being amended in this supplement.

4.3 AERMOD Near-field Modeling

The near-field ambient air quality impacts on NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$ were assessed in the vicinity of the proposed project using USEPA's guideline model of assessing near-field impacts, AERMOD (Version ***09292***). AERMOD was executed using the USEPA-default recommended settings. Emissions sources that were associated with the project development and included in the near-field AERMOD analysis consisted of activities associated with drill rigs, compressor stations, single pad construction, and the actual producing well. These operations require the use of diesel engines with the capability of producing air emissions, which potentially could have an impact on surrounding air quality. ***The air quality assessment addresses impacts associated with emissions from both Tier 2 and Tier 4 engines.***

AERMOD (USEPA 2004) was adopted by USEPA in a final rule (FR November 9, 2005) that replaced the ISC model with AERMOD, effective on December 9, 2005. The AERMOD model was developed by the AERMIC work group (the American Meteorological Society/USEPA Regulatory Model Improvement Committee) and was intended to incorporate improved understanding of PBL meteorology into air dispersion calculations. The current version of AERMOD is ***09292*** and includes the PRIME (Plume Rise Model Enhancement) building downwash algorithms. The AERMOD modeling system consists of two preprocessors and the dispersion model. AERMET is the meteorological preprocessor component and AERMAP is the terrain pre-processor component that characterizes the terrain and generates receptor elevations along with critical hill heights for those receptors. The AERMOD model runs reported in this section used the 5-year meteorological database.

4.3.1 Criteria Pollutant Analysis

The near-field impacts were assessed to quantify air quality impacts related to the density of well pad development and drill rig operations within a hypothetical designated area (e.g., a section/township/range). Near-field impacts were addressed for NO_X, CO, SO_2, PM_{10}, and $PM_{2.5}$ within the immediate vicinity of these development areas. The AERMOD modeling analysis consisted of three phases: 1) single source impact analysis, 2) well pad production analysis, and 3) well drilling analysis.

For the newly promulgated 1-hour SO_2 and 1-hour NO_2 NAAQS modeling, special modeling techniques were needed beyond what was required for the other pollutants. USEPA's Guideline on Air Quality Models (USEPA 2005b) provides a tiered approach for modeling NO_2 that provides for increased levels of refinement for the treatment of the in-plume conversion of nitric oxide (NO) to NO_2. For this analysis, a Tier 3 approach was followed, as discussed in the June 2010 USEPA Clarification Memo regarding the application of AERMOD for 1-hour NO_2 modeling (USEPA 2010a). The Tier 3 approach involves using the Plume Volume Molar Ratio Method (PVMRM), which computes the available moles of ozone to combine with the moles of NO. The moles of ozone available to combine with the in-plume moles of NO are restricted to the plume cross-sectional area at each downwind distance considered. The PVMRM option appears to provide a more realistic treatment of the conversion of NO to NO_2 as a function of distance downwind from the source than the Ozone Limiting Method (OLM) or the other NO_2 screening options. Because PVMRM better simulates the NO to NO_2 conversion chemistry during

plume expansion, it is particularly well suited for near-field receptors and, therefore, simulating the project sources where the maximum modeled NO_X concentrations would occur near the stacks. In addition, unlike OLM, PVMRM is designed to work with either single or multiple plumes as is the case for the project.

The application of AERMOD with PVMRM requires specification of the equilibrium ratio and the in-stack NO_2/NO_X ratio. The default equilibrium ratio for the NO_2/NO_X ratio in AERMOD of 0.90 was used and the in-stack NO_2/NO_X ratio of 0.1 was used. The use of the 0.1 in-stack ratio is supported by stack-test data as provided in Appendix B.

PVMRM requires the use of hourly ozone data with concurrent meteorological data to approximate the rate of conversion of NO to NO_2. The current meteorological inputs to AERMOD are based on the years 2002 through 2006. Since the ozone monitoring near the GNBPA did not begin until July 2009, concurrent hourly ozone monitoring data are not available from either the Ouray or Redwash monitors. Therefore, a diurnal profile of hourly ozone background concentrations was developed for the Ouray and Redwash monitors for each season defined as follows:

- ***Winter – December, January, February, and March;***
- ***Spring – April and May;***
- ***Summer – June, July, August; and***
- ***Fall – September, October, and November.***

For each of these seasons at each monitor, the highest monitored concentration for each hour of the day was selected to represent all of the hours for the entire season. The ozone data indicates that the Ouray winter peak value is slightly higher than other seasons, but the other seasons are comparable in trend and magnitude. The diurnal values developed for the Ouray monitor were used to develop a full year of hourly ozone values for each season because it is closest to the GNBPA. Figure 4-6.1 shows the diurnal profile of hourly ozone used in this study.

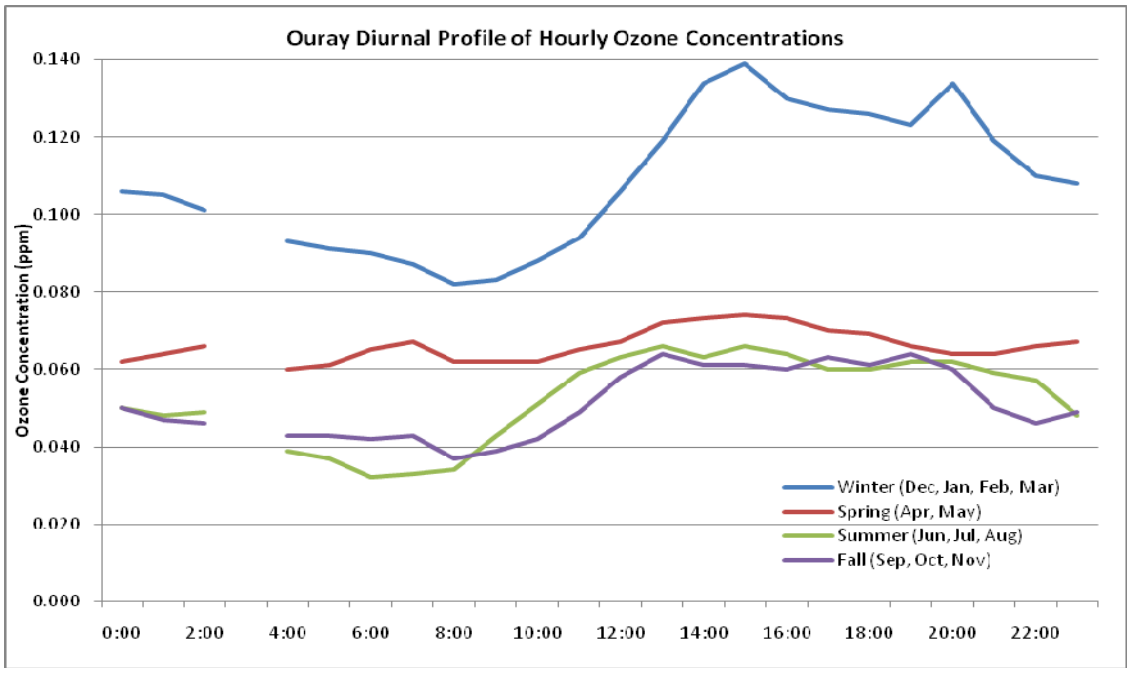


Figure 4-6.1 Ouray Diurnal Ozone Profile of Maximum Hourly Values by Season

The 5-year average of the 98th percentile highest daily 1-hour maximum modeled NO_2 concentrations was computed and added to the representative 1-hour NO_2 background concentration to determine compliance with the 1-hour NO_2 NAAQS. The 5-year average of the 99th percentile highest daily 1-hour maximum modeled SO_2 concentrations was computed and added to the representative 1-hour SO_2 background concentration to determine compliance with the NAAQS. Background concentrations are discussed in Section 2.3.

4.3.1.1 Single Source *Group* Impact Analysis

The single source impact analysis was designed to assess the near-field impacts from each type of project source individually. AERMOD was run for each of the following types of project sources: 1) a compressor station; 2) a drill rig ***consisting of 2 drill rig engines, a completion rig, and a rig boiler*****;** and 3) a production well. A uniform polar grid of receptors was placed in a radial fashion around the modeled source every 100 m starting at 100 m downwind out to 2,000 m with radials every 10°. **Figure 4-7** shows the source/receptor setup used for the single source impact analysis, and **Table 4-6** lists the emission and modeling parameters for each source assessed ***for Tier 2 and Tier 4 engines***.

Emissions for a compressor station were calculated based on the assumption of 3 separate compressor engines with 1,340 bhp engine capacity, equivalent to 9.38 MMBtu/hour each. Compressor stations were assumed to operate 8,760 hours per year, and used emission factors that were provided in **Tables 3-40** through **3-42**.

Short-term emissions for drilling operations were based on the emissions from one well including a drill rig ***(two rig engines), a completion rig,*** and a rig boiler. **Tables 3-20** and **3-21** provide a summary of short-term and annual emissions from these sources. Fugitive emissions from well drilling and completion road traffic were not included because of the dispersed and temporary nature of the source. For addressing impacts, the wells were aggregated as discussed above.

Emissions from production wells included the separator heater for short-term emissions (**Table 3-28**) and included both that unit and the fugitive emissions from production traffic for annual emissions (**Tables 3-28** and **3-31**). For modeling impacts, the wells were aggregated over a square mile, as discussed above.

For the single source near-field analysis, building downwash and receptor terrain elevations were ignored largely due to the uncertainty in location and orientation of each source relative to terrain and buildings. These assumptions should not have a measurable impact on the overall modeling results because the terrain within the immediate vicinity of these sources likely would be relatively flat and there are few buildings or structures associated with these project sources.

Modeling results for the AERMOD single source impact analysis were tabulated for NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. No distinction was made between the short-term and annual modeling scenarios because it was assumed that these sources could operate 8,760 hours per year. The results of this analysis ***are*** reported in ***Chapter 5.0***.

4.3.1.2 Well Pad Production Analysis

The well pad production analysis was designed to assess air quality impacts related to the density of well pad production within a hypothetical square mile section/township/range for three production density levels. Well pad density was assessed at 10-acre spacing, 20-acre spacing, and 40-acre spacing. For example, the 10-acre spacing well pad production scenario contained producing well pads that were spaced uniformly at 10-acre intervals throughout the hypothetical square mile section. For each well pad scenario, a compressor station was placed in the middle of each producing field of well pads.

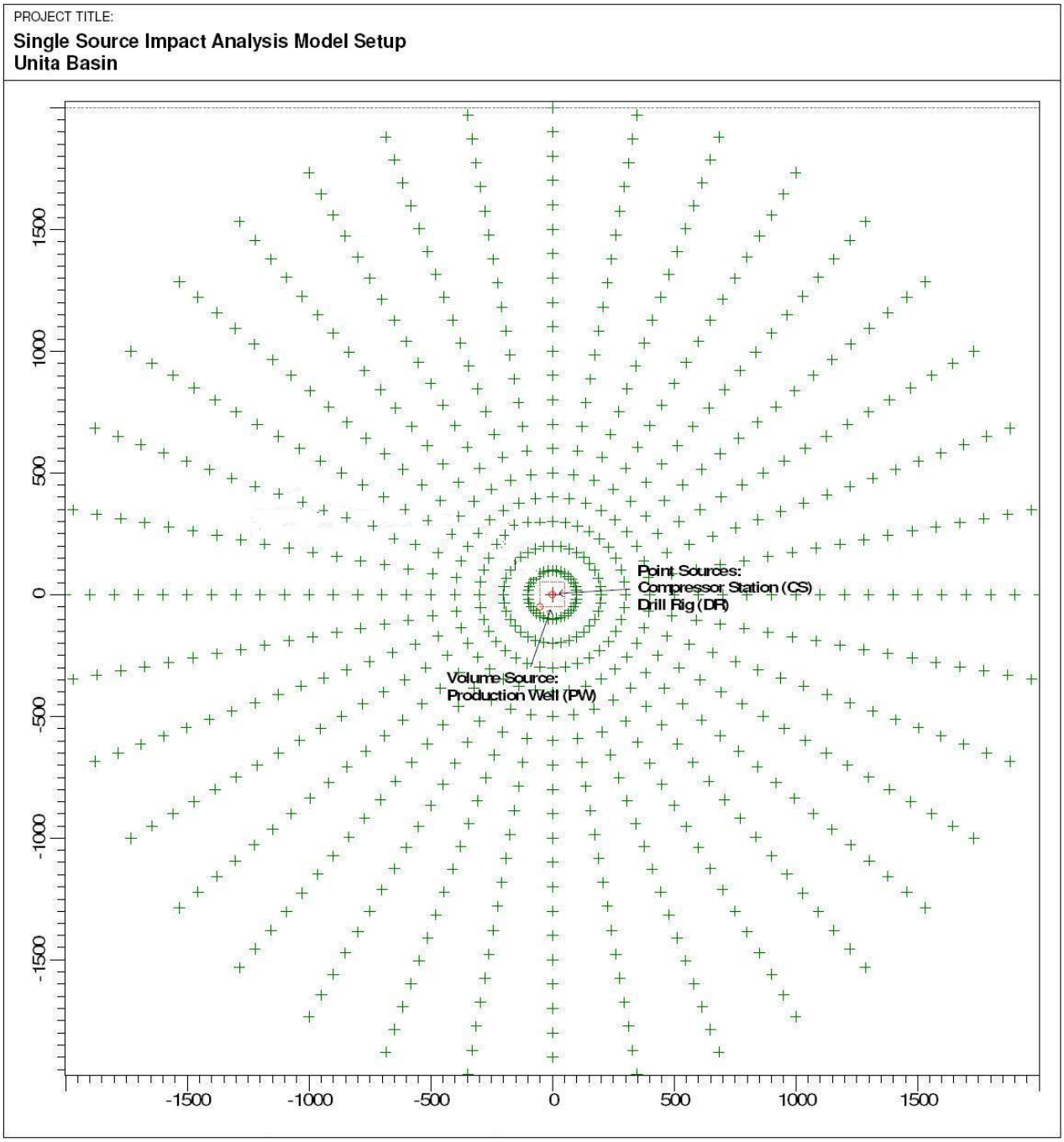


Figure 4-7 Single Source Impact Analysis Model Setup and Receptor Location

Table 4-6 Project Source Modeling Parameters and Emission Rates

Tier 2 Engines

Point Source Parameters

ID	Activity	Operating Hours (hr/day)	Emission Rate per activity (g/s)											Stack Parameters[1]				
			NO_X		CO		SO_2				PM_{10}	$PM_{2.5}$		Stack	H	V	T	D
			1-hr	Annual	1-hr	8-hr	1-hr	3-hr	24-hr	Annual	24-hr	24-hr	Annual	Orientation	(m)	(m/s)	(K)	(m)
CS	Compressor Station	24	1.68	1.68	0.19	0.19	0.012	0.012	0.012	0.012	0.14	0.14	0.14	Vertical	10.0	51.1	755	0.30
DR	Drill Rig	24	1.97	0.10	1.07	1.07	0.002	0.002	0.001	0.0001	0.04	0.04	0.003	Vertical	6.1	71.7	672	0.25
CR	Completion Rig	12	0.63	0.002	0.34	0.34	0.0006	0.0006	0.0002	0.000002	0.006	0.006	0.00005	Vertical	3.0	101.5	770	0.13
RB	Rig Boiler	24	0.04	0.02	0.01	0.01	0.0005	0.0005	0.0005	0.0003	0.005	0.005	0.002	Vertical	4.0	5.3	450	0.39

Volume Source Parameters

ID	Activity	Operating Hours (hr/day)	Emission Rate per activity (g/s)											Source Dimensions[1]			Release Parameters[1]		
			NO_X		CO		SO_2				PM_{10}	$PM_{2.5}$		W	Area	H	σ_y-init	σ_z-init	H_r
			1-hr	Annual	1-hr	8-hr	1-hr	3-hr	24-hr	Annual	24-hr	24-hr	Annual	(m)	(m^2)	(m)	(m)	(m)	(m)
PW	Production Well	24	0.0066	0.0033	0.0056	0.0056	0.00022	0.00022	0.00022	0.00011	0.00050	0.00050	0.00056	71.1	5,058.5	5	16.54	2.33	2.50

Tier 4 Engines

Point Source Parameters

ID	Activity	Operating Hours (hr/day)	Emission Rate per activity (g/s)											Stack Parameters[1]				
			NO_X		CO		SO_2				PM_{10}	$PM_{2.5}$		Stack	H	V	T	D
			1-hr	Annual	1-hr	8-hr	1-hr	3-hr	24-hr	Annual	24-hr	24-hr	Annual	Orientation	(m)	(m/s)	(K)	(m)
CS	Compressor Station	24	1.68	1.68	0.19	0.19	0.012	0.012	0.012	0.012	0.14	0.14	0.14	Vertical	10.0	51.1	755	0.30
DR	Drill Rig	24	1.07	0.06	1.07	1.07	0.002	0.002	0.001	0.0001	0.004	0.004	0.0003	Vertical	6.1	71.7	672	0.25
CR	Completion Rig	12	0.34	0.0009	0.34	0.34	0.0006	0.0006	0.0002	0.000002	0.0006	0.0006	0.000005	Vertical	3.0	101.5	770	0.13
RB	Rig Boiler	24	0.04	0.02	0.01	0.01	0.0005	0.0005	0.0005	0.0003	0.005	0.005	0.002	Vertical	4.0	5.3	450	0.39

Volume Source Parameters

ID	Activity	Operating Hours (hr/day)	Emission Rate per activity (g/s)											Source Dimensions[1]			Release Parameters[1]		
			NO_X		CO		SO_2				PM_{10}	$PM_{2.5}$		W	Area	H	σ_y-init	σ_z-init	H_r
			1-hr	Annual	1-hr	8-hr	1-hr	3-hr	24-hr	Annual	24-hr	24-hr	Annual	(m)	(m^2)	(m)	(m)	(m)	(m)
PW	Production Well	24	0.0066	0.0033	0.0056	0.0056	0.00022	0.00022	0.00022	0.00011	0.00050	0.00050	0.00056	71.1	5,058.5	5	16.54	2.33	2.50

[1] Units for dimensions and parameters

H = height
V = vertical exhaust speed
T = temperature
D = diameter
W = width
Hr = height of release

This design allowed for the allocation of the following number of producing wells per scenario:

- 10-acre spacing → 64 production wells, 1 compressor station;
- 20-acre spacing → 32 production wells, 1 compressor station; and
- 40-acre spacing → 16 production wells, 1 compressor station.

The production wells were evenly spaced throughout the hypothetical square mile section centered on the compressor station. Uniformly spaced Cartesian receptors were placed throughout the hypothetical square mile section at 100-m intervals. Each source had a 100-m buffer to the nearest receptor point to minimize the impact of extremely localized high model predictions. **Figures 4-8** through **4-10** depict the source/receptor model setup for each of the three well pad production scenarios. The compressor station and production well emissions and modeling parameters used to develop each well pad production scenario are provided in **Table 4-6**.

As in the single source near-field analysis, building downwash and receptor terrain elevations were ignored largely due to the uncertainty in location and orientation of each source relative to terrain and buildings. These assumptions should not have an impact on the overall modeling results because the terrain within the immediate vicinity of these sources likely would be relatively flat and there are few buildings or structures associated with these project sources.

Modeling results for the AERMOD well pad production analysis were tabulated for NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. No distinction was made between the short-term and annual modeling scenarios because it was assumed that these sources could operate 8,760 hours per year. The results of this analysis were reported in Chapter 5.0.

4.3.1.3 Well Drilling Analysis

The well drilling analysis was designed to assess air quality impacts related to the drilling operations at the well pad site. ***Modeling was conducted over the short term to address the new 1-hour standards and over a 1-year time frame to address other criteria pollutant standards, as described below.***

Short-term modeling was conducted using four well pad sites, all with simultaneous drilling operations. Specifically, one drill rig with two drill rig engines, a completion rig, and a rig boiler were all assumed to be operating continuously at the same time at each well pad site. The four well pads were centered in a 2 x 2 array in the center of the section. For all alternatives, five surface spacing scenarios were evaluated to determine predicted ambient air quality impacts from the simultaneous operation of multiple rigs within a section. The pads were placed at intervals of 400 m, 500 m, 600 m, 700 m, and 800 m between the centers of the pads. The 400-m interval is equivalent to the maximum density of a 40-acre surface spacing, while the 800-m interval is equivalent to half-mile spacing. For this analysis, it also was assumed that the four well pads would actively drill simultaneously within a given day, which is conservative and would capture the peak impacts that could occur at any downwind receptor.

For annual impacts, emissions from the drill rig (two drill rig engines), completion rig, and rig boiler were modeled over a 1-year time frame. For the project alternatives, it was assumed that the maximum downhole spacing was 10 acres (64 wells per section); however, the surface spacing of the wells varies by alternative. A 40-acre surface spacing (16 pads per section) represents a worst-case scenario for this analysis because of the denser concentration of emission sources. Therefore, the annual modeling was based on the emissions from 64 wells drilled in a section, with 4 wells drilled at each of the 16 well pads.

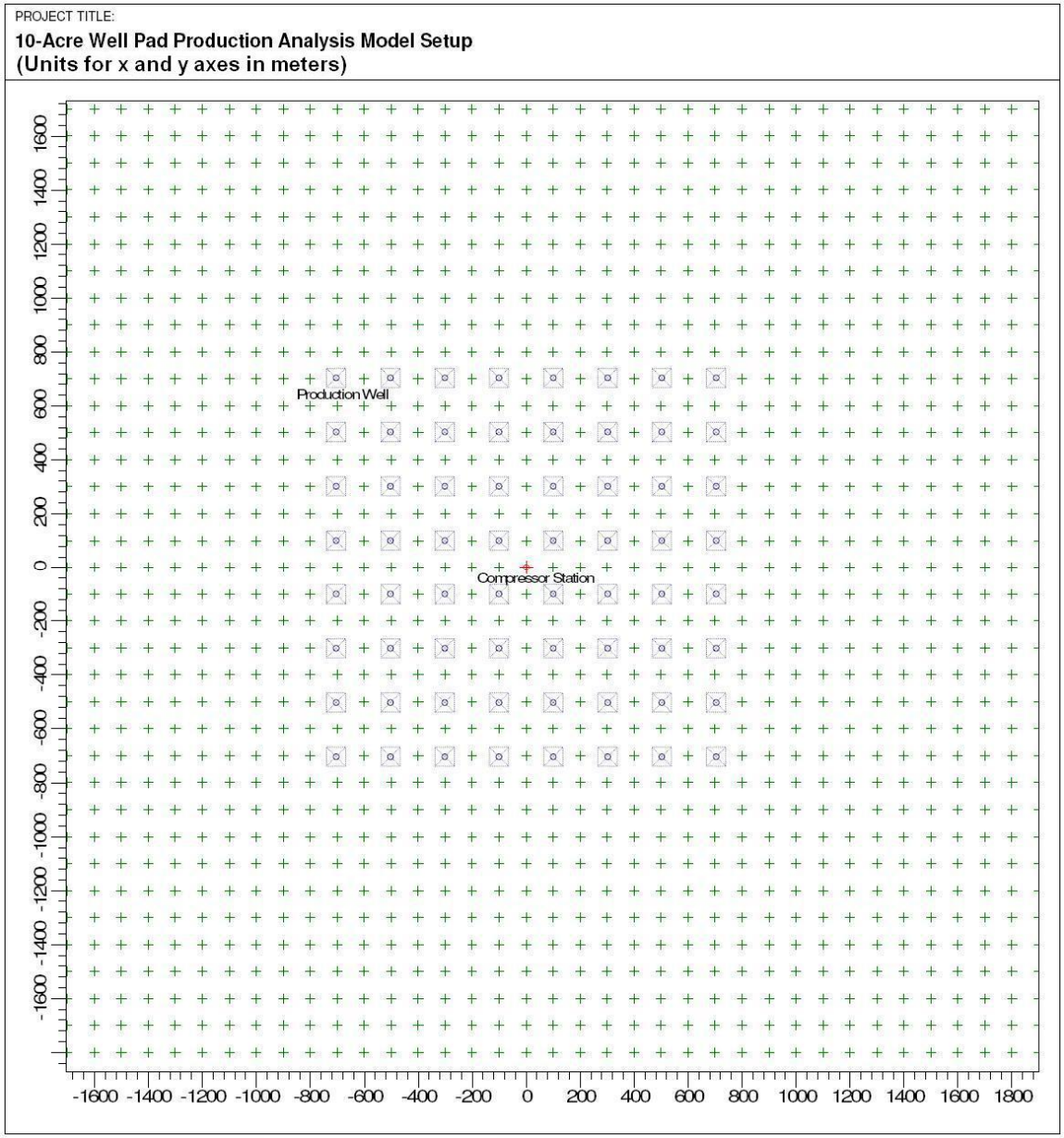


Figure 4-8 10-Acre Well Pad Production Analysis Model Setup and Receptor Location

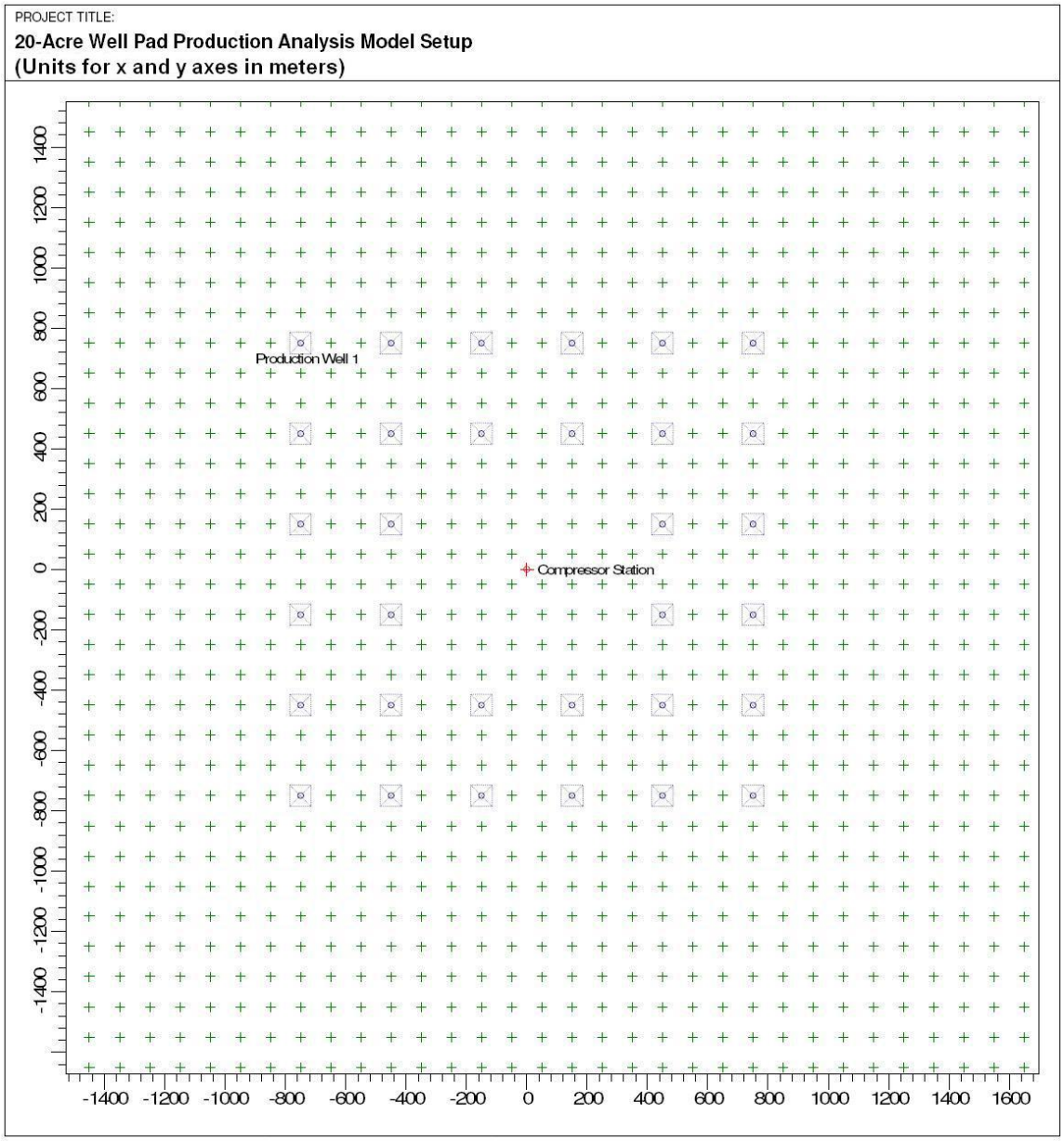


Figure 4-9 20-Acre Well Pad Production Analysis Model Setup and Receptor Location

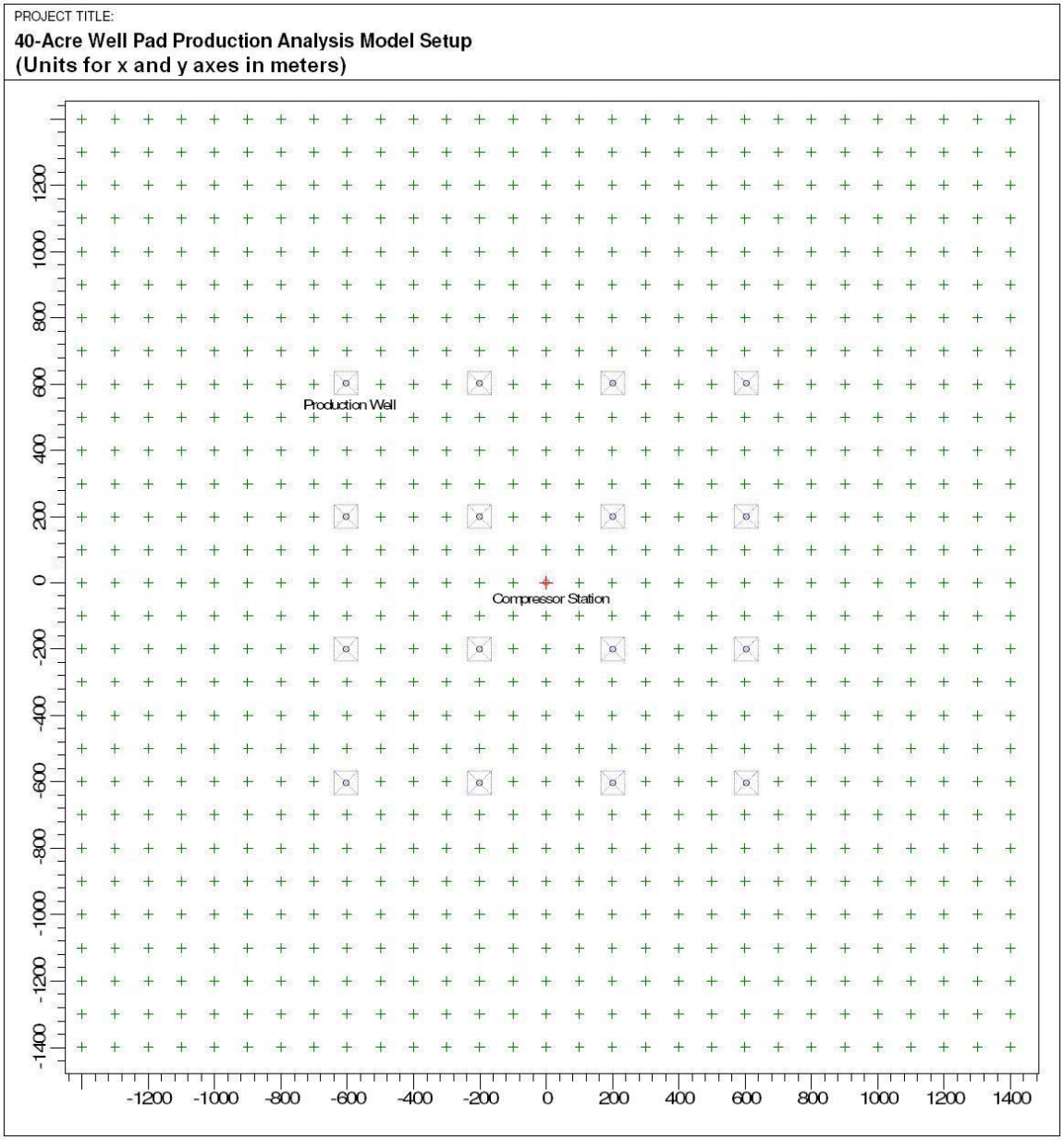


Figure 4-10 40-Acre Well Pad Production Analysis Model Setup and Receptor Location

Uniformly spaced Cartesian receptors were placed throughout the hypothetical section at 100-m intervals. Each source had a 100-m buffer to the nearest receptor point to minimize the impact of extremely localized high model predictions. **Figures 4-11*.1 through 4-11.5*** show examples of the source/receptor model setup for the ***five surface spacing scenarios evaluated for the*** short-term well pad construction analysis, ***and Figure 4-12 shows an example of the setup for the annual analysis***. **Table 4-6** provides modeling parameters and emission rates for drilling, which includes emissions from the drill rig, single pad construction, and drilling/completion mobile equipment emissions.

As in the previous analyses, building downwash and receptor terrain elevations were ignored largely due to the uncertainty in location and orientation of each source relative to terrain and buildings. These assumptions should not have an impact on the overall modeling results because the terrain within the immediate vicinity of these sources likely would be relatively flat and there are few buildings or structures associated with these project sources.

Modeling results for the AERMOD well pad construction analysis were tabulated for NO_X, CO, SO_2, PM_{10}, and $PM_{2.5}$. The results of this analysis are reported in ***Chapter 5.0***.

4.3.2 Meteorological Data Development

This section is included in the Draft EIS and is not being amended in this supplement.

4.3.3 HAPS Analysis

The ambient air concentration of selected HAPs was evaluated by modeling the emission rates for HAPs listed in Table 4-7. The HAP modeling analysis employed the same key elements of the modeling analysis as for modeling the criteria pollutants, such as:

- ***AERMOD (Version 09292);***
- ***5 years of hourly meteorological data, 2002-2006 consisting of surface observations from Vernal, Utah, and upper air data from Salt Lake City, Utah;***
- ***Assumed flat terrain; and***
- ***No building downwash.***

AERMOD was run for all scenarios outlined in Section 4.3.1 using the 5 years of meteorological data to estimate air concentrations of formaldehyde, benzene, toluene, ethyl benzene, xylene(s), and n-hexane. The maximum modeled concentrations over the 5-year period for each applicable HAP/averaging period (i.e., annual and 24-hour) was compared to the Toxic Screening Level (TSLs) and Reference Concentrations for Chronic Inhalation (RfCs). See Chapter 5.0 for this comparison.

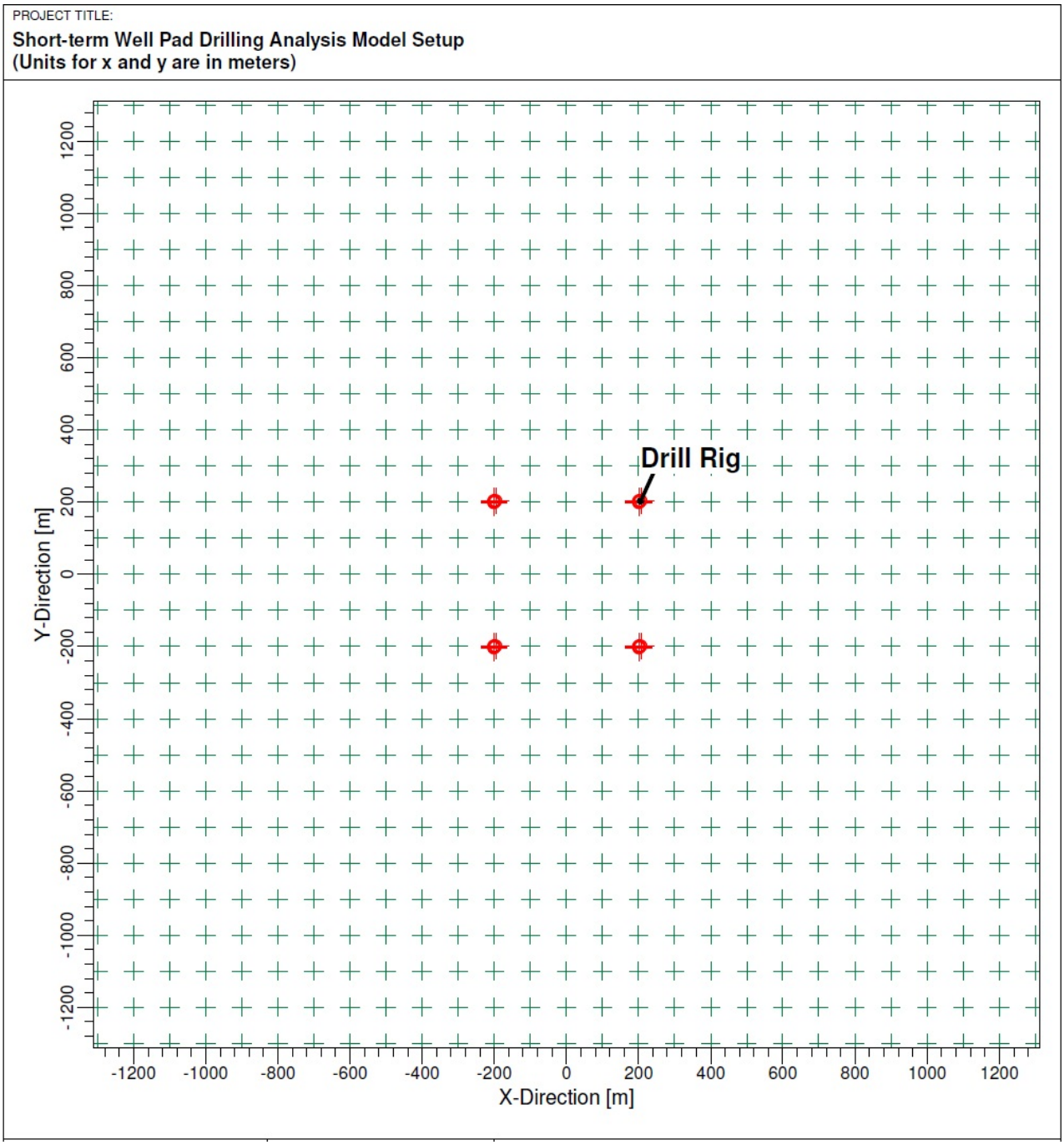


Figure 4-*11.1* Short-term Drill Rig Analysis Model Setup and Receptor Location *(400-m spacing)*

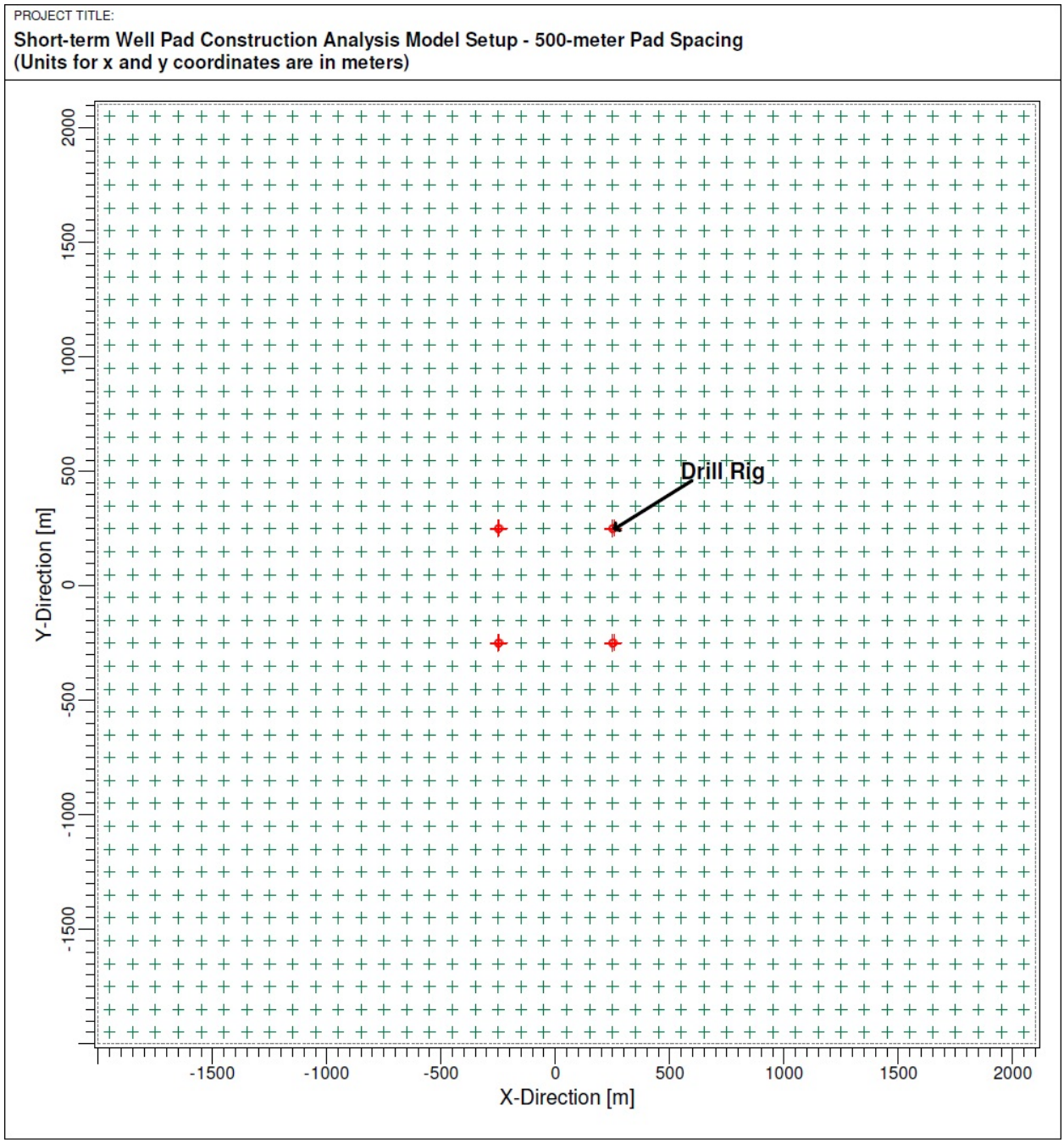


Figure 4-11.2 Short-term Drill Rig Analysis Model Setup and Receptor Location (500-m spacing)

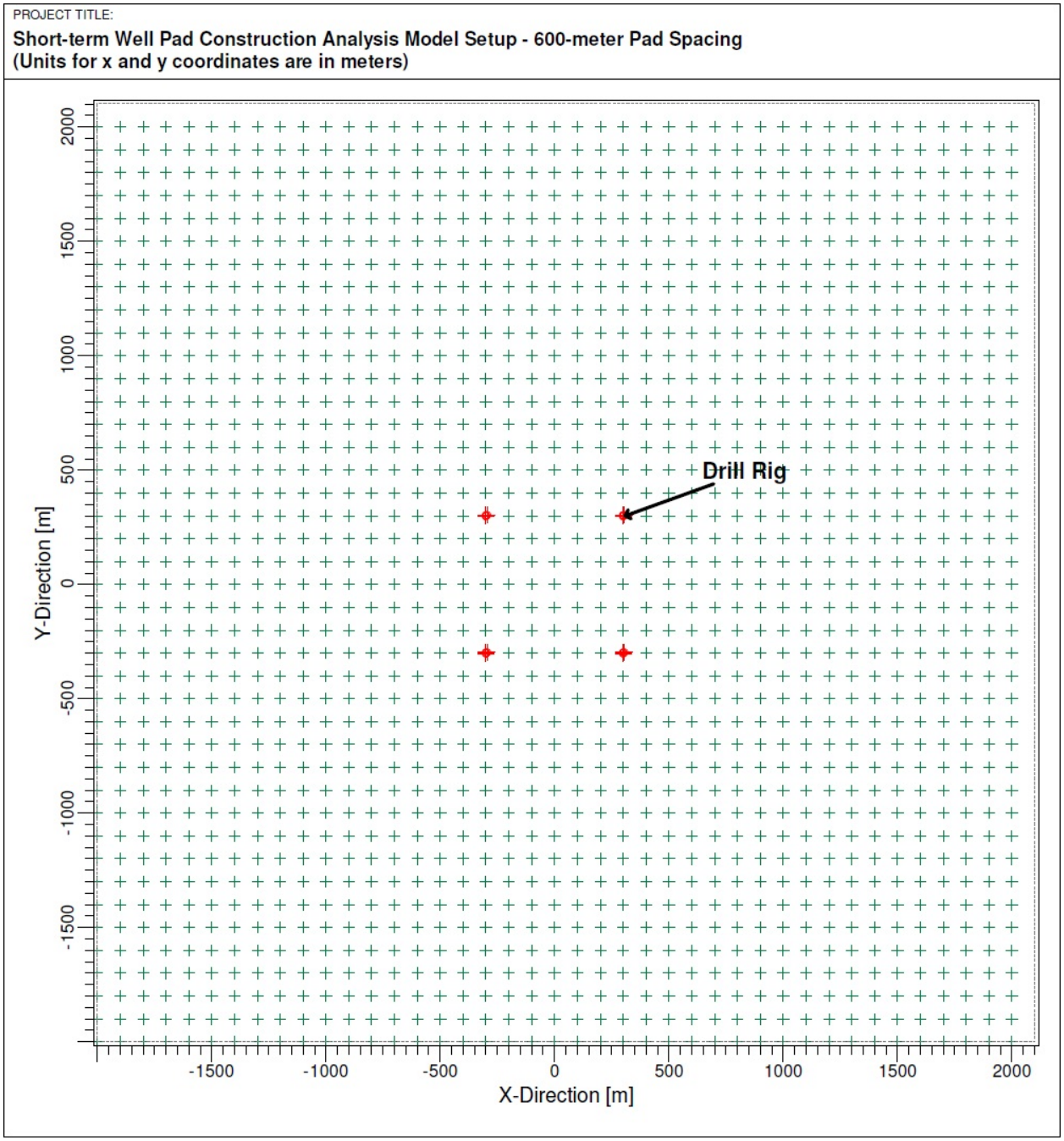


Figure 4-11.3 Short-term Drill Rig Analysis Model Setup and Receptor Location (600-m spacing)

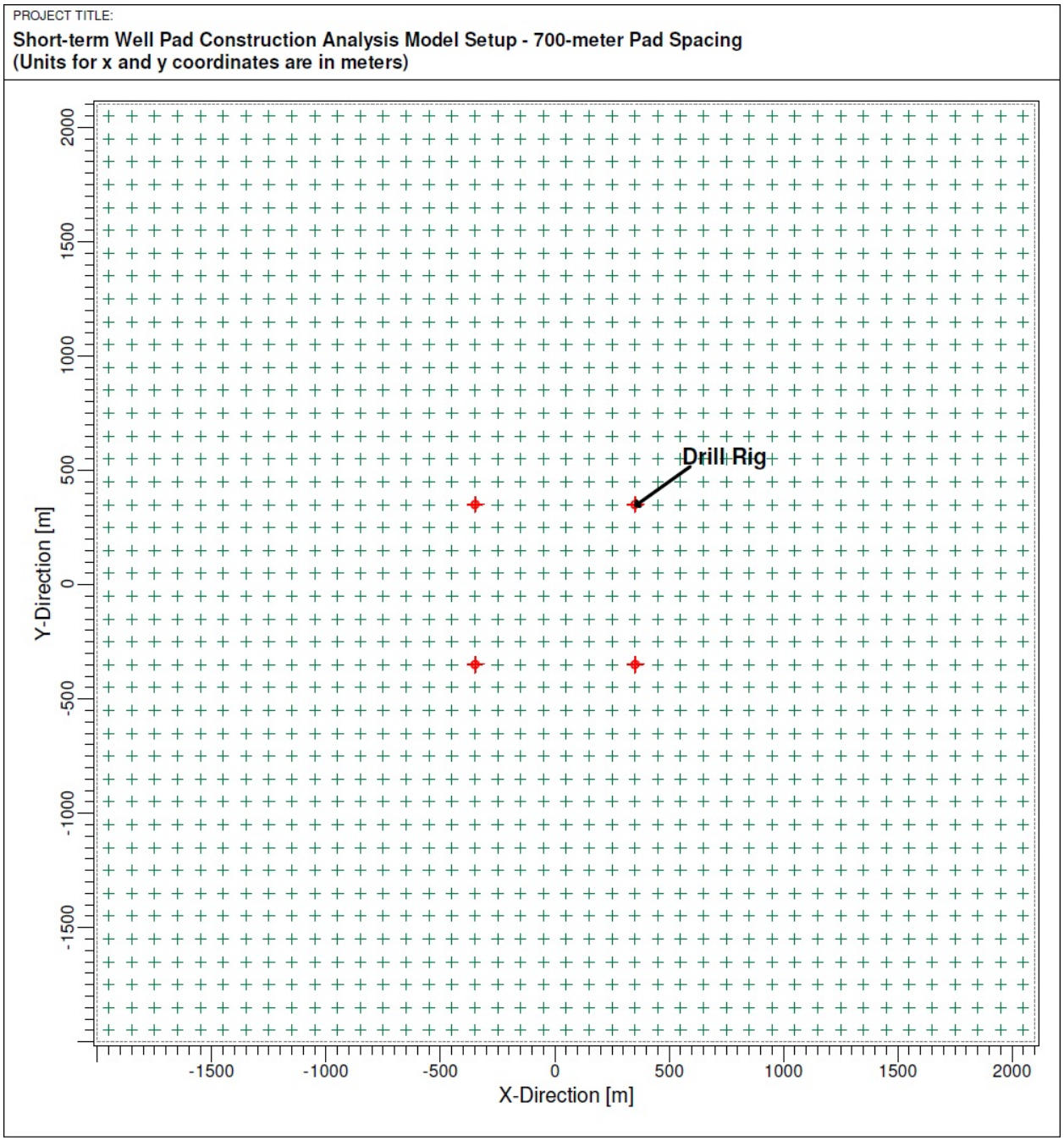


Figure 4-11.4 Short-term Drill Rig Analysis Model Setup and Receptor Location (700-m spacing)

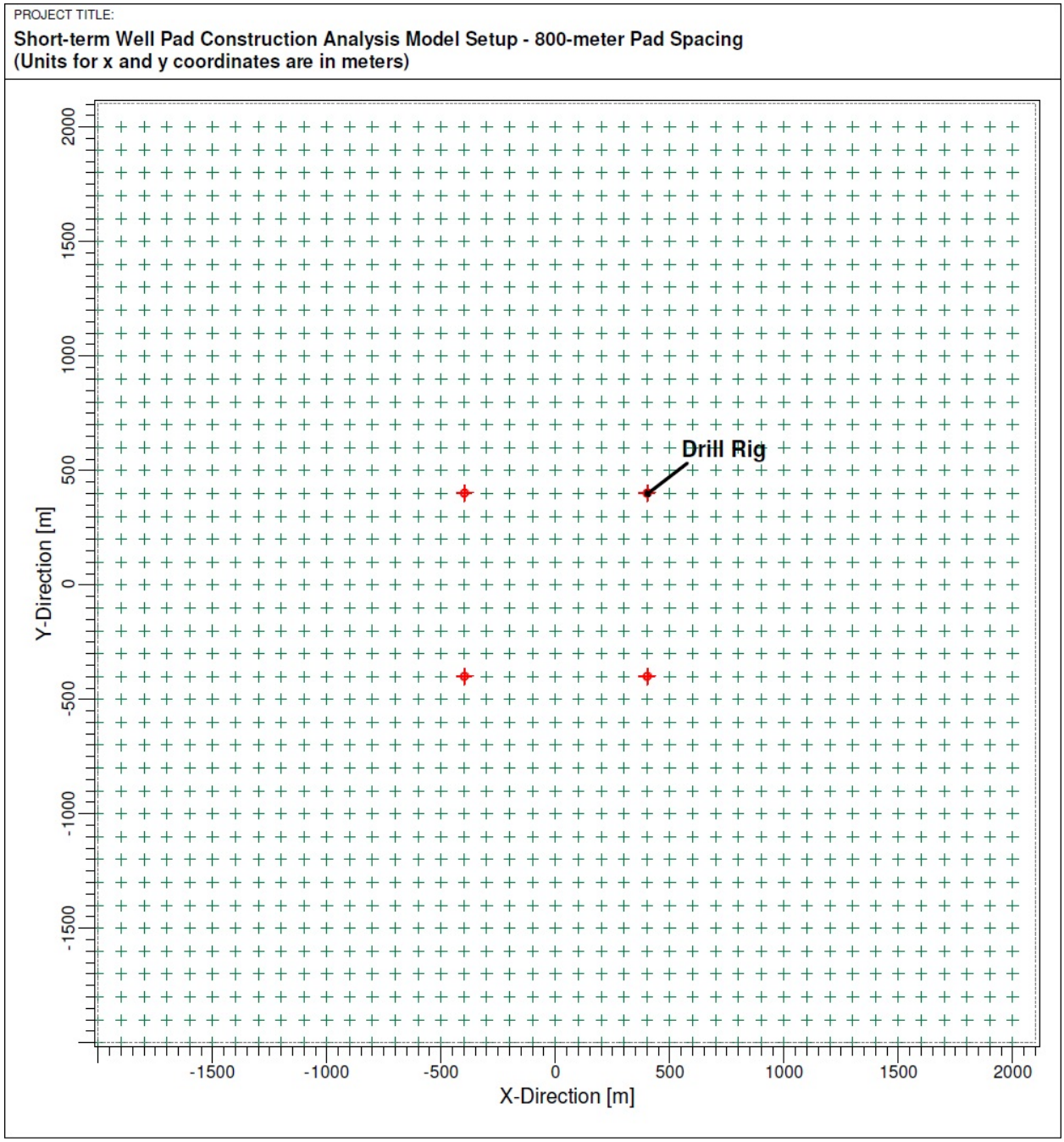


Figure 4-11.5 Short-term Drill Rig Analysis Model Setup and Receptor Location (800-m spacing)

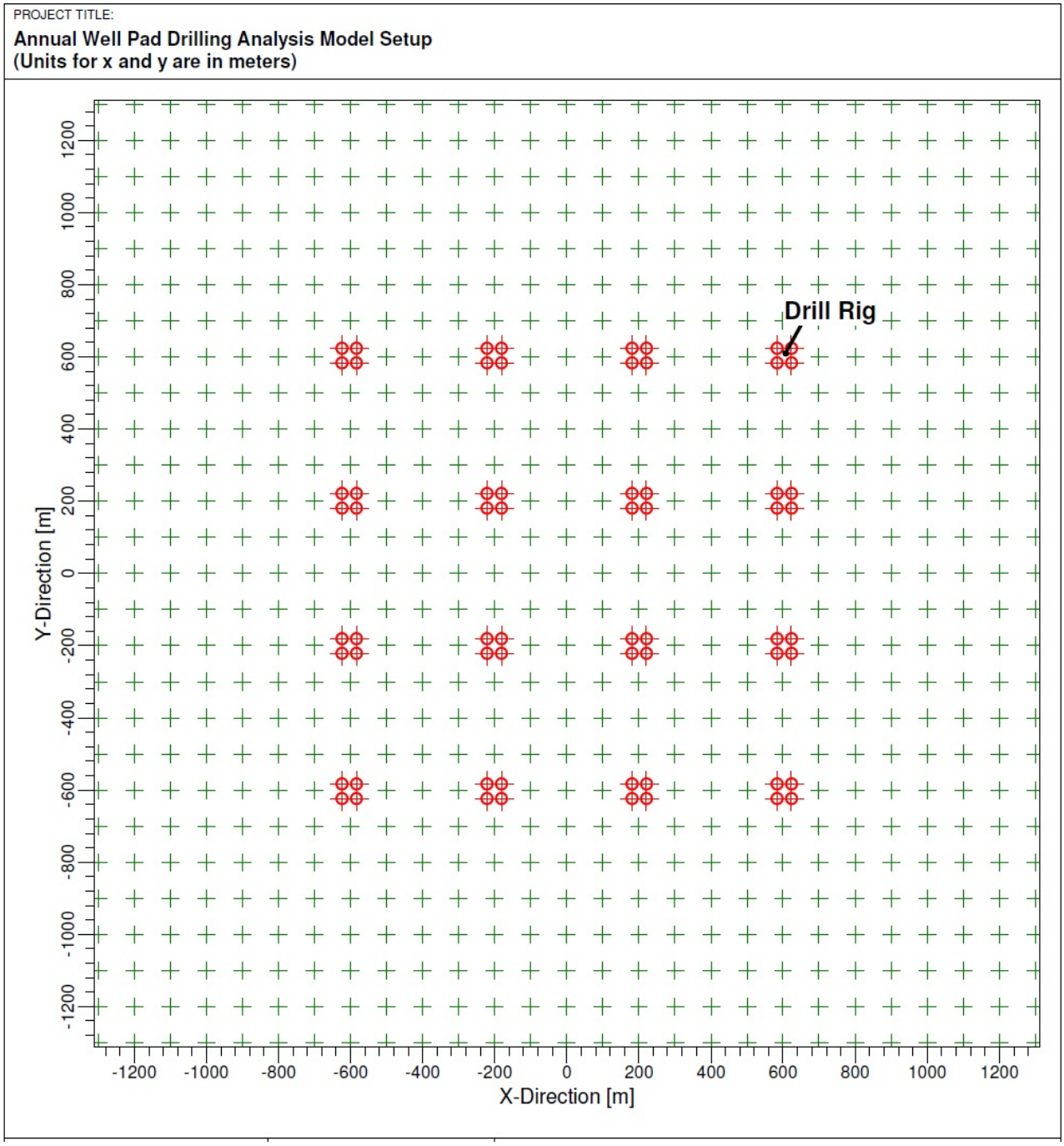


Figure 4-12 Annual Drill Rig Analysis Model Setup and Receptor Location

Table 4-7 HAP Emission Rates

Activity	Operating Hours (hr/day)	Emission Rate per activity (g/s)											
		Benzene		Toluene		Ethyl Benzene		Xylene		Formaldehyde		n-Hexane	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
Compressor Station	24	1.56E-03	1.56E-03	1.45E-03	1.45E-03	1.41E-04	1.41E-04	6.52E-04	6.52E-04	1.87E-01	1.87E-01	3.94E-03	3.94E-03
Drill Rig	24	7.59E-04	6.24E-05	5.58E-04	4.59E-05	1.16E-04	9.51E-06	3.95E-04	3.25E-05	4.41E-03	3.62E-04	5.94E-05	4.88E-06
Completion Rig	12	1.22E-04	1.00E-06	8.99E-05	7.39E-07	1.86E-05	1.53E-07	6.35E-05	5.22E-07	7.09E-04	5.83E-06	9.55E-06	7.85E-08
Rig Boiler	24	4.49E-08	1.12E-08	1.56E-05	3.25E-07	1.56E-05	3.34E-09	1.60E-07	5.72E-09	2.75E-07	1.73E-06	0	0
Production Well	24	1.29E-03	1.26E-03	2.99E-03	2.95E-03	7.96E-05	1.37E-04	2.23E-03	2.18E-03	5.55E-04	5.53E-04	3.65E-03	3.63E-03

5.0 Assessment and Reporting of Air Quality Impacts

This section is included in the Draft EIS and is not being amended in this supplement.

5.1 CALPUFF Impact Assessment for Class I and Sensitive Class II Areas

This section is included in the Draft EIS and is not being amended in this supplement.

5.2 CMAQ Ozone Impact Assessment

This section is included in the Draft EIS and is not being amended in this supplement.

5.3 AERMOD Impact Assessment for Near-Field Receptors

5.3.1 Criteria Pollutant Analysis

The near-field impacts from the proposed project were assessed using procedures described in Section 4.3 to quantify air quality impacts related to the density of well pad development and drill rig operations within a hypothetical designated square mile area (e.g., a section/township/range). Near-field impacts were addressed for NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$ within the immediate vicinity of these development areas using the 5 years of meteorological data. The AERMOD modeling approach consisted of three phases: 1) single source ***group*** impact analysis, 2) well pad production analysis, and 3) well drilling analysis.

The AERMOD modeled impacts were compared to the PSD Class II increments because they represent a convenient quantitative measure to evaluate the air quality impacts of the proposed project. In addition to reporting modeled concentrations alone, total impacts were assessed for compliance with the NAAQS and SAAQS by adding the modeled concentrations for the applicable averaging periods to their appropriate counterpart of background air quality data. These totals were compared to the applicable NAAQS for NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. As a conservative approach, the NO_X adjustment option based on the ambient ratio method (40 CFR 51, Appendix W), which assumes a conversion rate of 75 percent, was not used for the ***annual*** NO_X to NO_2 conversion rate.

Tables 5-11 through **5-13** contain the AERMOD maximum modeled concentrations over the 5 meteorological modeled years for NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$ for representative source types. The modeled impacts plus the background air quality concentrations were compared to the applicable NAAQS/SAAQS. Background air quality data were obtained as described in Chapter 2.0 for this analysis.

Table 5-11 provides a summary of maximum modeled impacts of these criteria air pollutants for three separate point source types. **Table 5-12** provides similar summaries for well pad production operations at various well densities, as described in the table. **Table 5-13** provides a summary of annualized and short-term impacts for ***well pad drilling***, as discussed in Section 4.3.1.3. The results in **Tables 5-11** through **5-13** show that total concentrations for all source types for all pollutants are below the applicable NAAQS/SAAQS***, with the exception of 1-hour NO_2 for the well drilling analyses***.

Table 5-11 AERMOD Near-field *Criteria Pollutants* Assessment Modeling Result Summary – Single Source Impact Analysis

Pollutant Average Time	Maximum Model Concentration by Source[1] (µg/m^3)			Background Concentration (µg/m^3)	Total Concentration by Source[1] (µg/m^3)			NAAQS (µg/m^3)	PSD Increments (µg/m^3)
	Compressor Station	Drill Rig[2]	Production Well		Compressor Station	Drill Rig	Production Well		
NO_2									
1-hour[3]	***37.56***	***114.8 (93.6)***	***22.97***	***69.6***	***107.2***	***184.4 (163.2)***	***92.6***	***188***	**--**
Annual[4]	2.53	***0.5 (0.3)***	1.58	***8.0***	***10.5***	***8.5 (8.3)***	***9.6***	100	25
CO									
1-hour	***13***	***329***	***22***	6,325	6,33***8***	***6,654***	6,34***7***	40,000	--
8-hour	***7***	***240***	***17***	3,910	3,91***7***	4,***150***	3,92***7***	10,000	--
SO_2									
1-hour[5]	***0.55***	***0.6***	***0.87***	***21.7***	***22.3***	***22.3***	***22.6***	***196***	**--**
3-hour	0.***62***	0.***6***	0.85	***16.7***	***17.3***	***17.3***	***17.6***	1,300	512
24-hour	0.25	0.***2***	0.39	***5.9***	***6.1***	***6.1***	***6.3***	365	91
Annual	0.02	0.***001***	0.05	***1.5***	***1.5***	***1.5***	***1.6***	80	20
PM_{10}									
24-hour	2.87	***4.5 (0.7)***	***0.89***	18	20.***9***	***22.5 (18.7)***	***18.9***	150	30
$PM_{2.5}$									
24-hour	2.87	***4.5 (0.7)***	***0.89***	***16***	***18.9***	***20.5 (16.7)***	***16.9***	35	--
Annual	0.21	***0.0 (0.0)***	***0.27***	7	***6.2***	***6.0 (6.0)***	***6.3***	15	--

[1] Modeled results are based on Tier 2 engine emission factors unless otherwise noted.

[2] Results in parentheses reflect Tier 4 engine emission factors.

[3] Modeled impacts are the 5-year average 98th percentile daily maximum.

[4] For annual averaging period, predicted concentration does not include a reduction from NO_X to NO_2. All NO_X is presumed to be NO_2.

[5] Modeled impacts are the 5-year average 99th percentile daily maximum.

Table 5-12 AERMOD Near-field *Criteria Pollutants* Modeling Results – Well Pad Production Analysis

Pollutant	Averaging Time	Maximum Modeled Concentration[1] (µg/m^3)	Background Concentration (µg/m^3)	Total Impact[1] (µg/m3)	NAAQS (µg/m^3)	PSD Increment (µg/m^3)	Distance (m)	Direction (deg)
10-Acre Spacing Well Production								
NO_2	***1-hour[2]***	***63.9***	***69.6***	***133.5***	***188***	***--***	***806***	***97***
	Annual[3]	5.7	***8.0***	***13.7***	100	25	224	63
CO	1-hour	***69***	6,325	6,39***4***	40,000	--	806	***97***
	8-hour	3***4***	3,910	3,94***4***	10,000	--	80***6***	***83***
SO_2	***1-hour[4]***	***2.6***	***21.7***	***24.3***	***196***	***--***	***854***	***111***
	3-hour	1.9	***16.7***	***18.6***	1,300	512	***854***	***111***
	24-hour	0.9	***5.9***	***6.8***	365	91	***854***	***69***
	Annual	0.1	***1.5***	***1.6***	80	20	224	63
PM_{10}	24-hour	***2.9***	18	***20.9***	150	30	***224***	***207***
$PM_{2.5}$	24-hour	***2.9***	***16***	***18.9***	35	--	***854***	***69***
	Annual	***0.8***	***6***	***6.8***	15	--	224	63
20-Acre Spacing Well Production								
NO_2	***1-hour[2]***	***53.1***	***69.6***	***122.7***	***188***	***--***	***141***	***225***
	Annual[3]	***4.2***	***8.0***	***12.2***	100	25	***224***	***333***
CO	1-hour	***51***	6,325	6,37***6***	40,000	--	***640***	***129***
	8-hour	***27***	3,910	3,93***7***	10,000	--	***1,714***	***13***
SO_2	***1-hour[4]***	***2.6***	***21.7***	***24.3***	***196***	***--***	***854***	***111***
	3-hour	1.***4***	***16.7***	***18.1***	1,300	512	***447***	***27***
	24-hour	***0.7***	***5.9***	***6.6***	365	91	***447***	***27***
	Annual	***0.1***	***1.5***	***1.6***	80	20	***447***	***27***
PM_{10}	24-hour	***2.7***	18	***20.7***	150	30	***224***	***207***
$PM_{2.5}$	24-hour	***2.7***	***16***	***18.7***	35	--	***854***	***69***
	Annual	***0.6***	7	***7.6***	15	--	***447***	***27***
40-Acre Spacing Well Production								
NO_2	***1-hour[2]***	***53.1***	***69.6***	***122.7***	***188***	***--***	***141***	***225***
	Annual[3]	3.7	***8.0***	***11.7***	100	25	224	333
CO	1-hour	***40***	6,325	6,36***5***	40,000	--	728	106
	8-hour	***20***	3,910	3,9***30***	10,000	--	***1,679***	***7***
SO_2	***1-hour[4]***	***1.5***	***21.7***	***23.2***	***196***	***--***	***728***	***106***
	3-hour	1.***1***	***16.7***	***17.8***	1,300	512	***728***	***74***
	24-hour	0.5	***5.9***	***6.4***	365	91	***922***	***49***
	Annual	0.***1***	***1.5***	***1.6***	80	20	224	333
PM_{10}	24-hour	***2.7***	18	***20.7***	150	30	***224***	***207***
$PM_{2.5}$	24-hour	***2.7***	***16***	***18.7***	35	--	***854***	***69***
	Annual	***0.4***	7	***7.4***	15	--	224	333

[1] Modeled results are based on Tier 2 engine emission factors unless otherwise noted.
[2] Modeled impacts are the 5-year average 98th percentile daily maximum.
[3] For annual averaging period, predicted concentration does not include a reduction from NO_X to NO_2. All NO_X is presumed to be NO_2.
[4] Modeled impacts are the 5-year average 99th percentile daily maximum.

Table 5-13 AERMOD Near-field *Criteria Pollutants* Modeling Results – Well Drilling Analysis

Pollutant	Averaging Time	Spacing (m)	Maximum Modeled Concentration[1] ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Impact[1] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)	Distance (m)	Direction (deg)
NO_2[2]	1-hour[3]	400	217.7 (160.4)	69.6	287.3 (230.0)	188	--	361	146
		500	199.5 (145.6)		269.2 (215.2)			430	144 (143)
		600	189.52 (138.4)		259.1 (208.0)			500	217 (142)
		700	183.7 (133.1)		253.3 (202.7)			570	218 (142)
		800	179.5 (128.4)		249.1 (199.0)			640	219 (141)
	Annual[4]	400	7.7 (2.0)	8.0	15.7 (10.0)	100	25	510	79
CO	1-hour	400	399	6,325	6724	40,000	--	361	214
	8-hour		251	3,910	4,161	10,000	--	361	326
SO_2	1-hour[5]	400	0.7	21.7	22.4	196	8	361	214
	3-hour		0.8	16.7	17.5	1,300	512	361	214
	24-hour		0.2	5.9	6.1	365	91	424	225
	Annual		0.0	1.5	1.5	80	20	728	106
PM_{10}	24-hour	400	0.9	18	18.9	150	30	424	225
$PM_{2.5}$	24-hour	400	0.9	16	16.9	35	--	806	97
	Annual		0.0	6	6.0	15	--	728	106

[1] Modeled results are based on Tier 2 engine emission factors unless otherwise noted.

[2] Results in parentheses reflect Tier 4 engine emission factors.

[3] Modeled impacts are the 5-year average 98th percentile daily maximum.

[4] For annual averaging period, predicted concentration does not include a reduction from NO_X to NO_2. All NO_X is presumed to be NO_2.

[5] Modeled impacts are the 5-year average 99th percentile daily maximum.

Near-field modeling showed that simultaneous operation of drill rigs on adjacent pads could cause an exceedance of the NAAQS for 1-hour NO_2, regardless of the space between rigs. However, compliance with the NAAQS for 1-hour NO_2 is based on the 98th percentile of the daily 1-hour maxima for each of 3 consecutive years. Because the duration of this drilling scenario is limited, the drilling activity likely would not coincide with the 8 highest impact days in 1 year. Also, because drill rigs move to different locations during the course of development, it is not possible that the same level of drilling would occur for 3 consecutive years at the same location. Therefore, although the project has been modeled to exceed the 1-hour NO_2 standard by this operation, the project may not result in a violation of the standard.

Further, the extent of these impacts is very limited as shown in the plots in Figures 5-17.1 through 5-17.5 and 5-18.1 through 5-18.5. The values on these plots represent the 5-year average of annual 98th percentile values, including background. These figures show that peak impacts occur at receptors adjacent to the drill rigs (within 100 m) and fall below the NAAQS within 200 m. Figure 5-19 shows the relationship of the well drilling 1-hour NO_2 modeled design concentrations as a function of downwind distance from the drill rigs. This figure shows the 98th percentile of modeled concentrations of the maximum receptor at the indicated distance. The peak impact is predicted immediately adjacent to the drill rigs and rapidly decreases to approach background levels. More importantly, this figure demonstrates that conversion of NO and NO_2 completes rapidly and reaches equilibrium at 800 m from the drill rig.

5.3.2 HAP Analysis

AECOM evaluated the ambient air concentration of HAPs by modeling the emission rates for the HAPs listed in Table 4-7. AERMOD was run for all scenarios outlined in Section 4.3.1 using 5 years of meteorological data to estimate air concentrations of formaldehyde, benzene, toluene, ethyl benzene, xylene(s), and n-hexane. The maximum modeled concentrations over the 5-year period for each applicable HAP/averaging period (i.e., annual and 24-hour) was compared to the RfCs and TSLs.

Table 5-14 provides a summary of maximum modeled impacts of HAPs for three separate point source types. Table 5-15 provides similar summaries for well pad production operations at three different well densities: 10-, 20-, and 40-acre spacing. Table 5-16 provides a summary of annualized and short-term impacts for well drilling. The results in Tables 5-14 through 5-16 show that maximum concentrations for all source types for all HAPs are below the applicable RfCs and TSLs.

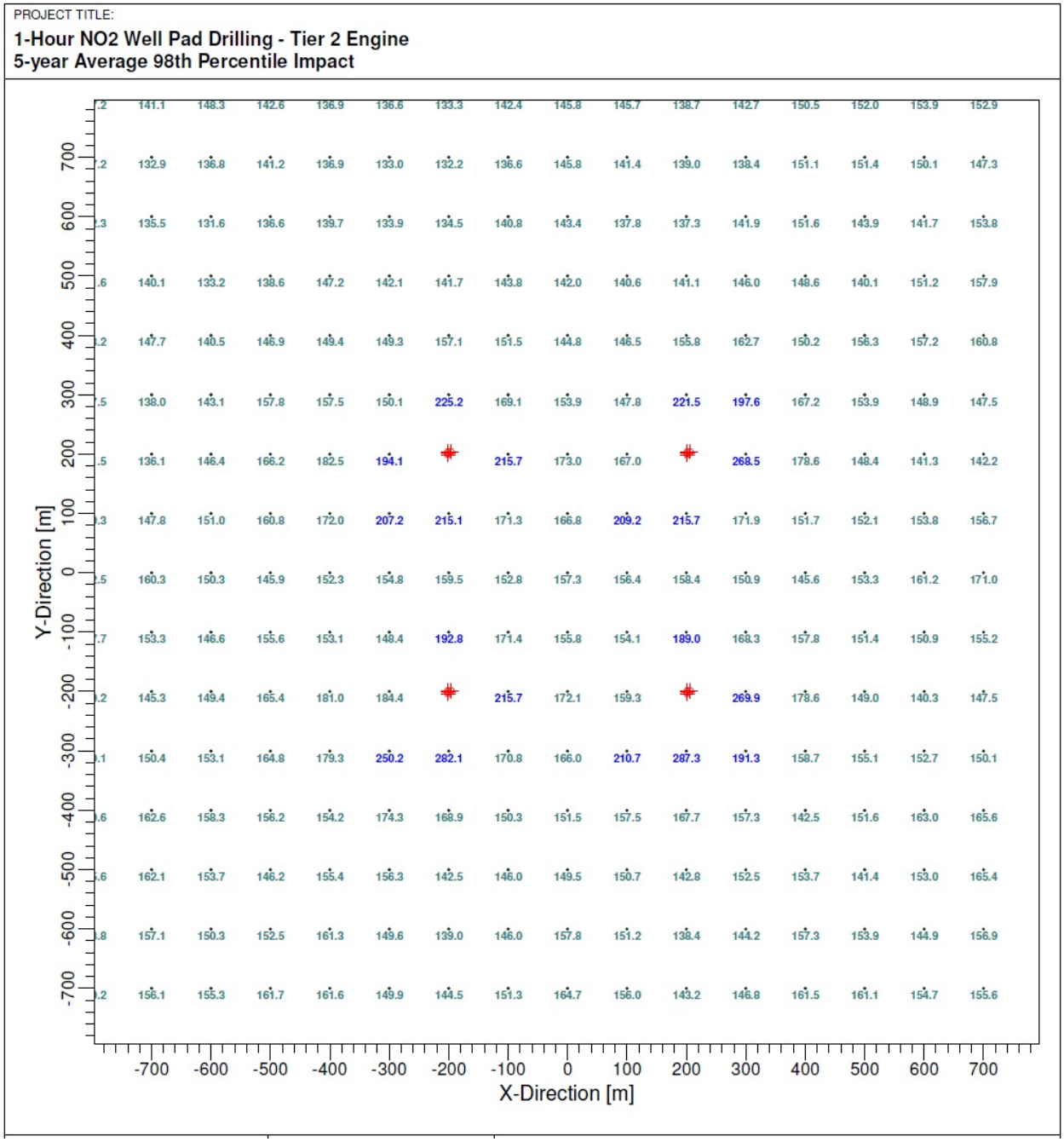


Figure 5-17.1 1-hour NO_2 Well Drilling Results Plot for Tier 2 Engines (400-m spacing)

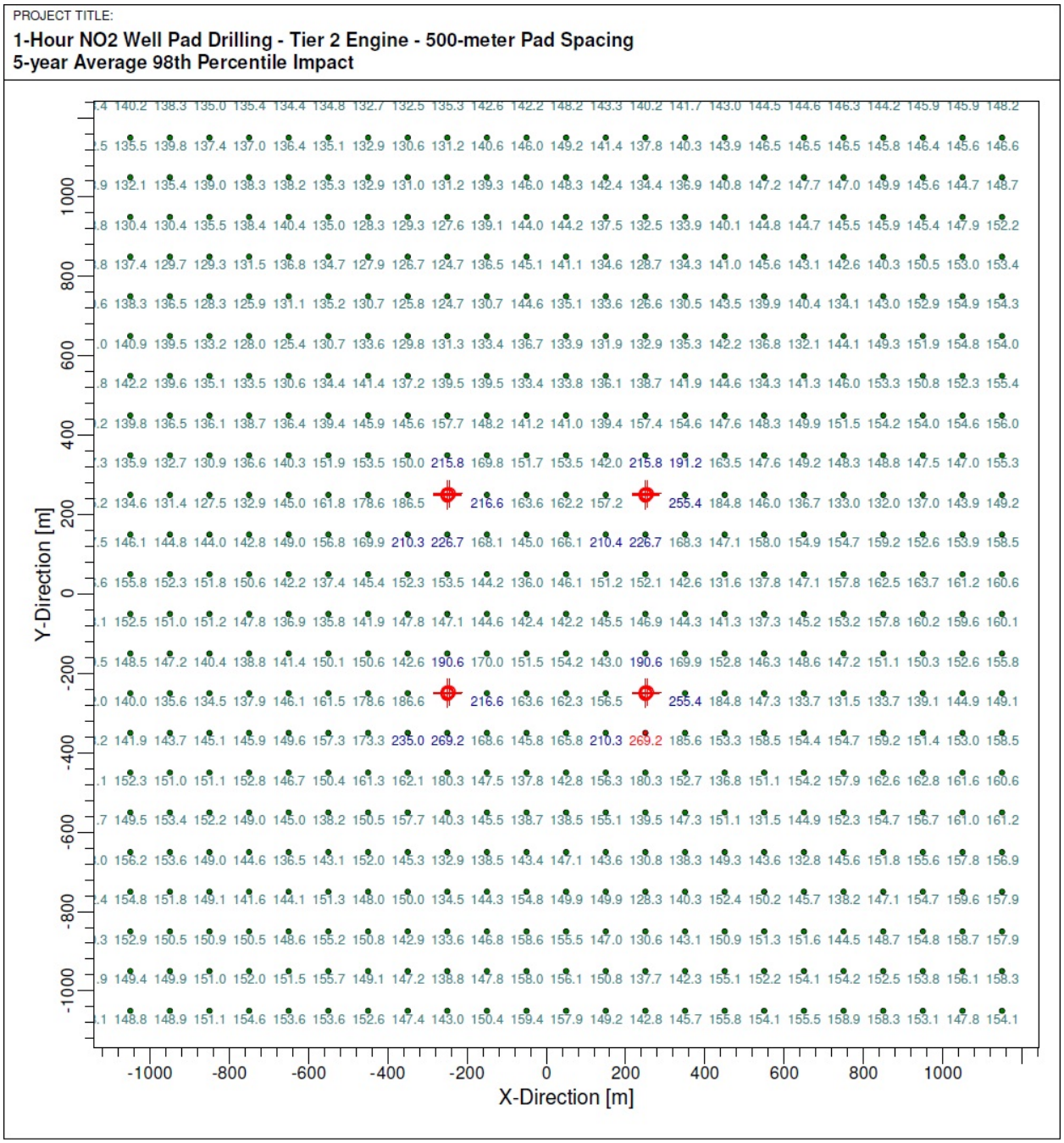


Figure 5-17.2 1-hour NO_2 Well Drilling Results Plot for Tier 2 Engines (500-m spacing)

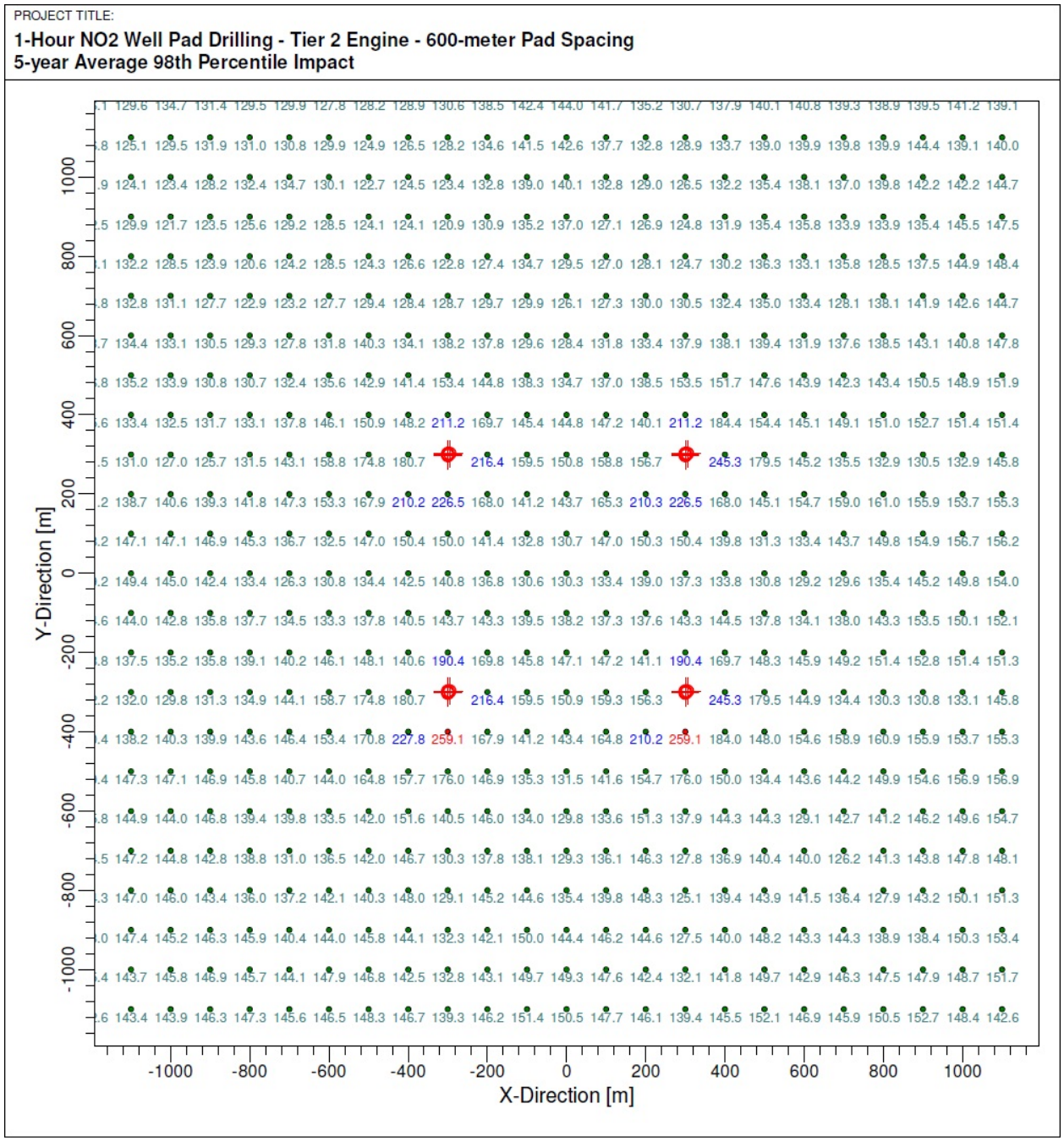


Figure 5-17.3 1-hour NO_2 Well Drilling Results Plot for Tier 2 Engines (600-m spacing)

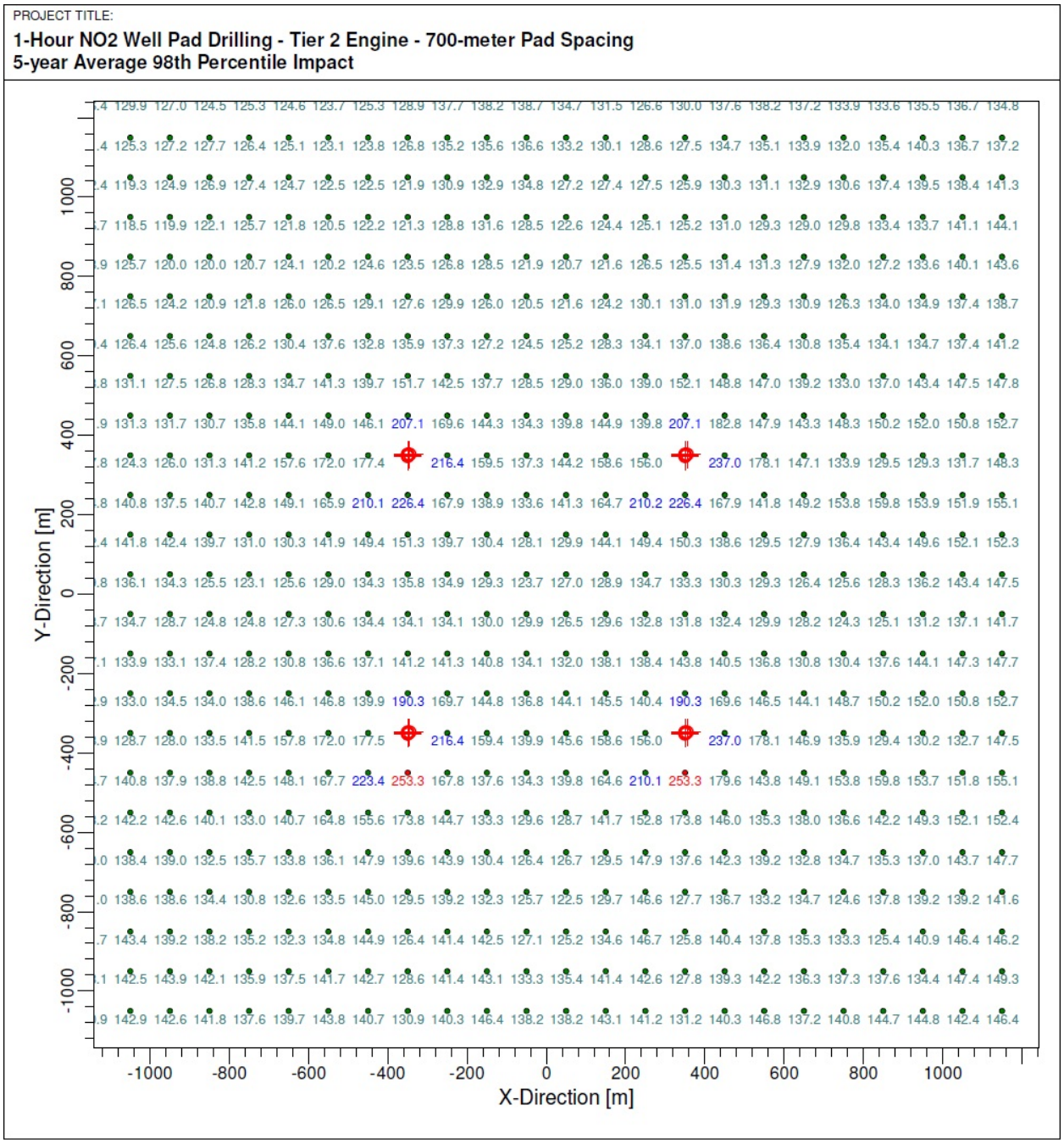


Figure 5-17.4 1-hour NO_2 Well Drilling Results Plot for Tier 2 Engines (700-m spacing)

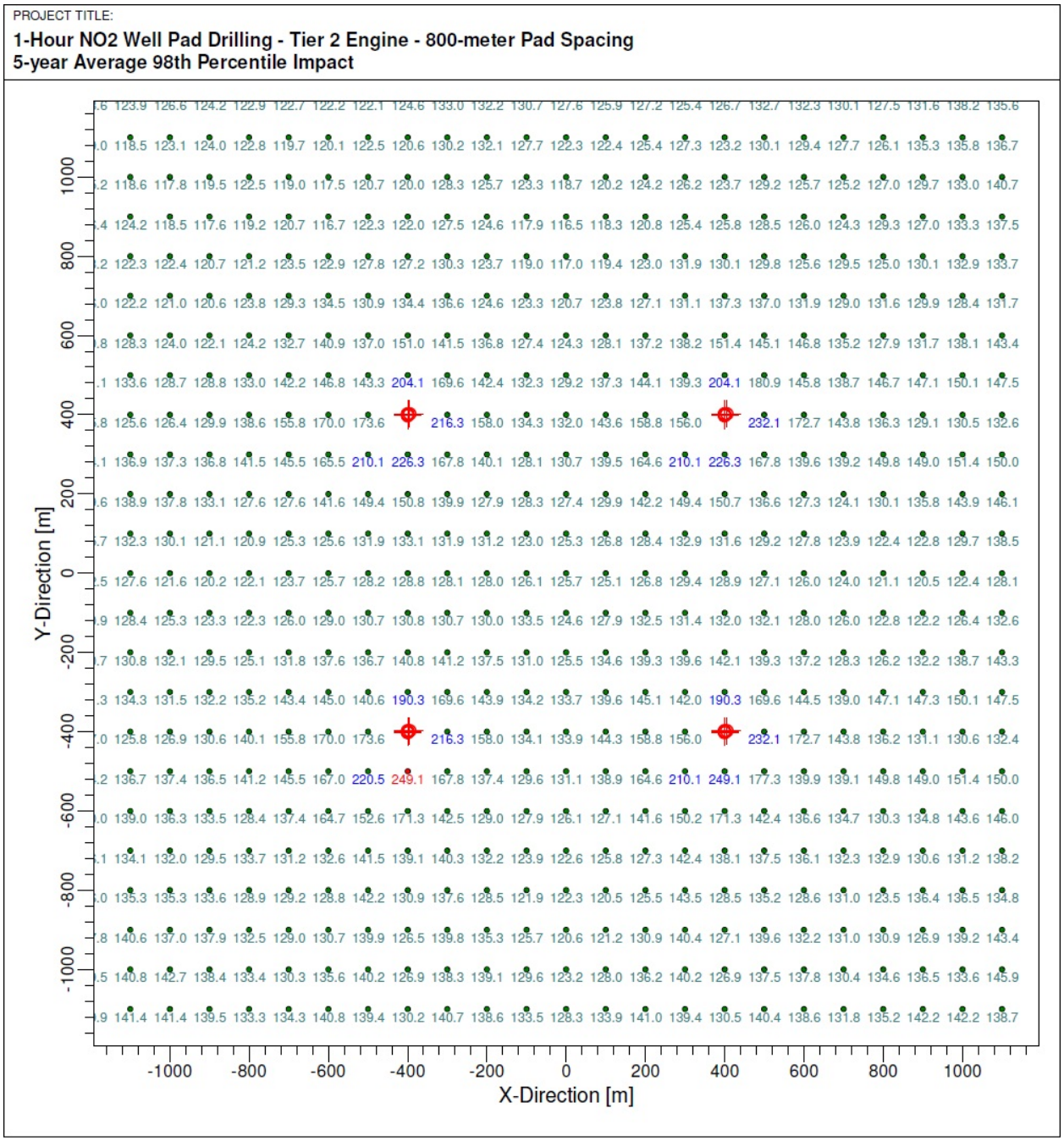


Figure 5-17.5 1-hour NO_2 Well Drilling Results Plot for Tier 2 Engines (800-m spacing)

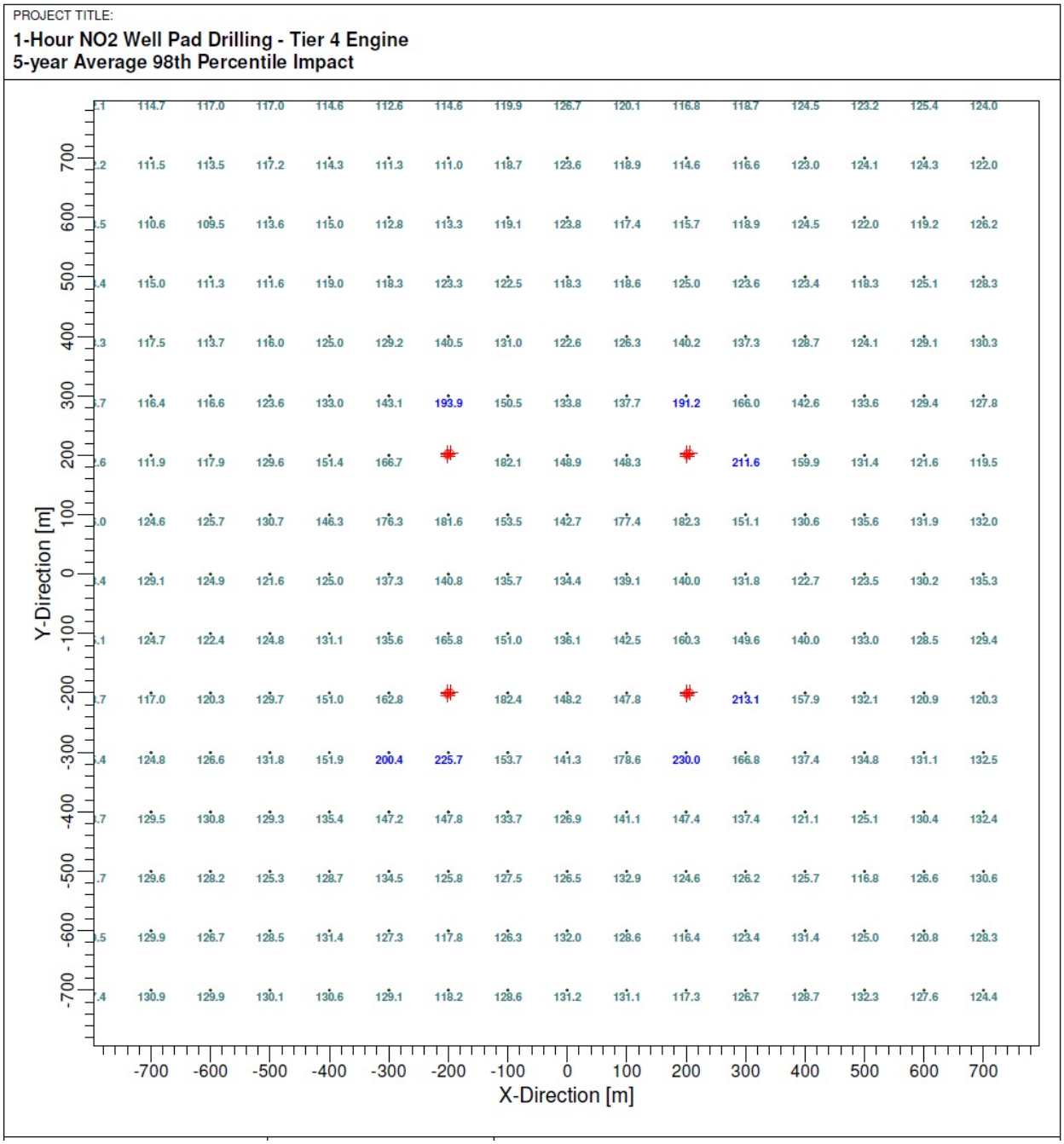


Figure 5-18.1 1-hour NO_2 Well Drilling Results Plot for Tier 4 Engines (400-m spacing)

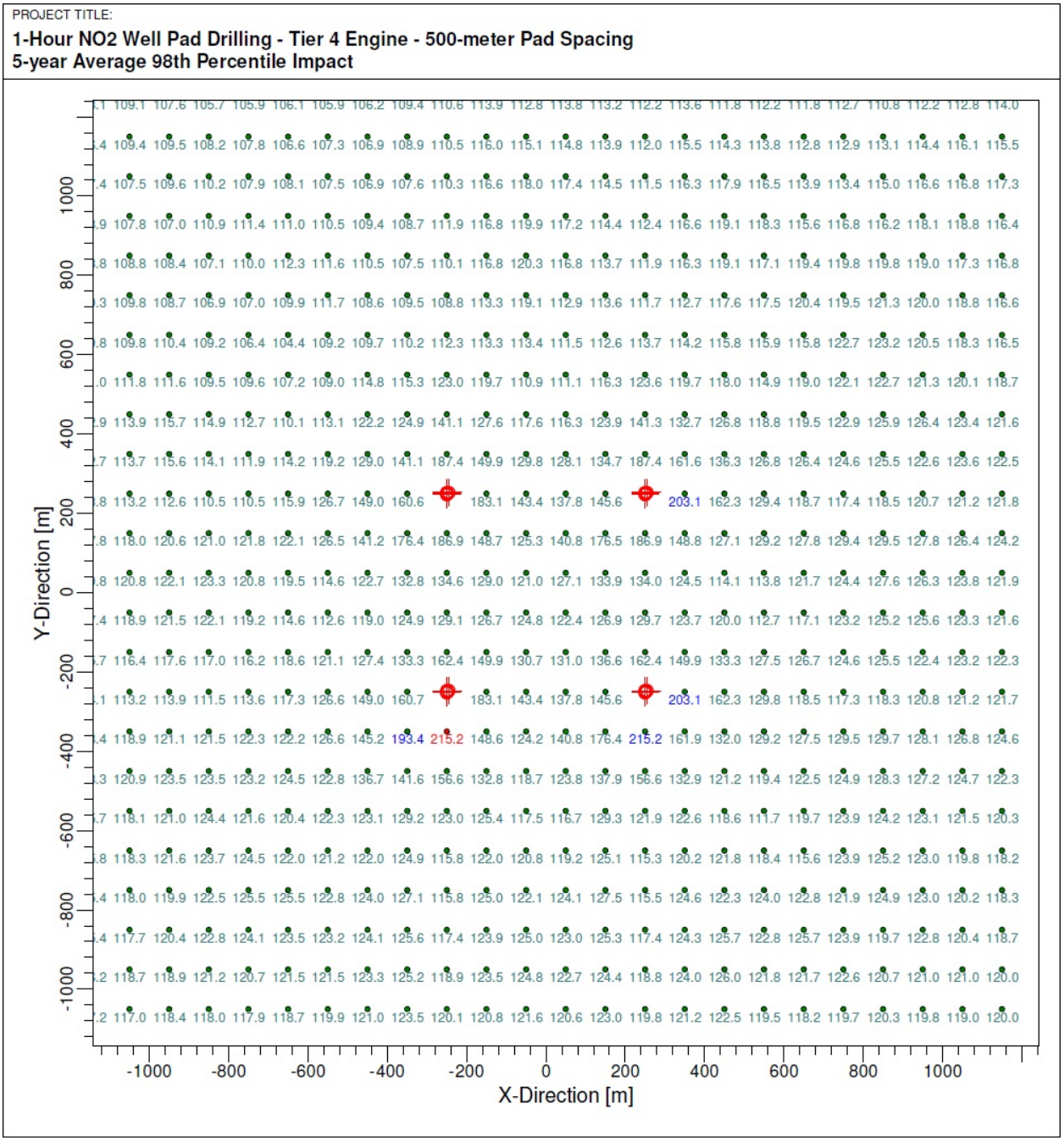


Figure 5-18.2 1-hour NO_2 Well Drilling Results Plot for Tier 4 Engines (500-m spacing)

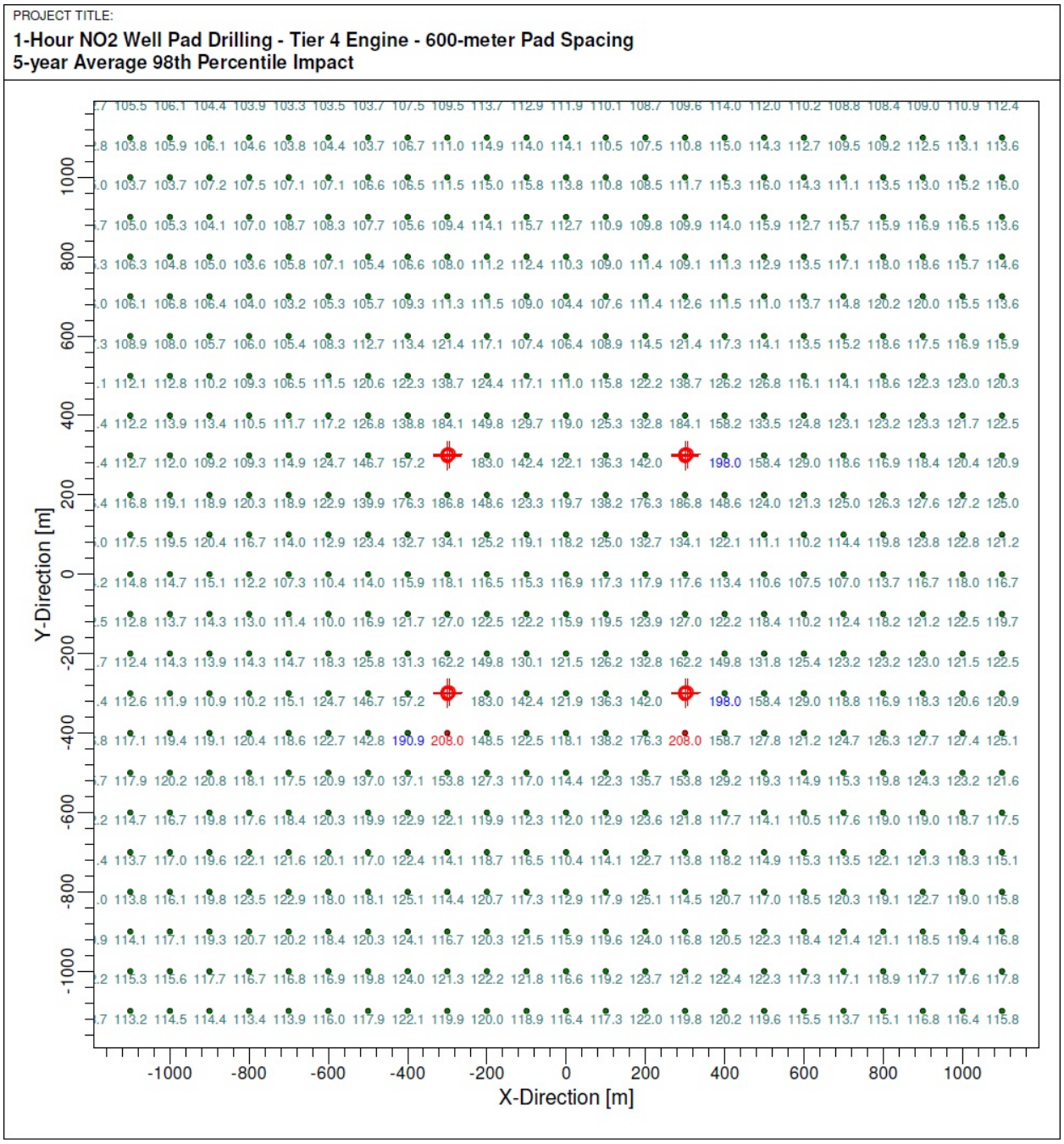


Figure 5-18.3 1-hour NO_2 Well Drilling Results Plot for Tier 4 Engines (600-m spacing)

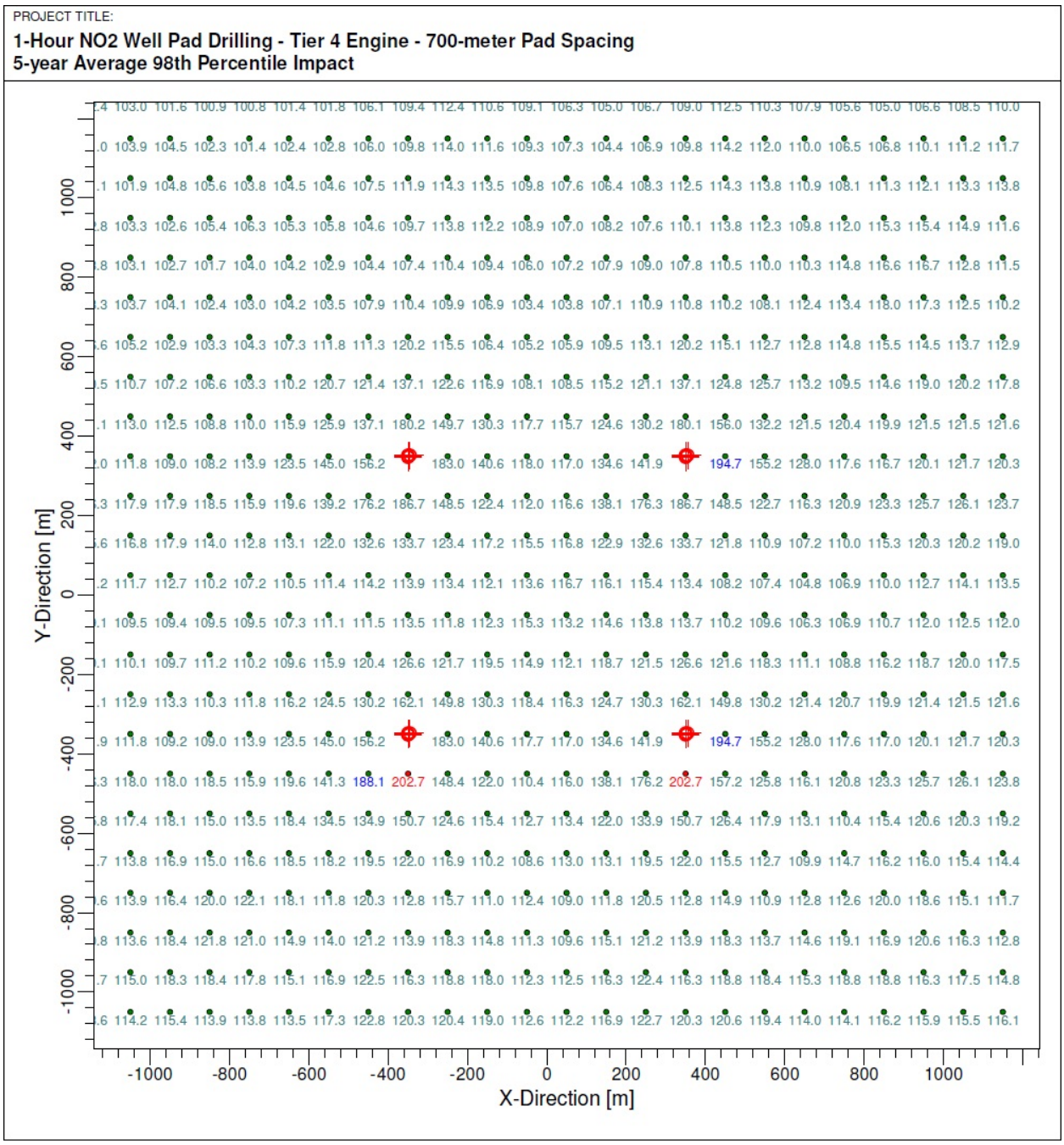


Figure 5-18.4 1-hour NO_2 Well Drilling Results Plot for Tier 4 Engines (700-m spacing)

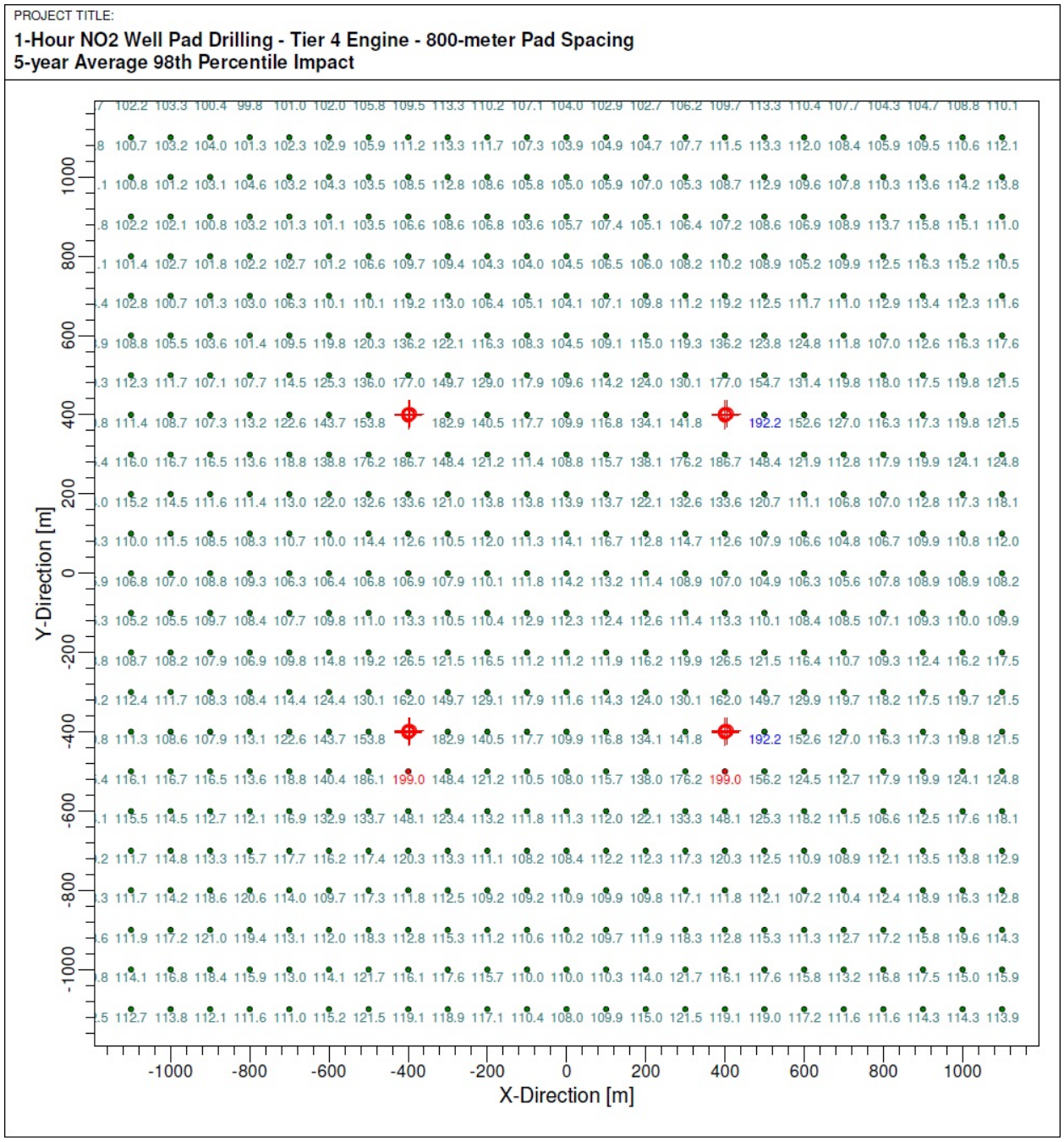


Figure 5-18.5 1-hour NO_2 Well Drilling Results Plot for Tier 4 Engines (800-m spacing)

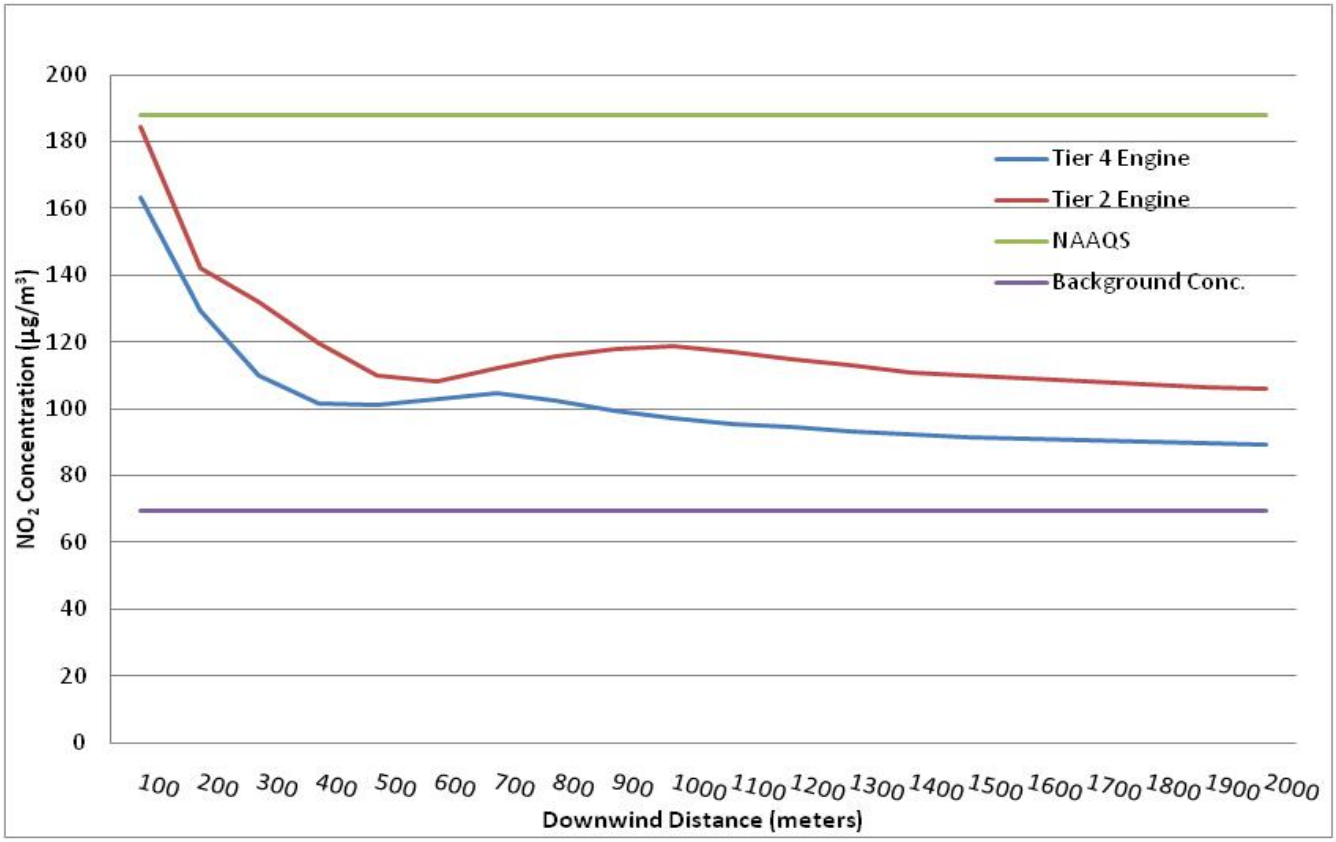


Figure 5-19 Modeled 1-hour NO_2 Impact for Well Drilling as a Function of Downwind Distance for Tier 2 and Tier 4 Engines at a Single Drill Rig

Table 5-14 AERMOD HAPs Near-field Assessment Modeling Result Summary – Single Source Impact Analysis

Pollutant/Averaging Period	Concentration by Source Type (µg/m^3)			Non-Carcinogenic RfC[1] (µg/m^3)	TSL[2] (µg/m^3)
	Compressor Station	Drill Rigs	Production Well		
Benzene					
24-hour	0.03	0.08	2.26	-	53.3
Annual	0.002	0.0003	0.60	30	-
Ethylbenzene					
24-hour	0.003	0.01	0.14	-	14,473
Annual	0.0002	0.00005	0.07	1,000	-
Formaldehyde					
24-hour	3.94	0.47	0.95	-	37
Annual	0.28	0.002	0.26	9.8	-
n-Hexane					
24-hour	0.08	0.006	6.41	-	5,875
Annual	0.006	0.00002	1.73	700	-
Toluene					
24-hour	0.03	0.06	5.26	-	2,512
Annual	0.002	0.0002	1.41	5,000	-
Xylene					
24-hour	0.01	0.04	3.91	-	14,473
Annual	0.001	0.0002	1.04	100	-

[1] USEPA Air Toxics Database, Table 1 (USEPA 2010b).
[2] UDAQ Air Toxic Modeling Guidance for TSLs (UDAQ 2007).

Table 5-15 AERMOD HAPs Near-field Modeling Results – Well Pad Production Analysis

Pollutant/Averaging Period	Concentration per Production Well Density ($\mu g/m^3$)			Non-Carcinogenic RfC[1] ($\mu g/m^3$)	TSL[2] ($\mu g/m^3$)
	10-Acre Spacing	20-Acre Spacing	40-Acre Spacing		
Benzene					
24-hour	5.25	4.14	2.99	-	53.3
Annual	1.55	1.22	0.71	30	-
Ethylbenzene					
24-hour	0.32	0.26	0.18	-	14,473
Annual	0.17	0.13	0.08	1,000	-
Formaldehyde					
24-hour	3.89	3.76	3.76	-	37
Annual	0.85	0.64	0.50	9.8	-
n-Hexane					
24-hour	14.85	11.70	8.45	-	5,875
Annual	4.47	3.52	2.05	700	-
Toluene					
24-hour	12.17	9.59	6.93	-	2,512
Annual	3.63	2.86	1.67	5,000	-
Xylene					
24-hour	9.08	7.15	5.16	-	14,473
Annual	2.68	2.11	1.23	100	-

[1] USEPA Air Toxics Database, Table 1 (USEPA 2010b).
[2] UDAQ Air Toxic Modeling Guidance for TSLs (UDAQ 2007).

Table 5-16 AERMOD HAPs Near-field Modeling Results – Well Drilling Analysis

Pollutant / Averaging Period	Maximum Modeled AERMOD Results ($\mu g/m^3$)	Non-Carcinogenic RfC[1] ($\mu g/m^3$)	TSL[2] ($\mu g/m^3$)
Benzene			
24-hour	0.06	-	53.3
Annual	0.002	30	-
Ethylbenzene			
24-hour	0.01	-	14,473
Annual	0.0003	1,000	-
Formaldehyde			
24-hour	0.3	-	37
Annual	0.01	9.8	-
n-Hexane			
24-hour	0.005	-	5,875
Annual	0.0002	700	-
Toluene			
24-hour	0.04	-	2,512
Annual	0.002	5,000	-
Xylene			
24-hour	0.03	-	14,473
Annual	0.001	100	-

[1] USEPA Air Toxics Database, Table 1 (USEPA 2010b).

[2] UDAQ Air Toxic Modeling Guidance for TSLs (UDAQ 2007).

6.0 Greenhouse Gas Emissions

This chapter is included in the Draft EIS and is not being amended in this supplement.

7.0 Air Quality Summary

This section is included in the Draft EIS and is not being amended in this supplement.

7.1 Impact on Class I and II Areas – Air Quality

This section is included in the Draft EIS and is not being amended in this supplement.

7.2 Impact at Class I and II Areas – Visibility

This section is included in the Draft EIS and is not being amended in this supplement.

7.3 Impacts at Class I and II areas – Acid Deposition

This section is included in the Draft EIS and is not being amended in this supplement.

7.4 Impacts on Ambient Ozone Levels

Impacts on ozone were evaluated using the CMAQ model system. The modeling system meets the USEPA-established criteria for acceptable model accuracy and error statistics at the existing monitoring stations in the modeling domain, but not in the region. There are no recent or statistically valid representative monitoring data that can be used to compare to baseline modeled impacts actual levels in the GNBPA. This lack of concurrent data prevents validation and calibration of the model results; however, the model does provide a means to compare the relative change in ambient ozone concentration between the project alternatives and baseline air quality.

The model results showed ozone levels below the current ozone standard of 75 ppb for the fourth highest annual level in the Uinta Basin for the Projected Baseline and for the project alternatives. The maximum fourth highest impact was 2.4 ppb from the Proposed Action scenario and 4.9 ppb from the Optimal Recovery Alternative. For both scenarios, the impacts were occurring in areas simulated to remain below the 75 ppb ozone standard.

As stated in Section 3.7, the regional inventory for the action alternatives was revised for the analysis conducted for the SDEIS due to one additional rig needed to drill slightly more wells per year. While this would result in almost no change in VOCs, the project-related NO_X emissions would increase by 6.8 percent for the Proposed Action. This project-related NO_X emissions increase could result in project-specific impacts to ambient ozone levels slightly different than those modeled for the scenario that assumed one less drill rig.

7.5 Localized Impacts on Air Quality

The AERMOD modeling system was used to evaluate localized impacts on criteria air pollutants at receptors within the GNBPA. The analysis was based on a series of source configurations, including well sites, drilling, operation, and compression, and provided projected air quality impacts on the near field. A 5-year period of meteorological data from the Vernal Airport was utilized.

Using background data from AQS, the localized impacts on ambient air quality for criteria pollutants of single sources plus background were all less than the NAAQS. The impacts of all multiple production well scenarios also were below the NAAQS. Near-field modeling showed that simultaneous operation of drill rigs on adjacent pads could cause an exceedance of the NAAQS for 1-hour NO_2. This impact is predicted to be localized to within 200 m of the source. However, compliance with the NAAQS for 1-hour NO_2 is based on the 98th percentile of the daily 1-hour maxima for each of 3 consecutive years. Because the duration of this drilling scenario is limited, likely would not occur for

8 days in 1 year, and would be even more unlikely to occur for 3 consecutive years at the same location, the 1-hour NO_2 standard would not be violated by this operation. The modeled ambient air concentrations of HAPs does not exceed USEPA RfCs or TSLs for any scenario or pollutant.

7.6 Greenhouse Gas Emissions

This section is included in the Draft EIS and is not being amended in this supplement.

8.0 References

This chapter includes only references for this supplemental document.

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Appendix B

Project-specific Emissions Calculations Supporting Data

EMPACT ANALYTICAL SYSTEMS, INC

365 S. MAIN STREET
BRIGHTON, CO 80601
(303) 637-0150

EXTENDED NATURAL GAS LIQUID ANALYSIS (*DHA)

PROJECT NO. :	**200705124**	ANALYSIS NO. :	**01**
COMPANY NAME :	**ANADARKO**	ANALYSIS DATE:	MAY 24, 2007
ACCOUNT NO. :		SAMPLE DATE :	MAY 14, 2007
PRODUCER :		CYLINDER NO. :	Q12374
LEASE NO. :		SAMPLED BY :	J. S. JOHNSON
NAME/DESCRIP :	NATURAL BUTTES NBU 920 - 25F		

FIELD DATA		SAMPLE TEMP. :	78
SAMPLE PRES. :	140	AMBIENT TEMP.:	
VAPOR PRES. :		GRAVITY :	
COMMENTS :	GAS VOLUME: 1,061 MCF MANUAL; CYL. PRESS: 140		

COMPONENT	MOLE %	MASS %	VOL %
NITROGEN (AIR)	0.000	0.000	0.000
CO2	0.219	0.091	0.081
METHANE	4.224	0.647	1.561
ETHANE	2.156	0.614	1.257
PROPANE	2.127	0.888	1.280
I-BUTANE	1.037	0.571	0.738
N-BUTANE	1.849	1.018	1.274
2,2 DIMETHYLPROPANE	0.000	0.000	0.000
I-PENTANE	1.791	1.224	1.430
N-PENTANE	1.895	1.295	1.499
HEXANES PLUS	84.702	93.652	90.880
TOTALS	100.000	100.000	100.000

BTEX COMPONENTS	**MOLE%**	**MASS%**
BENZENE	0.942	0.697
TOLUENE	5.668	4.946
ETHYLBENZENE	0.431	0.433
XYLENE	6.198	6.231
TOTAL BTEX	13.239	12.307

(CALC: GPA STD 2145-94 & TP-17 @14.696 & 60 F)

Specific Gravity (H2O=1) =	**0.7327**	60/60
API Gravity =	**61.62**	60/60
Molecular Weight =	**105.58**	
Absolute Density =	**6.09**	LBS/GAL
Heating Value Liq. Idl Gas=	**123403**	BTU/GAL
Vapor/Liquid =	**21.89**	CUFT/GAL
Vapor Pressure =	**235.91**	PSIA & 100 F

**(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730*
THIS DATA HAS BEEN ACQUIRED THROUGH APPLICATION OF CURRENT STATE-OF-THE-ART ANALYTICAL TECHNIQUES. THE USE OF THIS INFORMATION IS THE RESPONSIBLITY OF THE USER. EMPACT ANALYTICAL SYSTEMS, ASSUMES NO RESPONSIBLITY FOR ACCURACY OF THE REPORTED INFORMATION NOR ANY CONSEQUENCES OF IT'S APPLICATION.

EMPACT ANALYTICAL SYSTEMS, INC

365 S. MAIN STREET
BRIGHTON, CO 80601
(303) 637-0150

EXTENDED NATURAL GAS LIQUID ANALYSIS (*DHA)

PROJECT NO. :	**200705124**	ANALYSIS NO. :	**01**
COMPANY NAME :	**ANADARKO**	ANALYSIS DATE:	MAY 24, 2007
ACCOUNT NO. :		SAMPLE DATE :	MAY 14, 2007
PRODUCER :		CYLINDER NO. :	Q12374
LEASE NO. :		SAMPLED BY :	J. S. JOHNSON
NAME/DESCRIP :	NATURAL BUTTES NBU 920 - 25F		
FIELD DATA		SAMPLE TEMP. :	78
SAMPLE PRES. :	140	AMBIENT TEMP.:	
VAPOR PRES. :		GRAVITY :	
COMMENTS :	GAS VOLUME: 1,061 MCF MANUAL; CYL. PRESS: 140		

TOTALS BY CARBON NUMBER

CARBON NUMBER	MOLE%	MASS %	VOL %
Nitrogen (air)	0.000	0.000	0.000
Carbon Dioxide	0.219	0.091	0.081
Methanol	0.000	0.000	0.000
C1	4.224	0.647	1.561
C2	2.156	0.614	1.257
C3	2.127	0.888	1.280
C4	2.886	1.589	2.012
C5	4.122	2.809	3.211
C6	10.147	8.138	8.302
C7	22.854	21.074	20.240
C8	21.942	23.123	21.913
C9	12.345	14.780	14.465
C10	7.924	11.117	11.057
C11	4.019	6.483	6.290
C12	2.222	3.584	3.476
C13	1.535	2.681	2.577
C14	0.845	1.474	1.418
C15	0.306	0.636	0.600
C16	0.114	0.244	0.231
C17	0.011	0.024	0.023
C18	0.002	0.004	0.006
C19	0.000	0.000	0.000
C20+	0.000	0.000	0.000
Total	100.000	100.000	100.000

Average Molecular Weight of Hexanes plus	=	**116.98**
Average Specific Gravity of Hexanes plus	=	**0.756**
Average Molecular Weight of Decanes plus	=	**160.26**
Average Specific Gravity of Decanes plus	=	**0.741**

EMPACT ANALYTICAL SYSTEMS, INC

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(303) 637-0150

E & P Tank / GlyCalc Information

PROJECT NO. :	**200705124**	ANALYSIS NO. :	**01**
COMPANY NAME :	**ANADARKO**	ANALYSIS DATE:	MAY 24, 2007
ACCOUNT NO. :		SAMPLE DATE :	MAY 14, 2007
PRODUCER :		CYLINDER NO. :	Q12374
LEASE NO. :		SAMPLED BY :	J. S. JOHNSON
NAME/DESCRIP :	NATURAL BUTTES NBU 920 - 25F		
FIELD DATA		SAMPLE TEMP. :	78
SAMPLE PRES. :	140	AMBIENT TEMP.:	
VAPOR PRES. :		GRAVITY :	
COMMENTS :	GAS VOLUME: 1,061 MCF		

COMPONENT	Mole %		Wt %		LV %	
CO2	0.219		0.091		0.081	
HYDROGEN SULFIDE	0.000		0.000		0.000	
METHANOL	0.000		0.000		0.000	
NITROGEN (AIR)	0.000		0.000		0.000	
METHANE	4.224		0.647		1.561	
ETHANE	2.156		0.614		1.257	
PROPANE	2.127		0.888		1.280	
I-BUTANE	1.037		0.571		0.738	
N-BUTANE	1.849		1.018		1.274	
I-PENTANE	1.791		1.224		1.430	
N-PENTANE	1.895		1.295		1.499	
CYCLOPENTANE (N-C5)	0.436		0.290		0.282	
N-HEXANE	2.805		2.289		2.519	
CYCLOHEXANE (OTHER C6)	2.548		2.031		1.891	
OTHER HEXANES	3.852		3.121		3.315	
OTHER HEPTANES	9.898		9.351		9.702	
METHYLCYCLOHEXANE (OTHER C6)	7.288		6.777		6.393	
2,2,4 TRIMETHYLPENTANE	0.000		0.000		0.000	
BENZENE	0.942		0.697		0.577	
TOLUENE	5.668		4.946		4.145	
ETHYLBENZENE	0.431		0.433		0.363	
XYLENES	6.198		6.231		5.200	
OTHER OCTANES	15.313		16.459		16.350	
OCTANES PLUS	----	44.636	----	57.486	----	56.493
NONANES	12.345		14.780		14.465	
DECANES PLUS	16.978		26.247		25.678	
SUBTOTAL	100.000		100.000		100.000	
OXYGEN	0.000		0.000		0.000	
TOTAL	100.000		100.000		100.000	

API Gravity = **61.62** 60/60
Vapor Pressure = **235.91** PSIA & 100 F
Average Molecular Weight of Decanes plus = **160.26**
Average Specific Gravity of Decanes plus = **0.741**

EMPACT ANALYTICAL SYSTEMS, INC

365 S. MAIN STREET
BRIGHTON, CO 80601
(303) 637-0150

EXTENDED NATURAL GAS LIQUID ANALYSIS (*DHA)

PROJECT NO. : **200705124** ANALYSIS NO. : **01**
COMPANY NAME : **ANADARKO** ANALYSIS DATE: **MAY 24, 2007**

COMPONENT	PIANO #	MOLE %	MASS %	VOL %
NITROGEN (AIR)		0.000	0.000	0.000
CO2		0.219	0.091	0.081
METHANE	P1	4.224	0.647	1.562
ETHANE	P2	2.156	0.614	1.256
PROPANE	P3	2.127	0.888	1.280
I-BUTANE	I4	1.037	0.571	0.738
N-BUTANE	P4	1.849	1.018	1.274
2,2 DIMETHYLPROPANE	I5	0.000	0.000	0.000
I-PENTANE	I5	1.791	1.224	1.430
N-PENTANE	P5	1.895	1.295	1.499
2,2 DIMETHYLBUTANE	I6	0.157	0.128	0.144
METHANOL	X1	0.000	0.000	0.000
CYCLOPENTANE	N5	0.436	0.290	0.282
2 METHYLPENTANE	I6	1.534	1.252	1.389
3 METHYLPENTANE	I6	0.980	0.800	0.871
N-HEXANE	P6	2.805	2.289	2.519
2,2-DIMETHYLPENTANE	I7	0.075	0.071	0.075
METHYLCYCLOPENTANE	N6	1.181	0.941	0.911
2,4 DIMETHYLPENTANE	I7	0.377	0.358	0.386
2,2,3 TRIMETHYLBUTANE	I7	0.102	0.097	0.104
BENZENE	A6	0.942	0.697	0.577
3,3 DIMETHYLPENTANE	I7	0.139	0.132	0.138
CYCLOHEXANE	N6	2.548	2.031	1.891
2 METHYLHEXANE	I7	0.705	0.669	0.715
2,3 DIMETHYLPENTANE	I7	0.692	0.656	0.686
1,1 DIMETHYLCYCLOPENTANE	N7	0.474	0.441	0.421
3 METHYLHEXANE	I7	1.320	1.253	1.320
1,C 3 DIMETHYLCYCLOPENTANE	N7	0.398	0.370	0.363
1,T 3 DIMETHYLCYCLOPENTANE	N7	0.286	0.266	0.259
3 ETHYLPENTANE	I7	0.131	0.124	0.127
1,T 2 DIMETHYLCYCLOPENTANE	N7	0.877	0.816	0.790
N-HEPTANE	P7	4.063	3.856	4.093
1,C 2 DIMETHYLCYCLOPENTANE	N7	0.008	0.008	0.006
METHYLCYCLOHEXANE	N7	7.288	6.777	6.393
2,2-DIMETHYLHEXANE	I8	1.314	1.421	1.441
ETHYLCYCLOPENTANE	N7	0.251	0.234	0.219
2,2,3-TRIMETHYLPENTANE	I8	0.226	0.245	0.248
2,4-DIMETHYLHEXANE	I8	0.358	0.387	0.404
1C,2T,4-TRIMETHYLCYCLOPENTANE	N8	0.131	0.139	0.133

PROJECT NO. : **200705124** ANALYSIS NO. : **01**
COMPANY NAME : **ANADARKO** ANALYSIS DATE: **MAY 24, 2007**

COMPONENT	PIANO #	MOLE %	MASS %	VOL %
3,3-DIMETHYLHEXANE	I8	0.170	0.184	0.184
2,3,4-TRIMETHYLPENTANE	I8	0.036	0.039	0.040
2,3,3-TRIMETHYLPENTANE	I8	0.004	0.005	0.006
TOLUENE	A7	5.668	4.946	4.145
2,3-DIMETHYLHEXANE	I8	0.297	0.321	0.329
2-METHYL-3-ETHYLPENTANE	I8	0.127	0.137	0.127
1,1,2-TRIMETHCYCLOPENTANE	N8	0.072	0.078	0.081
2-METHYLHEPTANE	I8	0.747	0.808	0.842
4-METHYLHEPTANE	I8	0.642	0.695	0.715
3-METHYL-3-ETHYLPENTANE	I8	0.095	0.103	0.098
3,4-DIMETHYLHEXANE	I8	0.070	0.075	0.075
1C,2C,4-TRIMETHYLCYCLOPENTANE	N8	0.258	0.274	0.254
3-METHYLHEPTANE	I8	0.710	0.768	0.790
1C,2T,3-TRIMETHYLCYCLOPENTANE	N8	1.266	1.346	1.239
3-ETHYLHEXANE	I8	0.200	0.216	0.219
1T,4-DIMETHYLCYCLOHEXANE	N8	1.922	2.042	1.943
1,1-DIMETHYLCYCLOHEXANE	N8	0.470	0.499	0.461
3C-ETHYLMETHYLCYCLOPENTANE	N8	0.053	0.056	0.052
3T-ETHYLMETHYLCYCLOPENTANE	N8	0.120	0.128	0.115
2T-ETHYLMETHYLCYCLOPENTANE	N8	0.068	0.072	0.063
1,1-METHYLETHYLCYCLOPENTANE	N8	0.115	0.122	0.110
2,2,4-TRIMETHYLHEXANE	I9	0.063	0.077	0.075
1T,2-DIMETHYLCYCLOHEXANE	N8	0.794	0.844	0.778
N-OCTANE	P8	3.439	3.720	3.845
2,4,4-TRIMETHYLHEXANE	I9	0.235	0.286	0.288
1C,2-DIMETHYLCYCLOHEXANE	N8	0.093	0.099	0.092
2,2-DIMETHYLHEPTANE	I9	0.068	0.082	0.081
2,3,5-TRIMETHYLHEXANE	I9	0.121	0.147	0.150
1,1,4-TRIMETHYLCYCLOHEXANE	N9	0.839	1.004	0.945
2,2,3-TRIMETHYLHEXANE	I9	0.447	0.543	0.553
ETHYLCYCLOHEXANE	N9	0.261	0.312	0.294
N-PROPYLCYCLOPENTANE	N8	0.248	0.264	0.248
1C,3C,5-TRIMETHYLCYCLOHEXANE	N9	0.140	0.168	0.156
3,5-DIMETHYLHEPTANE	I9	0.061	0.075	0.075
2,6-DIMETHYLHEPTANE	I9	0.038	0.046	0.046
2,5-DIMETHYLHEPTANE	I9	0.073	0.088	0.092
3,3-DIMETHYLHEPTANE	I9	0.106	0.128	0.127
ETHYLBENZENE	A8	0.431	0.433	0.363
1C,2T,4T-TRIMETHYLCYCLOHEXANE	N9	0.053	0.063	0.058
1,3-DIMETHYLBENZENE (M-XYLENE)	A8	3.655	3.674	3.067
1,4-DIMETHYLBENZENE (P-XYLENE)	A8	1.423	1.431	1.193
3,4-DIMETHYLHEPTANE	I9	1.389	1.686	1.678
4-METHYLOCTANE	I9	0.234	0.285	0.288
2-METHYLOCTANE	I9	0.833	1.012	1.032
1C,2T,3-TRIMETHYLCYCLOHEXANE	N9	0.196	0.239	0.242
3-ETHYLHEPTANE	I9	0.112	0.136	0.138

PROJECT NO. : **200705124** ANALYSIS NO. : **01**

COMPANY NAME : **ANADARKO** ANALYSIS DATE: **MAY 24, 2007**

COMPONENT	PIANO #	MOLE %	MASS %	VOL %
3-METHYLOCTANE	I9	0.537	0.653	0.657
1C,2T,4C-TRIMETHYLCYCLOHEXANE	N9	0.184	0.220	0.202
1,1,2-TRIMETHYLCYCLOHEXANE	N9	0.011	0.012	0.012
1,2-DIMETHYLBENZENE (O-XYLENE)	A8	1.120	1.126	0.940
I-BUTYCYCLOPENTANE	N9	0.285	0.341	0.306
UNKNOWN OCTANE'S	U8	1.268	1.372	1.418
N-NONANE	P9	2.777	3.373	3.413
I-PROPYLBENZENE	A9	0.292	0.294	0.242
I-PROPYLCYCLOHEXANE	N9	0.358	0.360	0.300
2,4-DIMETHYLOCTANE	I10	0.324	0.437	0.427
2,6-DIMETHYLOCTANE	I10	0.427	0.575	0.582
N-BUTYCYCLOPENTANE	N9	0.570	0.682	0.617
3,3-DIMETHYLOCTANE	I10	0.316	0.426	0.421
N-PROPYLBENZENE	A9	0.479	0.546	0.455
3,6-DIMETHYLOCTANE	I10	0.051	0.069	0.069
3-METHYL-5-ETHYLHEPTANE	I10	0.069	0.084	0.081
UNKNOWN NONANE'S	U9	1.583	1.922	1.943
N-DECANE	P10	2.315	3.273	3.257
UNKNOWN DECANE'S	U10	4.422	6.253	6.220
N-UNDECANE	P11	4.019	6.483	6.290
DODECANES	C12'S	2.222	3.584	3.476
TRIDECANES	C13'S	1.535	2.681	2.577
TETRADECANES	C14'S	0.845	1.474	1.418
PENTADECANES	C15'S	0.306	0.636	0.600
HEXADECANES	C16'S	0.114	0.244	0.231
HEPTADECANES	C17'S	0.011	0.024	0.023
OCTADECANES	C18'S	0.002	0.004	0.006
TOTALS		100.000	100.000	100.000

EMPACT ANALYTICAL SYSTEMS, INC

365 S. MAIN STREET
BRIGHTON, CO 80601
(303) 637-0150

EXTENDED NATURAL GAS LIQUID ANALYSIS (*DHA)

PROJECT NO. :	**200705124**	ANALYSIS NO. :	**02**
COMPANY NAME :	**ANADARKO**	ANALYSIS DATE:	MAY 24, 2007
ACCOUNT NO. :		SAMPLE DATE :	MAY 14, 2007
PRODUCER :		CYLINDER NO. :	Q11074
LEASE NO. :		SAMPLED BY :	J. S. JOHNSON
NAME/DESCRIP :	NATURAL BUTTES NBU 920 - 25O		

FIELD DATA		SAMPLE TEMP. :	79
SAMPLE PRES. :	100	AMBIENT TEMP.:	
VAPOR PRES. :		GRAVITY :	
COMMENTS :	MANUAL; CYL. PRESS: 100		

COMPONENT	MOLE %	MASS %	VOL %
NITROGEN (AIR)	0.000	0.000	0.000
CO2	0.618	0.254	0.229
METHANE	3.864	0.569	1.423
ETHANE	1.778	0.499	1.029
PROPANE	1.794	0.738	1.069
I-BUTANE	0.845	0.458	0.600
N-BUTANE	1.561	0.847	1.063
2,2 DIMETHYLPROPANE	0.000	0.000	0.000
I-PENTANE	1.544	1.040	1.223
N-PENTANE	1.647	1.109	1.292
HEXANES PLUS	86.349	94.486	92.072
TOTALS	100.000	100.000	100.000

BTEX COMPONENTS	**MOLE%**	**MASS%**
BENZENE	0.871	0.635
TOLUENE	5.646	4.854
ETHYLBENZENE	0.466	0.462
XYLENE	6.947	6.882
TOTAL BTEX	13.930	12.833

(CALC: GPA STD 2145-94 & TP-17 @14.696 & 60 F)

Specific Gravity (H2O=1) =	**0.7353**	60/60
API Gravity =	**60.94**	60/60
Molecular Weight =	**107.18**	
Absolute Density =	**6.13**	LBS/GAL
Heating Value Liq. Idl Gas=	**123624**	BTU/GAL
Vapor/Liquid =	**21.67**	CUFT/GAL
Vapor Pressure =	**213.58**	PSIA & 100 F

**(DETAILED HYDROCARBON ANALYSIS/NJ 1993) ; ASTM D6730*
THIS DATA HAS BEEN ACQUIRED THROUGH APPLICATION OF CURRENT STATE-OF-THE-ART ANALYTICAL TECHNIQUES. THE USE OF THIS INFORMATION IS THE RESPONSIBLITY OF THE USER. EMPACT ANALYTICAL SYSTEMS, ASSUMES NO RESPONSIBLITY FOR ACCURACY OF THE REPORTED INFORMATION NOR ANY CONSEQUENCES OF IT'S APPLICATION.

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(303) 637-0150

EXTENDED NATURAL GAS LIQUID ANALYSIS (*DHA)

PROJECT NO. :	**200705124**	ANALYSIS NO. :	**02**
COMPANY NAME :	**ANADARKO**	ANALYSIS DATE:	MAY 24, 2007
ACCOUNT NO. :		SAMPLE DATE :	MAY 14, 2007
PRODUCER :		CYLINDER NO. :	Q11074
LEASE NO. :		SAMPLED BY :	J. S. JOHNSON
NAME/DESCRIP :	NATURAL BUTTES NBU 920 - 25O		
FIELD DATA		SAMPLE TEMP. :	79
SAMPLE PRES. :	100	AMBIENT TEMP.:	
VAPOR PRES. :		GRAVITY :	
COMMENTS :	MANUAL; CYL. PRESS: 100		

TOTALS BY CARBON NUMBER

CARBON NUMBER	MOLE%	MASS %	VOL %
Nitrogen (air)	0.000	0.000	0.000
Carbon Dioxide	0.618	0.254	0.229
Methanol	0.000	0.000	0.000
C1	3.864	0.569	1.423
C2	1.778	0.499	1.029
C3	1.794	0.738	1.069
C4	2.406	1.305	1.663
C5	3.611	2.424	2.784
C6	9.504	7.509	7.688
C7	22.715	20.631	19.935
C8	23.337	24.205	23.028
C9	12.817	15.083	14.796
C10	8.031	11.102	11.109
C11	4.344	6.904	6.740
C12	2.384	3.788	3.699
C13	1.531	2.634	2.550
C14	0.784	1.350	1.304
C15	0.329	0.672	0.640
C16	0.114	0.241	0.229
C17	0.024	0.054	0.051
C18	0.008	0.018	0.017
C19	0.002	0.006	0.006
C20+	0.005	0.014	0.011
Total	100.000	100.000	100.000

Average Molecular Weight of Hexanes plus	=	**117.50**
Average Specific Gravity of Hexanes plus	=	**0.755**
Average Molecular Weight of Decanes plus	=	**159.08**
Average Specific Gravity of Decanes plus	=	**0.742**

EMPACT ANALYTICAL SYSTEMS, INC

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E & P Tank / GlyCalc Information

PROJECT NO. :	**200705124**	ANALYSIS NO. :	**02**
COMPANY NAME :	**ANADARKO**	ANALYSIS DATE:	MAY 24, 2007
ACCOUNT NO. :		SAMPLE DATE :	MAY 14, 2007
PRODUCER :		CYLINDER NO. :	Q11074
LEASE NO. :		SAMPLED BY :	J. S. JOHNSON
NAME/DESCRIP :	NATURAL BUTTES NBU 920 - 25O		
FIELD DATA		SAMPLE TEMP. :	79
SAMPLE PRES. :	100	AMBIENT TEMP.:	
VAPOR PRES. :		GRAVITY :	
COMMENTS :	MANUAL; CYL. PRESS: 100		

COMPONENT	Mole %		Wt %		LV %	
CO2	0.618		0.254		0.229	
METHANOL	0.000		0.000		0.000	
NITROGEN (AIR)	0.000		0.000		0.000	
METHANE	3.864		0.569		1.423	
ETHANE	1.778		0.499		1.029	
PROPANE	1.794		0.738		1.069	
I-BUTANE	0.845		0.458		0.600	
N-BUTANE	1.561		0.847		1.063	
I-PENTANE	1.544		1.040		1.223	
N-PENTANE	1.647		1.109		1.292	
CYCLOPENTANE (N-C5)	0.420		0.275		0.269	
N-HEXANE	2.588		2.081		2.304	
CYCLOHEXANE (OTHER C6)	2.441		1.917		1.795	
OTHER HEXANES	3.604		2.876		3.063	
OTHER HEPTANES	9.616		8.949		9.358	
METHYLCYCLOHEXANE (OTHER C6)	7.453		6.828		6.483	
2,2,4 TRIMETHYLPENTANE	0.000		0.000		0.000	
BENZENE	0.871		0.635		0.526	
TOLUENE	5.646		4.854		4.094	
ETHYLBENZENE	0.466		0.462		0.389	
XYLENES	6.947		6.882		5.780	
OTHER OCTANES	15.924		16.861		16.859	
OCTANES PLUS	----	46.297	----	58.727	----	58.011
NONANES	12.817		15.083		14.796	
DECANES PLUS	17.556		26.783		26.356	
SUBTOTAL	100.000		100.000		100.000	
OXYGEN	0.000		0.000		0.000	
TOTAL	100.000		100.000		100.000	

API Gravity =	**60.94**	60/60
Vapor Pressure =	**213.58**	PSIA & 100 F
Average Molecular Weight of Decanes plus =	**159.08**	
Average Specific Gravity of Decanes plus =	**0.742**	

EMPACT ANALYTICAL SYSTEMS, INC

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BRIGHTON, CO 80601
(303) 637-0150

EXTENDED NATURAL GAS LIQUID ANALYSIS (*DHA)

PROJECT NO. : **200705124** ANALYSIS NO. : **02**
COMPANY NAME : **ANADARKO** ANALYSIS DATE: **MAY 24, 2007**

COMPONENT	PIANO #	MOLE %	MASS %	VOL %
NITROGEN (AIR)		0.000	0.000	0.000
CO2		0.618	0.254	0.229
METHANE	P1	3.864	0.569	1.423
ETHANE	P2	1.778	0.499	1.029
PROPANE	P3	1.794	0.738	1.069
I-BUTANE	I4	0.845	0.458	0.600
N-BUTANE	P4	1.561	0.847	1.063
2,2 DIMETHYLPROPANE	I5	0.000	0.000	0.000
I-PENTANE	I5	1.544	1.040	1.223
N-PENTANE	P5	1.647	1.109	1.292
2,2 DIMETHYLBUTANE	I6	0.148	0.119	0.131
METHANOL	X1	0.000	0.000	0.000
CYCLOPENTANE	N5	0.420	0.275	0.269
2,3 DIMETHYLBUTANE	I6	0.000	0.000	0.000
2 METHYLPENTANE	I6	1.366	1.099	1.229
3 METHYLPENTANE	I6	0.886	0.713	0.783
N-HEXANE	P6	2.588	2.081	2.304
2,2-DIMETHYLPENTANE	I7	0.077	0.072	0.080
METHYLCYCLOPENTANE	N6	1.204	0.945	0.920
2,4 DIMETHYLPENTANE	I7	0.307	0.287	0.314
2,2,3 TRIMETHYLBUTANE	I7	0.091	0.085	0.091
BENZENE	A6	0.871	0.635	0.526
3,3 DIMETHYLPENTANE	I7	0.118	0.110	0.114
CYCLOHEXANE	N6	2.441	1.917	1.795
2 METHYLHEXANE	I7	0.801	0.749	0.806
2,3 DIMETHYLPENTANE	I7	0.567	0.530	0.555
1,1 DIMETHYLCYCLOPENTANE	N7	0.424	0.389	0.377
3 METHYLHEXANE	I7	1.286	1.202	1.281
1,C 3 DIMETHYLCYCLOPENTANE	N7	0.392	0.359	0.354
1,T 3 DIMETHYLCYCLOPENTANE	N7	0.311	0.285	0.280
3 ETHYLPENTANE	I7	0.103	0.096	0.103
1,T 2 DIMETHYLCYCLOPENTANE	N7	0.841	0.771	0.749
N-HEPTANE	P7	4.037	3.775	4.031
1,C 2 DIMETHYLCYCLOPENTANE	N7	0.009	0.008	0.006
METHYLCYCLOHEXANE	N7	7.453	6.828	6.483
2,2-DIMETHYLHEXANE	I8	1.182	1.260	1.286
ETHYLCYCLOPENTANE	N7	0.252	0.231	0.217
2,5-DIMETHYLHEXANE	I8	0.218	0.232	0.246
2,4-DIMETHYLHEXANE	I8	0.332	0.354	0.366

PROJECT NO. : **200705124** ANALYSIS NO. : **02**
COMPANY NAME : **ANADARKO** ANALYSIS DATE: **MAY 24, 2007**

COMPONENT	PIANO #	MOLE %	MASS %	VOL %
1C,2T,4-TRIMETHYLCYCLOPENTANE	N8	0.137	0.144	0.137
3,3-DIMETHYLHEXANE	I8	0.167	0.178	0.183
2,3,4-TRIMETHYLPENTANE	I8	0.034	0.036	0.034
2,3,3-TRIMETHYLPENTANE	I8	0.006	0.007	0.006
TOLUENE	A7	5.646	4.854	4.094
2,3-DIMETHYLHEXANE	I8	0.327	0.348	0.360
2-METHYL-3-ETHYLPENTANE	I8	0.094	0.100	0.091
1,1,2-TRIMETHCYCLOPENTANE	N8	0.028	0.030	0.029
2-METHYLHEPTANE	I8	0.881	0.939	0.983
4-METHYLHEPTANE	I8	0.704	0.751	0.778
3-METHYL-3-ETHYLPENTANE	I8	0.071	0.075	0.069
3,4-DIMETHYLHEXANE	I8	0.069	0.073	0.074
1C,2C,4-TRIMETHYLCYCLOPENTANE	N8	0.168	0.176	0.166
3-METHYLHEPTANE	I8	0.804	0.857	0.886
1C,2T,3-TRIMETHYLCYCLOPENTANE	N8	1.406	1.472	1.366
3-ETHYLHEXANE	I8	0.330	0.352	0.360
1T,4-DIMETHYLCYCLOHEXANE	N8	1.783	1.867	1.789
1,1-DIMETHYLCYCLOHEXANE	N8	0.482	0.505	0.475
3C-ETHYLMETHYLCYCLOPENTANE	N8	0.047	0.049	0.046
3T-ETHYLMETHYLCYCLOPENTANE	N8	0.122	0.128	0.120
2T-ETHYLMETHYLCYCLOPENTANE	N8	0.068	0.071	0.063
1,1-METHYLETHYLCYCLOPENTANE	N8	0.119	0.124	0.114
2,2,4-TRIMETHYLHEXANE	I9	0.062	0.074	0.074
1T,2-DIMETHYLCYCLOHEXANE	N8	0.811	0.849	0.789
N-OCTANE	P8	4.048	4.314	4.488
I-PROPYLCYCLOPENTANE	N8	0.249	0.260	0.240
1C,2-DIMETHYLCYCLOHEXANE	N8	0.108	0.113	0.103
2,2-DIMETHYLHEPTANE	I9	0.073	0.087	0.086
2,3,5-TRIMETHYLHEXANE	I9	0.118	0.141	0.143
1,1,4-TRIMETHYLCYCLOHEXANE	N9	0.958	1.128	1.069
2,2,3-TRIMETHYLHEXANE	I9	0.442	0.528	0.543
ETHYLCYCLOHEXANE	N9	0.267	0.314	0.297
N-PROPYLCYCLOPENTANE	N8	0.309	0.323	0.303
1C,3C,5-TRIMETHYLCYCLOHEXANE	N9	0.125	0.148	0.137
3,5-DIMETHYLHEPTANE	I9	0.053	0.063	0.063
2,6-DIMETHYLHEPTANE	I9	0.013	0.015	0.017
2,5-DIMETHYLHEPTANE	I9	0.066	0.080	0.080
3,3-DIMETHYLHEPTANE	I9	0.096	0.115	0.114
ETHYLBENZENE	A8	0.466	0.462	0.389
1C,2T,4T-TRIMETHYLCYCLOHEXANE	N9	0.130	0.153	0.143
1,3-DIMETHYLBENZENE (M-XYLENE)	A8	4.309	4.269	3.585
1,4-DIMETHYLBENZENE (P-XYLENE)	A8	1.485	1.471	1.235
3,4-DIMETHYLHEPTANE	I9	0.541	0.648	0.646
4-METHYLOCTANE	I9	0.258	0.309	0.314
2-METHYLOCTANE	I9	0.897	1.073	1.098
1C,2T,3-TRIMETHYLCYCLOHEXANE	N9	0.173	0.207	0.212

PROJECT NO. : **200705124** ANALYSIS NO. : **02**

COMPANY NAME : **ANADARKO** ANALYSIS DATE: **MAY 24, 2007**

COMPONENT	PIANO #	MOLE %	MASS %	VOL %
3-ETHYLHEPTANE	I9	0.119	0.143	0.143
3-METHYLOCTANE	I9	0.587	0.703	0.715
1C,2T,4C-TRIMETHYLCYCLOHEXANE	N9	0.150	0.177	0.166
1,1,2-TRIMETHYLCYCLOHEXANE	N9	0.015	0.018	0.017
1,2-DIMETHYLBENZENE (O-XYLENE)	A8	1.153	1.142	0.960
I-BUTYCYCLOPENTANE	N9	0.325	0.382	0.349
UNKNOWN OCTANE'S	U8	0.820	0.874	0.909
N-NONANE	P9	3.108	3.719	3.785
I-PROPYLBENZENE	A9	0.346	0.343	0.286
I-PROPYLCYCLOHEXANE	N9	0.372	0.368	0.309
2,4-DIMETHYLOCTANE	I10	0.372	0.494	0.486
2,6-DIMETHYLOCTANE	I10	0.412	0.546	0.560
N-BUTYCYCLOPENTANE	N9	0.599	0.706	0.640
3,3-DIMETHYLOCTANE	I10	0.346	0.460	0.452
N-PROPYLBENZENE	A9	0.764	0.857	0.720
3,6-DIMETHYLOCTANE	I10	0.063	0.084	0.086
3-METHYL-5-ETHYLHEPTANE	I10	0.044	0.052	0.051
UNKNOWN NONANE'S	U9	2.160	2.584	2.630
N-DECANE	P10	2.501	3.485	3.488
UNKNOWN DECANE'S	U10	4.293	5.981	5.986
N-UNDECANE	P11	1.611	2.561	2.498
UNKNOWN UNDECANE'S	U11	2.733	4.343	4.242
DODECANES	C12'S	2.384	3.788	3.699
TRIDECANES	C13'S	1.531	2.634	2.550
TETRADECANES	C14'S	0.784	1.350	1.304
PENTADECANES	C15'S	0.329	0.672	0.640
HEXADECANES	C16'S	0.114	0.241	0.229
HEPTADECANES	C17'S	0.024	0.054	0.051
OCTADECANES	C18'S	0.008	0.018	0.017
NONADECANES	C19'S	0.002	0.006	0.006
EISCOSANE+	C20'S	0.005	0.014	0.011
TOTALS		100.000	100.000	100.000

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*     Project Setup Information                                               *
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Project File              : C:\Documents and Settings\ehodek\My Documents\Uintah Old Well 072009.ept
Flowsheet Selection       : Oil Tank with Separator
Calculation Method        : RVP Distillation
Control Efficiency        : 100.0%
Known Separator Stream    : High Pressure Oil
Entering Air Composition  : No

Filed Name                : Greater Natural Buttes
Well Name                 : Old Well
Date                      : 2008.03.25


*******************************************************************************
*     Data Input                                                              *
*******************************************************************************

Separator Pressure        : 90.00[psig]
Separator Temperature     : 78.00[F]
Ambient Pressure          : 14.70[psia]
Ambient Temperature       : 70.00[F]
C10+ SG                   : 0.7400
C10+ MW                   : 159.67

-- High Pressure Oil ----------------------------------------------------------
   No.    Component             mol %
   1      H2S                   0.0000
   2      O2                    0.0000
   3      CO2                   0.4190
   4      N2                    0.0000
   5      C1                    4.0438
   6      C2                    1.9669
   7      C3                    1.9609
   8      i-C4                  0.9410
   9      n-C4                  1.7049
   10     i-C5                  1.6679
   11     n-C5                  2.1989
   12     C6                    6.2227
   13     C7                   17.1271
   14     C8                   15.6182
   15     C9                   12.5804
   16     C10+                 17.2661
   17     Benzene               0.9069
   18     Toluene               5.6567
   19     E-Benzene             0.4490
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20	Xylenes	6.5727
21	n-C6	2.6969
22	224Trimethylp	0.0000

-- Sales Oil ----------

Production Rate : 3[bbl/day]
Days of Annual Operation : 365 [days/year]
API Gravity : 61.28
Reid Vapor Pressure : 7.25[psia]

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* Calculation Results *
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-- Emission Summary ----------

Item	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
Total HAPs	0.080	0.018	0.013	0.003
Page 1---------- E&P TANK				
Total HC	2.401	0.548	0.400	0.091
VOCs, C2+	1.796	0.410	0.299	0.068
VOCs, C3+	1.273	0.291	0.212	0.048

Uncontrolled Recovery Info.

Vapor	167.4000 x1E-3	[MSCFD]
HC Vapor	158.7100 x1E-3	[MSCFD]
GOR	55.80	[SCF/bbl]

-- Emission Composition ----------

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
1	H2S	0.000	0.000	0.000	0.000
2	O2	0.000	0.000	0.000	0.000
3	CO2	0.184	0.042	0.613	0.140
4	N2	0.000	0.000	0.000	0.000
5	C1	0.605	0.138	0.101	0.023
6	C2	0.522	0.119	0.087	0.020
7	C3	0.427	0.097	0.071	0.016
8	i-C4	0.133	0.030	0.022	0.005
9	n-C4	0.177	0.040	0.030	0.007
10	i-C5	0.090	0.021	0.015	0.003
11	n-C5	0.089	0.020	0.015	0.003
12	C6	0.106	0.024	0.018	0.004
13	C7	0.116	0.026	0.019	0.004
14	C8	0.040	0.009	0.007	0.002
15	C9	0.013	0.003	0.002	0.000
16	C10+	0.003	0.001	0.001	0.000

17	Benzene	0.010	0.002	0.002	0.000
18	Toluene	0.022	0.005	0.004	0.001
19	E-Benzene	0.001	0.000	0.000	0.000
20	Xylenes	0.009	0.002	0.001	0.000
21	n-C6	0.037	0.008	0.006	0.001
22	224Trimethylp	0.000	0.000	0.000	0.000
	Total	2.584	0.590	0.431	0.098

-- Stream Data ----------

No.	Component	MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S	34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2	32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2	44.01	0.3769	0.0840	0.0484	5.2604	4.3922	5.1881
4	N2	28.01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	C1	16.04	3.0671	0.2776	0.0764	49.5796	16.1487	46.7933
6	C2	30.07	1.8755	0.7128	0.5332	21.2616	24.7510	21.5524
7	C3	44.10	1.9500	1.3882	1.2657	11.3178	19.5050	12.0002
8	i-C4	58.12	0.9460	0.8468	0.8174	2.5996	5.4619	2.8382
9	n-C4	58.12	1.7176	1.6152	1.5774	3.4243	7.7374	3.7837
10	i-C5	72.15	1.6854	1.7044	1.6948	1.3689	3.6023	1.5550
11	n-C5	72.15	2.2232	2.2764	2.2705	1.3361	3.7528	1.5375
12	C6	86.16	6.2976	6.5962	6.6208	1.3189	4.3371	1.5705
13	C7	100.20	17.3395	18.3079	18.4224	1.1933	4.6814	1.4840
14	C8	114.23	15.8140	16.7422	16.8634	0.3374	1.5895	0.4418
15	C9	128.28	12.7386	13.4971	13.5994	0.0921	0.5165	0.1275
16	C10+	159.67	17.4836	18.5312	18.6751	0.0163	0.1260	0.0255
17	Benzene	78.11	0.9180	0.9649	0.9696	0.1354	0.4661	0.1630
18	Toluene	92.13	5.7273	6.0569	6.0982	0.2326	0.9761	0.2946
19	E-Benzene	106.17	0.4546	0.4815	0.4851	0.0060	0.0296	0.0079
20	Xylenes	106.17	6.6553	7.0499	7.1026	0.0756	0.3871	0.1016
21	n-C6	86.18	2.7297	2.8668	2.8797	0.4440	1.5392	0.5352
22	224Trimethylp	114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW		105.65	110.15	110.68	30.68	47.36	32.07
	Stream Mole Ratio		1.0000	0.9434	0.9361	0.0566	0.0051	0.0617
	Heating Value	[BTU/SCF]				1659.60	2560.36	1734.67
	Gas Gravity	[Gas/Air]				1.06	1.63	1.11
	Bubble Pt. @ 100F	[psia]	115.65	19.44	11.71			
	RVP @ 100F	[psia]	29.56	9.23	7.25			

Page 2---------- E&P TANK

Spec. Gravity @ 100F	0.679	0.684	0.685

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*     Project Setup Information                                               *
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Project File              : C:\Documents and Settings\ehodek\My Documents\Uintah New Well 072009.ept
Flowsheet Selection       : Oil Tank with Separator
Calculation Method        : RVP Distillation
Control Efficiency        : 100.0%
Known Separator Stream    : High Pressure Oil
Entering Air Composition  : No

Filed Name                : Greater Natural Buttes
Well Name                 : Old Well
Date                      : 2008.03.25


*******************************************************************************
*     Data Input                                                              *
*******************************************************************************

Separator Pressure        : 90.00[psig]
Separator Temperature     : 78.00[F]
Ambient Pressure          : 14.70[psia]
Ambient Temperature       : 70.00[F]
C10+ SG                   : 0.7400
C10+ MW                   : 159.67

-- High Pressure Oil ----------------------------------------------------------
   No.    Component             mol %
   1      H2S                   0.0000
   2      O2                    0.0000
   3      CO2                   0.4190
   4      N2                    0.0000
   5      C1                    4.0438
   6      C2                    1.9669
   7      C3                    1.9609
   8      i-C4                  0.9410
   9      n-C4                  1.7049
   10     i-C5                  1.6679
   11     n-C5                  2.1989
   12     C6                    6.2227
   13     C7                   17.1271
   14     C8                   15.6182
   15     C9                   12.5804
   16     C10+                 17.2661
   17     Benzene               0.9069
   18     Toluene               5.6567
   19     E-Benzene             0.4490
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20	Xylenes	6.5727
21	n-C6	2.6969
22	224Trimethylp	0.0000

-- Sales Oil ----------

Production Rate : 10[bbl/day]
Days of Annual Operation : 365 [days/year]
API Gravity : 61.28
Reid Vapor Pressure : 7.25[psia]

****
* Calculation Results *
****

-- Emission Summary ----------

Item	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
Total HAPs	0.260	0.059	0.013	0.003
Page 1---------- E&P TANK				
Total HC	8.002	1.827	0.400	0.091
VOCs, C2+	5.985	1.366	0.299	0.068
VOCs, C3+	4.244	0.969	0.212	0.048

Uncontrolled Recovery Info.

Vapor	557.9900 x1E-3	[MSCFD]
HC Vapor	529.0400 x1E-3	[MSCFD]
GOR	55.80	[SCF/bbl]

-- Emission Composition ----------

No	Component	Uncontrolled [ton/yr]	Uncontrolled [lb/hr]	Controlled [ton/yr]	Controlled [lb/hr]
1	H2S	0.000	0.000	0.000	0.000
2	O2	0.000	0.000	0.000	0.000
3	CO2	0.613	0.140	0.613	0.140
4	N2	0.000	0.000	0.000	0.000
5	C1	2.017	0.461	0.101	0.023
6	C2	1.741	0.397	0.087	0.020
7	C3	1.422	0.325	0.071	0.016
8	i-C4	0.443	0.101	0.022	0.005
9	n-C4	0.591	0.135	0.030	0.007
10	i-C5	0.301	0.069	0.015	0.003
11	n-C5	0.298	0.068	0.015	0.003
12	C6	0.354	0.081	0.018	0.004
13	C7	0.387	0.088	0.019	0.004
14	C8	0.132	0.030	0.007	0.002
15	C9	0.042	0.010	0.002	0.000
16	C10+	0.011	0.003	0.001	0.000

17	Benzene	0.034	0.008	0.002	0.000
18	Toluene	0.073	0.017	0.004	0.001
19	E-Benzene	0.002	0.000	0.000	0.000
20	Xylenes	0.029	0.007	0.001	0.000
21	n-C6	0.124	0.028	0.006	0.001
22	224Trimethylp	0.000	0.000	0.000	0.000
	Total	8.614	1.967	0.431	0.098

-- Stream Data ----------

No.	Component	MW	LP Oil mol %	Flash Oil mol %	Sale Oil mol %	Flash Gas mol %	W&S Gas mol %	Total Emissions mol %
1	H2S	34.80	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	O2	32.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	CO2	44.01	0.3769	0.0840	0.0484	5.2604	4.3922	5.1881
4	N2	28.01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	C1	16.04	3.0671	0.2776	0.0764	49.5796	16.1487	46.7933
6	C2	30.07	1.8755	0.7128	0.5332	21.2616	24.7510	21.5524
7	C3	44.10	1.9500	1.3882	1.2657	11.3178	19.5050	12.0002
8	i-C4	58.12	0.9460	0.8468	0.8174	2.5996	5.4619	2.8382
9	n-C4	58.12	1.7176	1.6152	1.5774	3.4243	7.7374	3.7837
10	i-C5	72.15	1.6854	1.7044	1.6948	1.3689	3.6023	1.5550
11	n-C5	72.15	2.2232	2.2764	2.2705	1.3361	3.7528	1.5375
12	C6	86.16	6.2976	6.5962	6.6208	1.3189	4.3371	1.5705
13	C7	100.20	17.3395	18.3079	18.4224	1.1933	4.6814	1.4840
14	C8	114.23	15.8140	16.7422	16.8634	0.3374	1.5895	0.4418
15	C9	128.28	12.7386	13.4971	13.5994	0.0921	0.5165	0.1275
16	C10+	159.67	17.4836	18.5312	18.6751	0.0163	0.1260	0.0255
17	Benzene	78.11	0.9180	0.9649	0.9696	0.1354	0.4661	0.1630
18	Toluene	92.13	5.7273	6.0569	6.0982	0.2326	0.9761	0.2946
19	E-Benzene	106.17	0.4546	0.4815	0.4851	0.0060	0.0296	0.0079
20	Xylenes	106.17	6.6553	7.0499	7.1026	0.0756	0.3871	0.1016
21	n-C6	86.18	2.7297	2.8668	2.8797	0.4440	1.5392	0.5352
22	224Trimethylp	114.24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MW		105.65	110.15	110.68	30.68	47.36	32.07
	Stream Mole Ratio		1.0000	0.9434	0.9361	0.0566	0.0051	0.0617
	Heating Value	[BTU/SCF]				1659.60	2560.36	1734.67
	Gas Gravity	[Gas/Air]				1.06	1.63	1.11
	Bubble Pt. @ 100F	[psia]	115.65	19.44	11.71			
	RVP @ 100F	[psia]	29.56	9.23	7.25			

Page 2---------- E&P TANK

Spec. Gravity @ 100F	0.679	0.684	0.685

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GNB001
City:	
State:	Utah
Company:	Anadarko Petroleum
Type of Tank:	Vertical Fixed Roof Tank
Description:	GNB Tank Battery Condensate Tank

Tank Dimensions

Shell Height (ft):		16.00
Diameter (ft):		26.74
Liquid Height (ft) :		15.00
Avg. Liquid Height (ft):		7.50
Volume (gallons):		63,000.00
Turnovers:		162.80
Net Throughput(gal/yr):		10,256,400.00
Is Tank Heated (y/n):	N	

Paint Characteristics

Shell Color/Shade:	Gray/Medium
Shell Condition	Good
Roof Color/Shade:	Gray/Medium
Roof Condition:	Good

Roof Characteristics

Type:	Cone	
Height (ft)		1.00
Slope (ft/ft) (Cone Roof)		0.06

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GNB001 - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max	Vapor Mol Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
GNB Condensate	All	63.14	51.01	75.26	56.01	5.0688	4.0662	6.2557	36.2400			110.68	Option 4: RVP=7.25

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GNB001 - Vertical Fixed Roof Tank

Annual Emission Calcaulations

Standing Losses (lb):	6,758.0928
Vapor Space Volume (cu ft):	4,960.6354
Vapor Density (lb/cu ft):	0.0327
Vapor Space Expansion Factor:	0.3645
Vented Vapor Saturation Factor:	0.2965
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	4,960.6354
Tank Diameter (ft):	26.7400
Vapor Spece Outage (ft):	8.8333
Tank Shell Height (ft):	16.0000
Average Liquid Height (ft):	7.5000
Roof Outage (ft):	0.3333
Roof Outage (Cone Roof)	
Roof Outage (ft):	0.3333
Roof Height (ft):	1.0000
Roof Slope (ft/ft):	0.0600
Shell Radius (ft):	13.3700
Vapor Density	
Vapor Density (lb/cu ft):	0.0327
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Daily Avg. Liquid Surface Temp. (deg. R):	522.8068
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)).	10.731
Liquid Bulk Temperature (deg. R):	515.6833
Tank Paint Solar Absorptance (Shell)	0.6800
Tank Paint Solar Absorptance (Roof):	0.6600
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.3845
Daily Vapor Temperature Range (deg. R):	48.5071
Daily Vapor Prassure Range (psia):	2.1895
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	4.0862
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	6.2557
Daily Avg. Liquid Surface Temp. (deg R):	522.8068
Daily Min. Liquid Surface Temp. (deg R).	510.6801
Daily Max. Liquid Surface Temp. (deg R):	534.9336
Daily Ambient Temp. Range (deg R)	25.6333
Vented Vapor Saturation Factor	
Vented Vepor Saturation Factor:	0.2965
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	5.0688
Vapor Space Outage (ft):	8.8333
Working Losses (lb):	11,806.9025
Vapor Molecular Weight (lb/lb-mole).	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Annual Net Throughput (gal/yr.).	10,258,400.0000

Annual Turnovers:	162.8000
Turnover Factor:	0.3509
Maximum Liquid Volume (gal):	63,000.0000
Maximum Liquid Height (ft):	15.0000
Tank Diameter (ft):	26.7400
Working Loss Product Factor:	0.7500

Total Losses (lb):	18,564.9953

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GNB001 - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
GNB Condensate	11,806.90	6,758.09	18,565.00

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GNB002
City:	
State:	Utah
Company:	Anadarko Petroleum
Type of Tank:	Vertical Fixed Roof Tank
Description:	GNB Tank Battery Total Fluid Tank

Tank Dimensions

Shell Height (ft):	21.00
Diameter (ft):	32.20
Liquid Height (ft) :	20.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	121,800.00
Turnovers:	247.40
Net Throughput(gal/yr):	30,133,320.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Medium
Shell Condition	Good
Roof Color/Shade:	Gray/Medium
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft)	1.00
Slope (ft/ft) (Cone Roof)	0.06

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GNB002 - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
GNB Condensate	All	63.14	51.01	75.26	56.01	5.0686	4.0662	6.2557	36.2400			110.68	Option 4: RVP=7.25

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GNB002 - Vertical Fixed Roof Tank

Annual Emission Calcaulations

Standing Losses (lb):	10,485.4259
Vapor Space Volume (cu ft):	9,229.0986
Vapor Density (lb/cu ft):	0.0327
Vapor Space Expansion Factor.	0.3845
Vented Vapor Saturation Factor.	0.2472
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft).	9,229.0986
Tank Diameter (ft):	32.2000
Vapor Space Outage (ft):	11.3333
Tank Shell Height (ft):	21.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.3333
Roof Outage (Cone Roof)	
Roof Outage (ft):	0.3333
Roof Height (ft):	1.0000
Roof Slope (ft/ft).	0.0600
Shell Radius (ft):	18.1000
Vapor Density	
Vapor Density (lb/cu ft):	0.0327
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Daily Avg. Liquid Surface Temp. (deg. R):	522.8068
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg R):	515.6833
Tank Paint Solar Absorptance (Shell):	0.6800
Tank Paint Solar Absorptance (Roof):	0.6800
Daily Total Solar Insulation Factor (Btu/sqft day)	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.3845
Daily Vapor Temperature Range (deg R):	48.5071
Daily Vapor Pressure Range (psia):	2.1895
Breather Vent Press. Setting Range(psia).	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	4.0682
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	6.2557
Daily Avg. Liquid Surface Temp. (deg R):	522.8068
Daily Min. Liquid Surface Temp. (deg R):	510.6801
Daily Max. Liquid Surface Temp. (deg R):	534.9336
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.2472
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	5.0688
Vapor Space Outage (ft):	11.3333
Working Losses (lb):	28,460.1000
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Annual Net Throughput (gal/yr.):	30,133,320.0000

Annual Turnovers:	247.4000
Turnover Factor:	0.2879
Maximum Liquid Volume (gal):	121,800.0000
Maximum Liquid Height (ft):	20.0000
Tank Diameter (ft):	32.2000
Working Loss Product Factor:	0.7500

Total Losses (lb):	38,945.5258

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GNB002 - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
GNB Condensate	28,460.10	10,485.43	38,945.53

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GNB001OR
City:	
State:	Utah
Company:	Anadarko Petroleum
Type of Tank:	Vertical Fixed Roof Tank
Description:	GNB Tank Battery Condensate Tank Optimal Recovery

Tank Dimensions

Shell Height (ft):	16.00
Diameter (ft):	26.74
Liquid Height (ft) :	15.00
Avg. Liquid Height (ft):	7.50
Volume (gallons):	63,000.00
Turnovers:	210.80
Net Throughput(gal/yr):	13,280,400.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Medium
Shell Condition	Good
Roof Color/Shade:	Gray/Medium
Roof Condition:	Good

Roof Characteristics

Type:	Cone
Height (ft)	1.00
Slope (ft/ft) (Cone Roof)	0.06

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GNB001OR - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
GNB Condensate	All	63.14	51.01	75.26	56.01	5.0688	4.0662	6.2557	36.2400			110.68	Option 4: RVP=7.25

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GNB001OR - Vertical Fixed Roof Tank

Annual Emission Calcaulations	
Standing Losses (lb):	6,758.0928
Vapor Space Volume (cu ft):	4,960.6354
Vapor Density (lb/cu ft):	0.0327
Vapor Space Expansion Factor:	0.3845
Vented Vapor Saturation Factor:	0.2965
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	4,960.6354
Tank Diameter (ft):	26.7400
Vapor Space Outage (ft):	8.8333
Tank Shell Height (ft):	16.0000
Average Liquid Height (ft):	7.5000
Roof Outage (ft):	0.3333
Roof Outage (Cone Roof)	
Roof Outage (ft):	0.3333
Roof Height (ft):	1.0000
Roof Slope (ft/ft):	0.0800
Shell Radius (ft):	13.3700
Vapor Density	
Vapor Density (lb/cu ft):	0.0327
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Daily Avg. Liquid Surface Temp. (deg. R):	522.8068
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	515.6833
Tank Paint Solar Absorptance (Shell):	0.6800
Tank Paint Solar Absorptance (Roof):	0.6800
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.3845
Daily Vapor Temperature Range (deg. R):	48.5071
Daily Vapor Pressure Range (psia):	2.1895
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	4.0862
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	6.2557
Daily Avg. Liquid Surface Temp. (deg R):	522.8068
Daily Min. Liquid Surface Temp. (deg R):	510.6801
Daily Max. Liquid Surface Temp. (deg R):	534.9336
Daily Ambient Temp. Range (deg. R):	25.8333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.2965
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Vapor Space Outage (ft):	8.8333
Working Losses (lb):	13,460.1444
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Annual Net Throughput (gal/yr.):	13,280,400.0000

Annual Turnovers:	210.8000
Turnover Factor:	0.3090
Maximum Liquid Volume (gal):	63,000.0000
Maximum Liquid Height (ft):	15.0000
Tank Diameter (ft):	26.7400
Working Loss Product Factor:	0.7500

Total Losses (lb):	20,218.2372

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GNB001OR - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
GNB Condensate	13,460.14	6,758.09	20,218.24

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GNB002OR
City:	
State:	Utah
Company:	Anadarko Petroleum
Type of Tank:	Vertical Fixed Roof Tank
Description:	GNB Tank Battery Total Fluid Tank Optimal Recovery

Tank Dimensions

Shell Height (ft):		21.00
Diameter (ft):		32.20
Liquid Height (ft) :		20.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		121,800.00
Turnovers:		368.10
Net Throughput(gal/yr):		44,834,580.00
Is Tank Heated (y/n):	N	

Paint Characteristics

Shell Color/Shade:	Gray/Medium
Shell Condition	Good
Roof Color/Shade:	Gray/Medium
Roof Condition:	Good

Roof Characteristics

Type:	Cone	
Height (ft)		1.00
Slope (ft/ft) (Cone Roof)		0.06

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GNB002OR - Vertical Fixed Roof Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
GNB Condensate	All	63.14	51.01	75.26	56.01	5.0688	4.0662	6.2557	36.2400			110.68	Option 4: RVP=7.25

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GNB002OR - Vertical Fixed Roof Tank

Annual Emission Calcaulations

Standing Losses (lb):	10,485.4259
Vapor Space Voluma (cu ft):	9,229.0986
Vapor Density (lb/cu ft):	0.0327
Vapor Space Expansion Factor:	0.3845
Vented Vapor Saturation Factor:	0.2472
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	9,229.0986
Tank Diameter (ft):	32.2000
Vapor Space Outage (ft):	11.3333
Tank Shell Height (ft):	21.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.3333
Roof Outage (Cone Roof)	
Roof Outage (ft):	0.3333
Roof Height (ft):	1.0000
Roof Slope (ft/ft):	0.0600
Shell Radius (ft):	16.1000
Vapor Density	
Vapor Density (lb/cu ft):	0.0327
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	5.0688
Daily Avg. Liquid Surface Temp. (deg. R):	522.8068
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	515.6833
Tank Paint Solar Absorptance (Shell):	0.6800
Tank Paint Solar Absorptance (Roof):	0.6800
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.3845
Daily Vapor Temperature Range (deg. R):	48.5071
Daily Vapor Pressure Range (psia):	2.1895
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Avarage Liquid Surface Temperature (psia):	5.0688
Vapor Pressure at Daily Minimum Liquid Surface Tamperature (psia):	4.0862
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	6.2557
Daily Avg. Liquid Surface Temp. (deg R):	522.8068
Daily Min. Liquid Surface Temp. (deg R):	510.6801
Daily Max. Liquid Surface Temp. (deg R):	534.9336
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturetion Factor:	0.2472
Vapor Pressura at Daily Average Liquid: Surface Temperature (psia):	5.0688
Vapor Space Outage (ft):	11.3333
Working Losses (lb).	36,497.3814
Vapor Molecular Weight (lb/lb-mole):	36.2400
Vapor Pressure at Daily Average Liquid Surfaca Temperature (psia):	5.0688
Annual Net Throughput (gal/yr.):	44,834,580.0000

Annual Turnovers:	368.1000
Turnover Factor:	0.2482
Maximum Liquid Volume (gal):	121,800.0000
Maximum Liquid Height (ft):	20.0000
Tank Diameter (ft):	32.2000
Working Loss Product Factor:	0.7500

Total Losses (lb):	46,982.8072

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GNB002OR - Vertical Fixed Roof Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
GNB Condensate	36,497.38	10,485.43	46,982.81

G3412C LE

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED:	1800	FUEL:	NAT GAS
COMPRESSION RATIO:	11.4:1	FUEL SYSTEM:	LPG IMPCO
AFTERCOOLER - MAX. INLET (°F):	130		
JACKET WATER - MAX. OUTLET (°F):	210	FUEL PRESS. RANGE (PSIG):	1.5 - 5.0
COOLING SYSTEM:	JW+OC, AC	MIN. METHANE NUMBER:	80
IGNITION SYSTEM:	EIS	RATED ALTITUDE (FT):	4922
EXHAUST MANIFOLD:	WC	AT AIR TO TURBO. TEMP. (°F):	77
COMBUSTION:	LOW EMISSION	NOx EMISSION LEVEL:	2.0 g/bhp-hr
		FUEL LHV (BTU/SCF):	905
		APPLICATION:	60 Hz GENSET

RATING AND EFFICIENCY		NOTES	LOAD	100%	75%	50%
ENGINE POWER	(WITHOUT FAN)	(1)	BHP	637	478	318
GENERATOR POWER	(WITH MECH FAN)	(2)	EKW	375	259	154
ENGINE EFFICIENCY	**(ISO 3046/1)**	(3)	%	**37.1**	**35.6**	**33.0**
ENGINE EFFICIENCY	(NOMINAL)	(3)	%	36.2	34.7	32.2
THERMAL EFFICIENCY	(NOMINAL)	(4)	%	42.4	44.6	50.9
TOTAL EFFICIENCY	(NOMINAL)	(5)	%	78.6	79.3	83.1

ENGINE DATA						
FUEL CONSUMPTION	**(ISO 3046/1)**	(6)	**BTU/bhp-hr**	**6854**	**7158**	**7716**
FUEL CONSUMPTION	(NOMINAL)	(6)	BTU/bhp-hr	7021	7332	7904
AIR FLOW (77 °F, 14.7 psi)		(7)	SCFM	1354	1047	673
AIR FLOW		(7)	lb/hr	6004	4641	2983
COMPRESSOR OUT PRESSURE			In. HG (abs)	66.3	63.3	47.4
COMPRESSOR OUT TEMPERATURE			°F	266	265	200
AFTERCOOLER AIR OUT TEMPERATURE			°F	148	145	140
INLET MAN. PRESSURE		(8)	in. HG (abs)	59.5	52.9	47.9
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(9)	°F	148	145	140
TIMING		(10)	°BTDC	27	27	27
EXHAUST STACK TEMPERATURE		(11)	°F	700	700	727
EXHAUST GAS FLOW (@ stack temp.)		(12)	CFM	3154	2440	1617
EXHAUST MASS FLOW		(12)	lb/hr	6229	4818	3110

EMISSIONS DATA					
NOx (as NO2)	(13)	g/bhp-hr	2	2.1	5.5
CO	(14)	g/bhp-hr	1.94	1.96	2.06
THC (molecular weight of 15.84)	(14)	g/bhp-hr	5.36	5.88	5.05
NMHC (molecular weight of 15.84)	(14)	g/bhp-hr	0.81	0.89	0.76
EXHAUST O2	(15)	% DRY	8.7	8.5	6.9
LAMBDA	(15)		1.68	1.66	1.48

HEAT BALANCE DATA					
LHV INPUT	(16)	BTU/min	74534	58378	41956
HEAT REJECTION TO JACKET	(17)	BTU/min	21942	16031	13917
HEAT REJECTION TO ATMOSPHERE	(18)	BTU/min	2961	2335	1678
HEAT REJECTION TO EXHAUST (LHV to 77°F)	(20)	BTU/min	18965	14778	9862
HEAT REJECTION TO EXHAUST (LHV to 350°F)	(20)	BTU/min	9647	7467	5236
HEAT REJECTION TO A/C	(21)	BTU/min	3632	2440	792

CONDITIONS AND DEFINITIONS

ENGINE RATING OBTAINED AND PRESENTED IN ACCORDANCE WITH ISO 3046/1STD. REF. CONDITIONS OF 77°F, 29.6 IN HG BAROMETRIC PRESSURE, 500 FT ALTITUDE). NO OVERLOAD PERMITTED AT RATING SHOWN. CONSULT ALTITUDE CHARTS FOR APPLICATIONS ABOVE MAXIMUM RATED ALTITUDE AND/OR TEMPERATURE.

EMISSION LEVELS ARE BASED ON THE ENGINE OPERATING AT STEADY STATE CONDITIONS AND ADJUSTED TO THE SPECIFIED NOx LEVEL AT 100% LOAD. EMISSION TOLERANCES SPECIFIED ARE DEPENDANT UPON FUEL QUALITY. METHANE NUMBER CANNOT VARY MORE THAN ± 3. PUBLISHED PART LOAD DATA MAY REQUIRE ENGINE

ENGINE RATING IS WITHOUT ENGINE DRIVEN WATER PUMPS.

FOR NOTES INFORMATION CONSULT PAGE THREE.

NOTES

1 ENGINE RATING IS WITHOUT ENGINE DRIVEN WATER PUMPS. TOLERANCE IS ± 3% OF FULL LOAD.

2 GENERATOR POWER DETERMINED WITH AN ASSUMED GENERATOR EFFICIENCY OF 93% AND POWER FACTOR OF 0.8 [GENERATOR POWER = ENGINE POWER x GENERATOR EFFICIENCY].

3 ISO 3046/1 ENGINE EFFICIENCY TOLERANCE IS (+)0, (-)5% OF FULL LOAD % EFFICIENCY VALUE. NOMINAL ENGINE EFFICIENCY TOLERANCE IS ± 2.5% OF FULL LOAD % EFFICIENCY VALUE.

4 THERMAL EFFICIENCY: JACKET HEAT + LUBE OIL HEAT + EXH. HEAT TO 350°F.

5 TOTAL EFFICIENCY = ENGINE EFF. + THERMAL EFF. TOLERANCE IS ± 10% OF FULL LOAD DATA.

6 ISO 3046/1 FUEL CONSUMPTION TOLERANCE IS (+)5, (-)0% OF FULL LOAD DATA. NOMINAL FUEL CONSUMPTION TOLERANCE IS ± 2.5 % OF FULL LOAD DATA.

7 UNDRIED AIR. FLOW TOLERANCE IS ± 5 %

8 INLET MANIFOLD PRESSURE TOLERANCE IS ± 5 %

9 INLET MANIFOLD TEMPERATURE TOLERANCE IS ± 9°F.

10 TIMING INDICATED IS FOR USE WITH THE MINIMUM FUEL METHANE NUMBER SPECIFIED. CONSULT THE APPROPRIATE FUEL USAGE GUIDE FOR TIMING AT OTHER METHANE NUMBERS.

11 EXHAUST STACK TEMPERATURE TOLERANCE IS (+)63°F, (-)54°F.

12 WET EXHAUST. FLOW TOLERANCE IS ± 6 %

13 NOX VALUES ARE SET POINTS AND WILL VARY WITH OPERATING CONDITIONS.

14 CO, CO2, THC, and NMHC VALUES ARE "NOT TO EXCEED".

15 O2% TOLERANCE IS ± 0.5; LAMBDA TOLERANCE IS ± 0.05. LAMBDA AND O2 LEVEL ARE THE RESULT OF ADJUSTING THE ENGINE TO OPERATE AT THE SPECIFIED NOX LEVEL.

16 LHV RATE TOLERANCE IS ± 2.5%.

17 TOTAL JW HEAT (based on treated water) = JACKET HEAT + LUBE OIL HEAT. TOLERANCE IS ± 10 % OF FULL LOAD DATA. HEAT REJECTION BASED ON 0 GPM WATER FLOW.

18 RADIATION HEAT RATE BASED ON TREATED WATER. TOLERANCE IS ± 50% OF FULL LOAD DATA.

19 LUBE OIL HEAT RATE BASED ON TREATED WATER. TOLERANCE IS ± 20% OF FULL LOAD DATA.

20 EXHAUST HEAT RATE BASED ON TREATED WATER. TOLERANCE IS ± 10% OF FULL LOAD DATA.

21 A/C HEAT (based on treated water) = A/C HEAT x A/C HEAT REJ. FACTOR. TOLERANCE IS ± 5 % OF FULL LOAD DATA. HEAT REJECTION BASED ON 151 GPM WATER FLOW.

G3516 LE

GAS COMPRESSION APPLICATION

GAS ENGINE PROJECT SPECIFIC TECHNICAL DATA

Westport Field Services
Cottonwood Station

CATERPILLAR®

ENGINE SPEED (rpm):	1400
COMPRESSION RATIO:	8:1
AFTERCOOLER WATER INLET (°F):	129
JACKET WATER OUTLET (°F):	210
COOLING SYSTEM:	JW+OC , AC
IGNITION SYSTEM:	EIS
EXHAUST MANIFOLD:	ASWC
COMBUSTION:	Low Emission
NOx EMISSION LEVEL (g/bhp-hr NOx):	1.5

FUEL SYSTEM:	HPG IMPCO with Air Fuel Ratio Control
SITE CONDITIONS:	
FUEL:	Gas Analysis
FUEL PRESSURE RANGE (psig):	35.0-40.0
FUEL METHANE NUMBER:	62.0
FUEL LHV (Btu/scf):	1013
ALTITUDE (ft):	5000
MAXIMUM AIR TO TURBO TEMPERATURE (°F):	100
NAMEPLATE RATING:	1340 bhp@1400rpm

			MAXIMUM RATING	SITE RATING AT MAXIMUM AIR TO TURBO TEMPERATURE		
RATING	Notes	LOAD	100%	100%	75%	52%
ENGINE POWER	(1)	bhp	1340	1280	960	670
AIR TO TURBO TEMPERATURE		°F	75	100	100	100
ENGINE DATA						
FUEL CONSUMPTION	(2)	Btu/bhp-hr	7569	7616	7897	8312
INLET MANIFOLD PRESSURE	(3)	in Hg(abs)	69.3	66.7	52.5	38.7
IGNITION TIMING		°BTDC	28.0	28.0	28.0	28.0
EXHAUST STACK TEMPERATURE	(4)	°F	899	896	884	886
EXHAUST GAS FLOW (@ stack temp, 14.5 psia)	(5)	ft3/min	7900	7564	5753	3859
EXHAUST GAS MASS FLOW	(5)	lb/hr	13314	12772	9798	6548
EMISSIONS DATA						
NOx (as NO2)	(6)	g/bhp-hr	1.50	1.50	1.50	1.50
CO	(6)	g/bhp-hr	2.42	2.44	2.51	2.43
THC (molecular wt. of 15.84)	(6)	g/bhp-hr	2.64	2.69	2.96	3.10
NMHC (molecular wt. of 15.84)	(6)	g/bhp-hr	0.56	0.57	0.63	0.66
NMNEHC (molecular wt. of 15.84)	(6)	g/bhp-hr	0.32	0.33	0.36	0.38
HCHO (Formaldehyde)	(6)	g/bhp-hr	0.28	0.28	0.32	0.34
CO2	(6)	g/bhp-hr	500	503	524	550
EXHAUST OXYGEN	(7)	% DRY	8.0	7.9	7.7	7.5
HEAT REJECTION						
HEAT REJ. TO JACKET WATER	(8)	Btu/min	39675	38773	33100	28953
HEAT REJ. TO ATMOSPHERE	(8)	Btu/min	5313	5154	4309	3543
HEAT REJ. TO LUBE OIL	(8)	Btu/min	6273	6131	5234	4578
HEAT REJ. TO AFTERCOOLER	(8)(9)	Btu/min	10792	14775	9975	3508
HEAT EXCHANGER SIZING CRITERIA						
HEAT REJ. TO JACKET WATER/LUBE OIL CIRCUIT	(10)	Btu/min	51170			
HEAT REJ. TO AFTERCOOLER	(9)(10)	Btu/min	15514			

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1, adjusted for fuel, site altitude and site air to turbo temperature.
100% rating at maximum air to turbo temperature is the maximum engine capability for the specified fuel at site altitude and maximum site air to turbo temperature.
Max. rating is the maximum capability for the specified fuel at site altitude and reduced air to turbo temperature.
Lowest load point is the lowest continuous duty operating load allowed. No overload permitted at rating shown.

For notes information consult page three.

PREPARED BY: Scott Oltrogge, Compressor Systems, Inc.
Data generated by Gas Engine Rating Pro Version 1.00.00
Ref. Data Set DM5155-04, Master Data Set 1.0, Printed 26Aug2004

Appendix C

Spatially Distributed Project Alternatives Emissions Inventories

Table C-1 Spatially Distributed Production and Drilling Emissions for the Proposed Action

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				336	10	3,339	2	13																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
8S	20E	33	08S20E33	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
8S	20E	34	08S20E34	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
8S	20E	35	08S20E35	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
8S	20E	36	08S20E36	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
8S	21E	31	08S21E31	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
8S	21E	32	08S21E32	2	0.06	13			3.77	3.92	0.01	3.33	0.53	0.28	1.55	1.39	0.06	1.51	0.33	24.74	5.32	5.32	0.07	4.84	0.86	25.02
8S	21E	33	08S21E33	2	0.06	20			3.77	3.92	0.01	3.33	0.53	0.28	2.38	2.14	0.09	2.32	0.50	38.07	6.15	6.06	0.10	5.65	1.03	38.34
8S	21E	34	08S21E34	2	0.06	18			3.77	3.92	0.01	3.33	0.53	0.28	2.14	1.93	0.08	2.09	0.45	34.26	5.91	5.85	0.09	5.42	0.98	34.53
8S	21E	35	08S21E35	2	0.06	12			3.77	3.92	0.01	3.33	0.53	0.28	1.43	1.28	0.05	1.39	0.30	22.84	5.20	5.21	0.06	4.72	0.83	23.11
8S	21E	36	08S21E36	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
8S	22E	31	08S22E31	2	0.06	14			3.77	3.92	0.01	3.33	0.53	0.28	1.66	1.50	0.06	1.62	0.35	26.65	5.44	5.42	0.07	4.95	0.88	26.92
8S	23E	33	08S23E33	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
8S	23E	34	08S23E34	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
8S	23E	35	08S23E35	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	20E	1	09S20E01	2	0.06	9			3.77	3.92	0.01	3.33	0.53	0.28	1.07	0.96	0.04	1.04	0.23	17.13	4.84	4.89	0.05	4.37	0.76	17.40
9S	20E	2	09S20E02	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
9S	20E	3	09S20E03	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
9S	20E	4	09S20E04	2	0.06	9			3.77	3.92	0.01	3.33	0.53	0.28	1.07	0.96	0.04	1.04	0.23	17.13	4.84	4.89	0.05	4.37	0.76	17.40
9S	20E	9	09S20E09	2	0.06	12			3.77	3.92	0.01	3.33	0.53	0.28	1.43	1.28	0.05	1.39	0.30	22.84	5.20	5.21	0.06	4.72	0.83	23.11
9S	20E	10	09S20E10	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	20E	11	09S20E11	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
9S	20E	12	09S20E12	2	0.06	18			3.77	3.92	0.01	3.33	0.53	0.28	2.14	1.93	0.08	2.09	0.45	34.26	5.91	5.85	0.09	5.42	0.98	34.53
9S	20E	13	09S20E13	3	0.09	6			5.66	5.88	0.02	4.99	0.80	0.41	0.71	0.64	0.03	0.70	0.15	11.42	6.37	6.53	0.04	5.69	0.95	11.83
9S	20E	14	09S20E14	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	20E	15	09S20E15	2	0.06	16		1	3.77	3.92	0.01	3.33	0.53	0.28	8.18	2.59	0.14	2.05	0.60	32.09	11.95	6.51	0.15	5.38	1.13	32.37
9S	20E	20	09S20E20	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
9S	20E	21	09S20E21	2	0.06	12			3.77	3.92	0.01	3.33	0.53	0.28	1.43	1.28	0.05	1.39	0.30	22.84	5.20	5.21	0.06	4.72	0.83	23.11
9S	20E	22	09S20E22	2	0.06	19			3.77	3.92	0.01	3.33	0.53	0.28	2.26	2.03	0.08	2.20	0.48	36.16	6.03	5.96	0.09	5.53	1.01	36.44
9S	20E	23	09S20E23	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	20E	24	09S20E24	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	20E	25	09S20E25	2	0.06	13			3.77	3.92	0.01	3.33	0.53	0.28	1.55	1.39	0.06	1.51	0.33	24.74	5.32	5.32	0.07	4.84	0.86	25.02
9S	20E	26	09S20E26	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24
9S	20E	27	09S20E27	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24
9S	20E	28	09S20E28	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	20E	29	09S20E29	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
9S	20E	32	09S20E32	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	20E	33	09S20E33	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	20E	34	09S20E34	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	20E	35	09S20E35	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24
9S	20E	36	09S20E36	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24
9S	21E	1	09S21E01	2	0.06	13		1	3.77	3.92	0.01	3.33	0.53	0.28	7.82	2.27	0.12	1.71	0.53	26.38	11.60	6.19	0.13	5.04	1.06	26.66
9S	21E	2	09S21E02	2	0.06	14			3.77	3.92	0.01	3.33	0.53	0.28	1.66	1.50	0.06	1.62	0.35	26.65	5.44	5.42	0.07	4.95	0.88	26.92
9S	21E	3	09S21E03	2	0.06	15			3.77	3.92	0.01	3.33	0.53	0.28	1.78	1.61	0.06	1.74	0.38	28.55	5.56	5.53	0.07	5.07	0.91	28.82
9S	21E	4	09S21E04	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	21E	5	09S21E05	2	0.06	13			3.77	3.92	0.01	3.33	0.53	0.28	1.55	1.39	0.06	1.51	0.33	24.74	5.32	5.32	0.07	4.84	0.86	25.02
9S	21E	6	09S21E06	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	21E	7	09S21E07	2	0.06	16			3.77	3.92	0.01	3.33	0.53	0.28	1.90	1.71	0.07	1.85	0.40	30.45	5.68	5.64	0.08	5.18	0.93	30.73
9S	21E	8	09S21E08	2	0.06	17			3.77	3.92	0.01	3.33	0.53	0.28	2.02	1.82	0.07	1.97	0.43	32.36	5.79	5.74	0.08	5.30	0.96	32.63
9S	21E	9	09S21E09	2	0.06	13			3.77	3.92	0.01	3.33	0.53	0.28	1.55	1.39	0.06	1.51	0.33	24.74	5.32	5.32	0.07	4.84	0.86	25.02
9S	21E	10	09S21E10	2	0.06	18			3.77	3.92	0.01	3.33	0.53	0.28	2.14	1.93	0.08	2.09	0.45	34.26	5.91	5.85	0.09	5.42	0.98	34.53
9S	21E	11	09S21E11	2	0.06	20			3.77	3.92	0.01	3.33	0.53	0.28	2.38	2.14	0.09	2.32	0.50	38.07	6.15	6.06	0.10	5.65	1.03	38.34
9S	21E	12	09S21E12	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24

Table C-1 Spatially Distributed Production and Drilling Emissions for the Proposed Action

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				336	10	3,339	2	13																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
9S	21E	13	09S21E13	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	21E	14	09S21E14	2	0.06	12			3.77	3.92	0.01	3.33	0.53	0.28	1.43	1.28	0.05	1.39	0.30	22.84	5.20	5.21	0.06	4.72	0.83	23.11
9S	21E	15	09S21E15	2	0.06	13			3.77	3.92	0.01	3.33	0.53	0.28	1.55	1.39	0.06	1.51	0.33	24.74	5.32	5.32	0.07	4.84	0.86	25.02
9S	21E	16	09S21E16	2	0.06	15			3.77	3.92	0.01	3.33	0.53	0.28	1.78	1.61	0.06	1.74	0.38	28.55	5.56	5.53	0.07	5.07	0.91	28.82
9S	21E	17	09S21E17	2	0.06	17			3.77	3.92	0.01	3.33	0.53	0.28	2.02	1.82	0.07	1.97	0.43	32.36	5.79	5.74	0.08	5.30	0.96	32.63
9S	21E	18	09S21E18	2	0.06	15			3.77	3.92	0.01	3.33	0.53	0.28	1.78	1.61	0.06	1.74	0.38	28.55	5.56	5.53	0.07	5.07	0.91	28.82
9S	21E	19	09S21E19	2	0.06	17		1	3.77	3.92	0.01	3.33	0.53	0.28	8.30	2.70	0.14	2.17	0.63	33.99	12.07	6.62	0.15	5.50	1.16	34.27
9S	21E	20	09S21E20	2	0.06	17			3.77	3.92	0.01	3.33	0.53	0.28	2.02	1.82	0.07	1.97	0.43	32.36	5.79	5.74	0.08	5.30	0.96	32.63
9S	21E	21	09S21E21	2	0.06	11			3.77	3.92	0.01	3.33	0.53	0.28	1.31	1.18	0.05	1.27	0.28	20.94	5.08	5.10	0.06	4.60	0.81	21.21
9S	21E	22	09S21E22	2	0.06	16			3.77	3.92	0.01	3.33	0.53	0.28	1.90	1.71	0.07	1.85	0.40	30.45	5.68	5.64	0.08	5.18	0.93	30.73
9S	21E	23	09S21E23	2	0.06	18			3.77	3.92	0.01	3.33	0.53	0.28	2.14	1.93	0.08	2.09	0.45	34.26	5.91	5.85	0.09	5.42	0.98	34.53
9S	21E	24	09S21E24	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24
9S	21E	25	09S21E25	2	0.06	14			3.77	3.92	0.01	3.33	0.53	0.28	1.66	1.50	0.06	1.62	0.35	26.65	5.44	5.42	0.07	4.95	0.88	26.92
9S	21E	26	09S21E26	2	0.06	13			3.77	3.92	0.01	3.33	0.53	0.28	1.55	1.39	0.06	1.51	0.33	24.74	5.32	5.32	0.07	4.84	0.86	25.02
9S	21E	27	09S21E27	2	0.06	12			3.77	3.92	0.01	3.33	0.53	0.28	1.43	1.28	0.05	1.39	0.30	22.84	5.20	5.21	0.06	4.72	0.83	23.11
9S	21E	28	09S21E28	2	0.06	9			3.77	3.92	0.01	3.33	0.53	0.28	1.07	0.96	0.04	1.04	0.23	17.13	4.84	4.89	0.05	4.37	0.76	17.40
9S	21E	29	09S21E29	2	0.06	16			3.77	3.92	0.01	3.33	0.53	0.28	1.90	1.71	0.07	1.85	0.40	30.45	5.68	5.64	0.08	5.18	0.93	30.73
9S	21E	30	09S21E30	2	0.06	17			3.77	3.92	0.01	3.33	0.53	0.28	2.02	1.82	0.07	1.97	0.43	32.36	5.79	5.74	0.08	5.30	0.96	32.63
9S	21E	31	09S21E31	2	0.06	21			3.77	3.92	0.01	3.33	0.53	0.28	2.50	2.25	0.09	2.43	0.53	39.97	6.27	6.17	0.10	5.76	1.06	40.24
9S	21E	32	09S21E32	2	0.06	20			3.77	3.92	0.01	3.33	0.53	0.28	2.38	2.14	0.09	2.32	0.50	38.07	6.15	6.06	0.10	5.65	1.03	38.34
9S	21E	33	09S21E33	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	21E	34	09S21E34	2	0.06	14			3.77	3.92	0.01	3.33	0.53	0.28	1.66	1.50	0.06	1.62	0.35	26.65	5.44	5.42	0.07	4.95	0.88	26.92
9S	21E	35	09S21E35	2	0.06	14	1	1	3.77	3.92	0.01	3.33	0.53	0.28	7.94	2.38	0.13	1.82	0.55	33.11	11.71	6.30	0.14	5.15	1.08	33.38
9S	21E	36	09S21E36	2	0.06	14			3.77	3.92	0.01	3.33	0.53	0.28	1.66	1.50	0.06	1.62	0.35	26.65	5.44	5.42	0.07	4.95	0.88	26.92
9S	22E	6	09S22E06	2	0.06	11			3.77	3.92	0.01	3.33	0.53	0.28	1.31	1.18	0.05	1.27	0.28	20.94	5.08	5.10	0.06	4.60	0.81	21.21
9S	22E	7	09S22E07	2	0.06	11			3.77	3.92	0.01	3.33	0.53	0.28	1.31	1.18	0.05	1.27	0.28	20.94	5.08	5.10	0.06	4.60	0.81	21.21
9S	22E	15	09S22E15	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	22E	18	09S22E18	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	22E	19	09S22E19	2	0.06	18			3.77	3.92	0.01	3.33	0.53	0.28	2.14	1.93	0.08	2.09	0.45	34.26	5.91	5.85	0.09	5.42	0.98	34.53
9S	22E	20	09S22E20	2	0.06	10			3.77	3.92	0.01	3.33	0.53	0.28	1.19	1.07	0.04	1.16	0.25	19.03	4.96	4.99	0.05	4.49	0.78	19.31
9S	22E	29	09S22E29	2	0.06	17			3.77	3.92	0.01	3.33	0.53	0.28	2.02	1.82	0.07	1.97	0.43	32.36	5.79	5.74	0.08	5.30	0.96	32.63
9S	22E	30	09S22E30	2	0.06	15		1	3.77	3.92	0.01	3.33	0.53	0.28	8.06	2.48	0.13	1.94	0.58	30.19	11.83	6.41	0.14	5.27	1.11	30.46
9S	22E	31	09S22E31	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
9S	22E	32	09S22E32	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	22E	33	09S22E33	1	0.03	10			1.89	1.96	0.01	1.66	0.27	0.14	1.19	1.07	0.04	1.16	0.25	19.03	3.08	3.03	0.05	2.82	0.52	19.17
9S	22E	34	09S22E34	2	0.06	5			3.77	3.92	0.01	3.33	0.53	0.28	0.59	0.54	0.02	0.58	0.13	9.52	4.37	4.46	0.03	3.91	0.66	9.79
9S	22E	35	09S22E35	1	0.03	12			1.89	1.96	0.01	1.66	0.27	0.14	1.43	1.28	0.05	1.39	0.30	22.84	3.31	3.25	0.06	3.06	0.57	22.98
9S	22E	36	09S22E36	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
9S	23E	1	09S23E01	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	23E	2	09S23E02	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
9S	23E	3	09S23E03	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	23E	4	09S23E04	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
9S	23E	8	09S23E05	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
9S	23E	9	09S23E06	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
9S	23E	10	09S23E10	1	0.03	10			1.89	1.96	0.01	1.66	0.27	0.14	1.19	1.07	0.04	1.16	0.25	19.03	3.08	3.03	0.05	2.82	0.52	19.17
9S	23E	11	09S23E11	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
9S	23E	12	09S23E12	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
9S	23E	13	09S23E13	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07
9S	23E	14	09S23E14	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07
9S	23E	15	09S23E15	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
9S	23E	23	09S23E23	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
9S	23E	24	09S23E24	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07

Table C-1 Spatially Distributed Production and Drilling Emissions for the Proposed Action

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				336	10	3,339	2	13																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
9S	23E	25	09S23E25	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	23E	26	09S23E26	3	0.09	6			5.66	5.88	0.02	4.99	0.80	0.41	0.71	0.64	0.03	0.70	0.15	11.42	6.37	6.53	0.04	5.69	0.95	11.83
9S	23E	31	09S23E31	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
9S	23E	35	09S23E35	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
9S	23E	36	09S23E36	-	-	15			-	-	-	-	-	-	1.78	1.61	0.06	1.74	0.38	28.55	1.78	1.61	0.06	1.74	0.38	28.55
9S	24E	21	09S24E21	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	24E	28	09S24E28	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	24E	29	09S24E29	2	0.06	6			3.77	3.92	0.01	3.33	0.53	0.28	0.71	0.64	0.03	0.70	0.15	11.42	4.49	4.57	0.04	4.02	0.68	11.69
9S	24E	30	09S24E30	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
9S	24E	31	09S24E31	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
9S	24E	32	09S24E32	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	24E	33	09S24E33	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9S	24E	34	09S24E34	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
10S	20E	1	10S20E01	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
10S	20E	2	10S20E02	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	20E	11	10S20E11	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
10S	20E	12	10S20E12	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	20E	13	10S20E13	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	20E	14	10S20E14	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
10S	20E	23	10S20E23	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
10S	20E	24	10S20E24	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	20E	25	10S20E25	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
10S	20E	26	10S20E26	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
10S	20E	35	10S20E35	1	0.03	19			1.89	1.96	0.01	1.66	0.27	0.14	2.26	2.03	0.08	2.20	0.48	36.16	4.15	4.00	0.09	3.87	0.74	36.30
10S	20E	36	10S20E36	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
10S	21E	1	10S21E01	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	2	10S21E02	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
10S	21E	3	10S21E03	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
10S	21E	4	10S21E04	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	21E	5	10S21E05	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	21E	6	10S21E06	2	0.06	17			3.77	3.92	0.01	3.33	0.53	0.28	2.02	1.82	0.07	1.97	0.43	32.36	5.79	5.74	0.08	5.30	0.96	32.63
10S	21E	7	10S21E07	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
10S	21E	8	10S21E08	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
10S	21E	9	10S21E09	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	21E	10	10S21E10	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	21E	11	10S21E11	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	21E	12	10S21E12	1	0.03	19			1.89	1.96	0.01	1.66	0.27	0.14	2.26	2.03	0.08	2.20	0.48	36.16	4.15	4.00	0.09	3.87	0.74	36.30
10S	21E	13	10S21E13	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
10S	21E	14	10S21E14	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
10S	21E	15	10S21E15	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	21E	16	10S21E16	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	17	10S21E17	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
10S	21E	18	10S21E18	1	0.03	19		1	1.89	1.96	0.01	1.66	0.27	0.14	8.54	2.91	0.15	2.40	0.68	37.80	10.42	4.87	0.15	4.07	0.94	37.94
10S	21E	19	10S21E19	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	21E	20	10S21E20	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	21E	21	10S21E21	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	21E	22	10S21E22	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	21E	23	10S21E23	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	24	10S21E24	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
10S	21E	25	10S21E25	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	26	10S21E26	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	21E	27	10S21E27	3	0.09	6			5.66	5.88	0.02	4.99	0.80	0.41	0.71	0.64	0.03	0.70	0.15	11.42	6.37	6.53	0.04	5.69	0.95	11.83

Table C-1 Spatially Distributed Production and Drilling Emissions for the Proposed Action

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				336	10	3,339	2	13																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
10S	21E	28	10S21E28	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	29	10S21E29	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	30	10S21E30	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
10S	21E	31	10S21E31	2	0.06	15		1	3.77	3.92	0.01	3.33	0.53	0.28	8.06	2.48	0.13	1.94	0.58	30.19	11.83	6.41	0.14	5.27	1.11	30.46
10S	21E	32	10S21E32	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	21E	33	10S21E33	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10S	21E	34	10S21E34	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07
10S	21E	35	10S21E35	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	21E	36	10S21E36	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	22E	1	10S22E01	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78
10S	22E	2	10S22E02	2	0.06	5			3.77	3.92	0.01	3.33	0.53	0.28	0.59	0.54	0.02	0.58	0.13	9.52	4.37	4.46	0.03	3.91	0.66	9.79
10S	22E	3	10S22E03	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
10S	22E	4	10S22E04	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
10S	22E	5	10S22E05	1	0.03	12			1.89	1.96	0.01	1.66	0.27	0.14	1.43	1.28	0.05	1.39	0.30	22.84	3.31	3.25	0.06	3.06	0.57	22.98
10S	22E	6	10S22E06	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07
10S	22E	7	10S22E07	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	22E	8	10S22E08	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	22E	9	10S22E09	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	22E	10	10S22E10	1	0.03	10			1.89	1.96	0.01	1.66	0.27	0.14	1.19	1.07	0.04	1.16	0.25	19.03	3.08	3.03	0.05	2.82	0.52	19.17
10S	22E	11	10S22E11	2	0.06	7		1	3.77	3.92	0.01	3.33	0.53	0.28	7.11	1.63	0.10	1.01	0.37	14.96	10.88	5.55	0.11	4.34	0.91	15.24
10S	22E	12	10S22E12	1	0.03	10			1.89	1.96	0.01	1.66	0.27	0.14	1.19	1.07	0.04	1.16	0.25	19.03	3.08	3.03	0.05	2.82	0.52	19.17
10S	22E	13	10S22E13	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	22E	14	10S22E14	2	0.06	5			3.77	3.92	0.01	3.33	0.53	0.28	0.59	0.54	0.02	0.58	0.13	9.52	4.37	4.46	0.03	3.91	0.66	9.79
10S	22E	15	10S22E15	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
10S	22E	16	10S22E16	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	22E	17	10S22E17	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
10S	22E	18	10S22E18	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
10S	22E	19	10S22E19	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	22E	20	10S22E20	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	22E	21	10S22E21	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
10S	22E	22	10S22E22	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	22E	23	10S22E23	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	22E	24	10S22E24	3	0.09				5.66	5.88	0.02	4.99	0.80	0.41	-	-	-	-	-	-	5.66	5.88	0.02	4.99	0.80	0.41
10S	22E	25	10S22E25	3	0.09	6			5.66	5.88	0.02	4.99	0.80	0.41	0.71	0.64	0.03	0.70	0.15	11.42	6.37	6.53	0.04	5.69	0.95	11.83
10S	22E	26	10S22E26	1	0.03	21		1	1.89	1.96	0.01	1.66	0.27	0.14	8.77	3.13	0.16	2.63	0.73	41.61	10.66	5.09	0.16	4.30	0.99	41.75
10S	22E	27	10S22E27	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
10S	22E	28	10S22E28	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
10S	22E	29	10S22E29	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
10S	22E	30	10S22E30	1	0.03	15	1	1	1.89	1.96	0.01	1.66	0.27	0.14	8.06	2.48	0.13	1.94	0.58	35.01	9.95	4.45	0.14	3.60	0.84	35.15
10S	22E	31	10S22E31	1	0.03	19			1.89	1.96	0.01	1.66	0.27	0.14	2.26	2.03	0.08	2.20	0.48	36.16	4.15	4.00	0.09	3.87	0.74	36.30
10S	22E	32	10S22E32	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	22E	33	10S22E33	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	22E	34	10S22E34	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	22E	35	10S22E35	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	22E	36	10S22E36	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	23E	1	10S23E01	1	0.03	16		1	1.89	1.96	0.01	1.66	0.27	0.14	8.18	2.59	0.14	2.05	0.60	32.09	10.07	4.55	0.14	3.72	0.87	32.23
10S	23E	2	10S23E02	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	23E	3	10S23E03	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	23E	4	10S23E04	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	23E	5	10S23E05	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	23E	6	10S23E06	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	23E	7	10S23E07	1	0.03	14			1.89	1.96	0.01	1.66	0.27	0.14	1.66	1.50	0.06	1.62	0.35	26.65	3.55	3.46	0.07	3.29	0.62	26.78

Table C-1 Spatially Distributed Production and Drilling Emissions for the Proposed Action

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				336	10	3,339	2	13																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
10S	23E	8	10S23E08	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
10S	23E	9	10S23E09	1	0.03	17		1	1.89	1.96	0.01	1.66	0.27	0.14	8.30	2.70	0.14	2.17	0.63	33.99	10.18	4.66	0.14	3.83	0.89	34.13
10S	23E	10	10S23E10	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	23E	11	10S23E11	1	0.03	17			1.89	1.96	0.01	1.66	0.27	0.14	2.02	1.82	0.07	1.97	0.43	32.36	3.91	3.78	0.08	3.64	0.69	32.49
10S	23E	12	10S23E12	4	0.12				7.55	7.85	0.02	6.66	1.06	0.55	-	-	-	-	-	-	7.55	7.85	0.02	6.66	1.06	0.55
10S	23E	13	10S23E13	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10S	23E	14	10S23E14	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
10S	23E	15	10S23E15	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
10S	23E	16	10S23E16	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
10S	23E	17	10S23E17	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
10S	23E	18	10S23E18	2	0.06	7			3.77	3.92	0.01	3.33	0.53	0.28	0.83	0.75	0.03	0.81	0.18	13.32	4.61	4.67	0.04	4.14	0.71	13.60
10S	23E	22	10S23E22	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11S	21E	1	11S21E01	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11S	21E	2	11S21E02	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
11S	21E	3	11S21E03	1	0.03	20		1	1.89	1.96	0.01	1.66	0.27	0.14	8.66	3.02	0.15	2.52	0.70	39.70	10.54	4.98	0.16	4.18	0.97	39.84
11S	21E	4	11S21E04	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
11S	21E	5	11S21E05	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
11S	21E	7	11S21E07	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
11S	21E	8	11S21E08	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	21E	9	11S21E09	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
11S	21E	10	11S21E10	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
11S	21E	11	11S21E11	1	0.03	21			1.89	1.96	0.01	1.66	0.27	0.14	2.50	2.25	0.09	2.43	0.53	39.97	4.38	4.21	0.10	4.10	0.79	40.11
11S	21E	12	11S21E12	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	21E	13	11S21E13	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	21E	14	11S21E14	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
11S	21E	15	11S21E15	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	21E	16	11S21E16	1	0.03	15			1.89	1.96	0.01	1.66	0.27	0.14	1.78	1.61	0.06	1.74	0.38	28.55	3.67	3.57	0.07	3.40	0.64	28.69
11S	21E	17	11S21E17	1	0.03	22			1.89	1.96	0.01	1.66	0.27	0.14	2.62	2.36	0.09	2.55	0.55	41.87	4.50	4.32	0.10	4.21	0.82	42.01
11S	21E	18	11S21E18	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07
11S	21E	24	11S21E24	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11S	22E	2	11S22E02	1	0.03	18			1.89	1.96	0.01	1.66	0.27	0.14	2.14	1.93	0.08	2.09	0.45	34.26	4.03	3.89	0.08	3.75	0.72	34.40
11S	22E	3	11S22E03	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	22E	4	11S22E04	1	0.03	16			1.89	1.96	0.01	1.66	0.27	0.14	1.90	1.71	0.07	1.85	0.40	30.45	3.79	3.67	0.07	3.52	0.67	30.59
11S	22E	5	11S22E05	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	22E	6	11S22E06	1	0.03	11			1.89	1.96	0.01	1.66	0.27	0.14	1.31	1.18	0.05	1.27	0.28	20.94	3.19	3.14	0.05	2.94	0.54	21.07
11S	22E	7	11S22E07	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11S	22E	8	11S22E08	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11S	22E	9	11S22E09	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
11S	22E	10	11S22E10	3	0.09	5			5.66	5.88	0.02	4.99	0.80	0.41	0.59	0.54	0.02	0.58	0.13	9.52	6.25	6.42	0.04	5.57	0.92	9.93
11S	22E	15	11S22E15	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11S	22E	16	11S22E16	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
11S	22E	17	11S22E17	3	0.09	5			5.66	5.88	0.02	4.99	0.80	0.41	0.59	0.54	0.02	0.58	0.13	9.52	6.25	6.42	0.04	5.57	0.92	9.93
11S	22E	18	11S22E18	1	0.03	20			1.89	1.96	0.01	1.66	0.27	0.14	2.38	2.14	0.09	2.32	0.50	38.07	4.26	4.10	0.09	3.98	0.77	38.20
11S	22E	19	11S22E19	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
11S	22E	20	11S22E20	2	0.06	5			3.77	3.92	0.01	3.33	0.53	0.28	0.59	0.54	0.02	0.58	0.13	9.52	4.37	4.46	0.03	3.91	0.66	9.79
11S	22E	21	11S22E21	1	0.03	13			1.89	1.96	0.01	1.66	0.27	0.14	1.55	1.39	0.06	1.51	0.33	24.74	3.43	3.35	0.06	3.17	0.59	24.88
11S	22E	22	11S22E22	1	0.03				1.89	1.96	0.01	1.66	0.27	0.14	-	-	-	-	-	-	1.89	1.96	0.01	1.66	0.27	0.14
11S	22E	23	11S22E23	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				336	10.1	3339	2	13	633.8	659.1	1.8	559.3	89.2	46.2	478.7	368.9	15.2	389.6	86.4	6,386.0	1,112.5	1,028.0	16.9	948.9	175.6	6,432.3

Table C-2 Spatially Distributed Production and Drilling Emissions for the Optimal Recovery Alternative

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				672	20	12,774	5	23																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
8S	20E	33	08S20E33	2	0.06	57			3.77	3.92	0.01	3.33	0.53	0.28	6.78	6.10	0.24	6.61	1.43	108.49	10.55	10.03	0.25	9.94	1.96	108.76
8S	20E	34	08S20E34	2	0.06	57			3.77	3.92	0.01	3.33	0.53	0.28	6.78	6.10	0.24	6.61	1.43	108.49	10.55	10.03	0.25	9.94	1.96	108.76
8S	20E	35	08S20E35	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
8S	20E	36	08S20E36	2	0.06	57			3.77	3.92	0.01	3.33	0.53	0.28	6.78	6.10	0.24	6.61	1.43	108.49	10.55	10.03	0.25	9.94	1.96	108.76
8S	21E	31	08S21E31	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
8S	21E	32	08S21E32	4	0.12	45			7.55	7.85	0.02	6.66	1.06	0.55	5.35	4.82	0.19	5.22	1.13	85.65	12.90	12.66	0.21	11.87	2.19	86.20
8S	21E	33	08S21E33	4	0.12	52			7.55	7.85	0.02	6.66	1.06	0.55	6.18	5.57	0.22	6.03	1.31	98.97	13.73	13.41	0.24	12.69	2.37	99.52
8S	21E	34	08S21E34	4	0.12	49			7.55	7.85	0.02	6.66	1.06	0.55	5.83	5.25	0.21	5.68	1.23	93.26	13.37	13.09	0.23	12.34	2.29	93.81
8S	21E	35	08S21E35	4	0.12	42			7.55	7.85	0.02	6.66	1.06	0.55	4.99	4.50	0.18	4.87	1.05	79.94	12.54	12.34	0.20	11.53	2.12	80.49
8S	21E	36	08S21E36	4	0.12	41			7.55	7.85	0.02	6.66	1.06	0.55	4.88	4.39	0.18	4.75	1.03	78.03	12.42	12.24	0.20	11.41	2.09	78.59
8S	22E	31	08S22E31	4	0.12	45			7.55	7.85	0.02	6.66	1.06	0.55	5.35	4.82	0.19	5.22	1.13	85.65	12.90	12.66	0.21	11.87	2.19	86.20
8S	23E	33	08S23E33	2	0.06	62			3.77	3.92	0.01	3.33	0.53	0.28	7.37	6.64	0.27	7.19	1.56	118.00	11.15	10.56	0.28	10.52	2.09	118.28
8S	23E	34	08S23E34	4	0.12	60			7.55	7.85	0.02	6.66	1.06	0.55	7.14	6.42	0.26	6.95	1.51	114.20	14.68	14.27	0.28	13.61	2.57	114.75
8S	23E	35	08S23E35	4	0.12	57			7.55	7.85	0.02	6.66	1.06	0.55	6.78	6.10	0.24	6.61	1.43	108.49	14.32	13.95	0.27	13.27	2.49	109.04
9S	20E	1	09S20E01	4	0.12	57			7.55	7.85	0.02	6.66	1.06	0.55	6.78	6.10	0.24	6.61	1.43	108.49	14.32	13.95	0.27	13.27	2.49	109.04
9S	20E	2	09S20E02	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
9S	20E	3	09S20E03	2	0.06	44			3.77	3.92	0.01	3.33	0.53	0.28	5.23	4.71	0.19	5.10	1.10	83.74	9.01	8.63	0.20	8.43	1.64	84.02
9S	20E	4	09S20E04	4	0.12	48			7.55	7.85	0.02	6.66	1.06	0.55	5.71	5.14	0.21	5.56	1.20	91.36	13.25	12.99	0.23	12.22	2.27	91.91
9S	20E	9	09S20E09	4	0.12	56			7.55	7.85	0.02	6.66	1.06	0.55	6.66	6.00	0.24	6.49	1.41	106.58	14.20	13.84	0.26	13.15	2.47	107.13
9S	20E	10	09S20E10	4	0.12	60			7.55	7.85	0.02	6.66	1.06	0.55	7.14	6.42	0.26	6.95	1.51	114.20	14.68	14.27	0.28	13.61	2.57	114.75
9S	20E	11	09S20E11	2	0.06	62		1	3.77	3.92	0.01	3.33	0.53	0.28	13.65	7.52	0.33	7.39	1.76	119.64	17.42	11.44	0.34	10.71	2.29	119.92
9S	20E	12	09S20E12	4	0.12	50			7.55	7.85	0.02	6.66	1.06	0.55	5.95	5.35	0.21	5.80	1.25	95.16	13.49	13.20	0.24	12.45	2.32	95.71
9S	20E	13	09S20E13	6	0.18	57			11.32	11.77	0.03	9.99	1.59	0.83	6.78	6.10	0.24	6.61	1.43	108.49	18.10	17.87	0.28	16.59	3.02	109.31
9S	20E	14	09S20E14	4	0.12	58			7.55	7.85	0.02	6.66	1.06	0.55	6.90	6.21	0.25	6.72	1.46	110.39	14.44	14.06	0.27	13.38	2.52	110.94
9S	20E	15	09S20E15	4	0.12	47			7.55	7.85	0.02	6.66	1.06	0.55	5.59	5.03	0.20	5.45	1.18	89.45	13.13	12.88	0.22	12.11	2.24	90.01
9S	20E	20	09S20E20	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
9S	20E	21	09S20E21	4	0.12	56			7.55	7.85	0.02	6.66	1.06	0.55	6.66	6.00	0.24	6.49	1.41	106.58	14.20	13.84	0.26	13.15	2.47	107.13
9S	20E	22	09S20E22	4	0.12	50			7.55	7.85	0.02	6.66	1.06	0.55	5.95	5.35	0.21	5.80	1.25	95.16	13.49	13.20	0.24	12.45	2.32	95.71
9S	20E	23	09S20E23	4	0.12	60			7.55	7.85	0.02	6.66	1.06	0.55	7.14	6.42	0.26	6.95	1.51	114.20	14.68	14.27	0.28	13.61	2.57	114.75
9S	20E	24	09S20E24	4	0.12	59			7.55	7.85	0.02	6.66	1.06	0.55	7.02	6.32	0.25	6.84	1.48	112.29	14.56	14.16	0.27	13.50	2.54	112.84
9S	20E	25	09S20E25	4	0.12	44			7.55	7.85	0.02	6.66	1.06	0.55	5.23	4.71	0.19	5.10	1.10	83.74	12.78	12.56	0.21	11.76	2.17	84.30
9S	20E	26	09S20E26	4	0.12	53			7.55	7.85	0.02	6.66	1.06	0.55	6.30	5.67	0.23	6.14	1.33	100.87	13.85	13.52	0.25	12.80	2.39	101.42
9S	20E	27	09S20E27	4	0.12	53			7.55	7.85	0.02	6.66	1.06	0.55	6.30	5.67	0.23	6.14	1.33	100.87	13.85	13.52	0.25	12.80	2.39	101.42
9S	20E	28	09S20E28	-	-	65		1	-	-	-	-	-	-	14.01	7.84	0.35	7.73	1.83	125.35	14.01	7.84	0.35	7.73	1.83	125.35
9S	20E	29	09S20E29	2	0.06	63			3.77	3.92	0.01	3.33	0.53	0.28	7.49	6.75	0.27	7.30	1.58	119.91	11.26	10.67	0.28	10.63	2.11	120.18
9S	20E	32	09S20E32	-	-	65			-	-	-	-	-	-	7.73	6.96	0.28	7.53	1.63	123.71	7.73	6.96	0.28	7.53	1.63	123.71
9S	20E	33	09S20E33	-	-	65			-	-	-	-	-	-	7.73	6.96	0.28	7.53	1.63	123.71	7.73	6.96	0.28	7.53	1.63	123.71
9S	20E	34	09S20E34	-	-	65			-	-	-	-	-	-	7.73	6.96	0.28	7.53	1.63	123.71	7.73	6.96	0.28	7.53	1.63	123.71
9S	20E	35	09S20E35	4	0.12	52			7.55	7.85	0.02	6.66	1.06	0.55	6.18	5.57	0.22	6.03	1.31	98.97	13.73	13.41	0.24	12.69	2.37	99.52
9S	20E	36	09S20E36	4	0.12	52		1	7.55	7.85	0.02	6.66	1.06	0.55	12.46	6.45	0.29	6.23	1.50	100.61	20.01	14.29	0.31	12.88	2.57	101.16
9S	21E	1	09S21E01	4	0.12	37		1	7.55	7.85	0.02	6.66	1.06	0.55	10.68	4.84	0.23	4.49	1.13	72.06	18.22	12.69	0.25	11.15	2.19	72.61
9S	21E	2	09S21E02	4	0.12	40			7.55	7.85	0.02	6.66	1.06	0.55	4.76	4.28	0.17	4.64	1.00	76.13	12.30	12.13	0.19	11.30	2.07	76.68
9S	21E	3	09S21E03	4	0.12	41			7.55	7.85	0.02	6.66	1.06	0.55	4.88	4.39	0.18	4.75	1.03	78.03	12.42	12.24	0.20	11.41	2.09	78.59
9S	21E	4	09S21E04	4	0.12	38			7.55	7.85	0.02	6.66	1.06	0.55	4.52	4.07	0.16	4.40	0.95	72.32	12.06	11.91	0.18	11.06	2.02	72.88
9S	21E	5	09S21E05	4	0.12	43			7.55	7.85	0.02	6.66	1.06	0.55	5.11	4.60	0.18	4.98	1.08	81.84	12.66	12.45	0.21	11.64	2.14	82.39
9S	21E	6	09S21E06	4	0.12	34			7.55	7.85	0.02	6.66	1.06	0.55	4.04	3.64	0.15	3.94	0.85	64.71	11.59	11.49	0.17	10.60	1.92	65.26
9S	21E	7	09S21E07	4	0.12	47			7.55	7.85	0.02	6.66	1.06	0.55	5.59	5.03	0.20	5.45	1.18	89.45	13.13	12.88	0.22	12.11	2.24	90.01
9S	21E	8	09S21E08	4	0.12	48			7.55	7.85	0.02	6.66	1.06	0.55	5.71	5.14	0.21	5.56	1.20	91.36	13.25	12.99	0.23	12.22	2.27	91.91
9S	21E	9	09S21E09	4	0.12	45		1	7.55	7.85	0.02	6.66	1.06	0.55	11.63	5.70	0.26	5.41	1.33	87.29	19.17	13.54	0.28	12.07	2.39	87.84
9S	21E	10	09S21E10	4	0.12	49			7.55	7.85	0.02	6.66	1.06	0.55	5.83	5.25	0.21	5.68	1.23	93.26	13.37	13.09	0.23	12.34	2.29	93.81
9S	21E	11	09S21E11	4	0.12	52			7.55	7.85	0.02	6.66	1.06	0.55	6.18	5.57	0.22	6.03	1.31	98.97	13.73	13.41	0.24	12.69	2.37	99.52
9S	21E	12	09S21E12	4	0.12	52			7.55	7.85	0.02	6.66	1.06	0.55	6.18	5.57	0.22	6.03	1.31	98.97	13.73	13.41	0.24	12.69	2.37	99.52
9S	21E	13	09S21E13	4	0.12	42			7.55	7.85	0.02	6.66	1.06	0.55	4.99	4.50	0.18	4.87	1.05	79.94	12.54	12.34	0.20	11.53	2.12	80.49

Table C-2 Spatially Distributed Production and Drilling Emissions for the Optimal Recovery Alternative

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				672	20	12,774	5	23																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
9S	21E	14	09S21E14	4	0.12	43			7.55	7.85	0.02	6.66	1.06	0.55	5.11	4.60	0.18	4.98	1.08	81.84	12.66	12.45	0.21	11.64	2.14	82.39
9S	21E	15	09S21E15	4	0.12	44			7.55	7.85	0.02	6.66	1.06	0.55	5.23	4.71	0.19	5.10	1.10	83.74	12.78	12.56	0.21	11.76	2.17	84.30
9S	21E	16	09S21E16	4	0.12	47			7.55	7.85	0.02	6.66	1.06	0.55	5.59	5.03	0.20	5.45	1.18	89.45	13.13	12.88	0.22	12.11	2.24	90.01
9S	21E	17	09S21E17	4	0.12	48			7.55	7.85	0.02	6.66	1.06	0.55	5.71	5.14	0.21	5.56	1.20	91.36	13.25	12.99	0.23	12.22	2.27	91.91
9S	21E	18	09S21E18	4	0.12	46			7.55	7.85	0.02	6.66	1.06	0.55	5.47	4.93	0.20	5.33	1.15	87.55	13.02	12.77	0.22	11.99	2.22	88.10
9S	21E	19	09S21E19	4	0.12	48	1	1	7.55	7.85	0.02	6.66	1.06	0.55	11.98	6.02	0.27	5.76	1.40	99.72	19.53	13.86	0.29	12.42	2.47	100.27
9S	21E	20	09S21E20	4	0.12	49			7.55	7.85	0.02	6.66	1.06	0.55	5.83	5.25	0.21	5.68	1.23	93.26	13.37	13.09	0.23	12.34	2.29	93.81
9S	21E	21	09S21E21	4	0.12	42			7.55	7.85	0.02	6.66	1.06	0.55	4.99	4.50	0.18	4.87	1.05	79.94	12.54	12.34	0.20	11.53	2.12	80.49
9S	21E	22	09S21E22	4	0.12	48			7.55	7.85	0.02	6.66	1.06	0.55	5.71	5.14	0.21	5.56	1.20	91.36	13.25	12.99	0.23	12.22	2.27	91.91
9S	21E	23	09S21E23	4	0.12	50			7.55	7.85	0.02	6.66	1.06	0.55	5.95	5.35	0.21	5.80	1.25	95.16	13.49	13.20	0.24	12.45	2.32	95.71
9S	21E	24	09S21E24	4	0.12	53		1	7.55	7.85	0.02	6.66	1.06	0.55	12.58	6.55	0.29	6.34	1.53	102.51	20.12	14.40	0.31	13.00	2.59	103.06
9S	21E	25	09S21E25	4	0.12	46			7.55	7.85	0.02	6.66	1.06	0.55	5.47	4.93	0.20	5.33	1.15	87.55	13.02	12.77	0.22	11.99	2.22	88.10
9S	21E	26	09S21E26	4	0.12	44			7.55	7.85	0.02	6.66	1.06	0.55	5.23	4.71	0.19	5.10	1.10	83.74	12.78	12.56	0.21	11.76	2.17	84.30
9S	21E	27	09S21E27	4	0.12	44			7.55	7.85	0.02	6.66	1.06	0.55	5.23	4.71	0.19	5.10	1.10	83.74	12.78	12.56	0.21	11.76	2.17	84.30
9S	21E	28	09S21E28	4	0.12	41			7.55	7.85	0.02	6.66	1.06	0.55	4.88	4.39	0.18	4.75	1.03	78.03	12.42	12.24	0.20	11.41	2.09	78.59
9S	21E	29	09S21E29	4	0.12	47			7.55	7.85	0.02	6.66	1.06	0.55	5.59	5.03	0.20	5.45	1.18	89.45	13.13	12.88	0.22	12.11	2.24	90.01
9S	21E	30	09S21E30	4	0.12	48			7.55	7.85	0.02	6.66	1.06	0.55	5.71	5.14	0.21	5.56	1.20	91.36	13.25	12.99	0.23	12.22	2.27	91.91
9S	21E	31	09S21E31	4	0.12	52			7.55	7.85	0.02	6.66	1.06	0.55	6.18	5.57	0.22	6.03	1.31	98.97	13.73	13.41	0.24	12.69	2.37	99.52
9S	21E	32	09S21E32	4	0.12	52			7.55	7.85	0.02	6.66	1.06	0.55	6.18	5.57	0.22	6.03	1.31	98.97	13.73	13.41	0.24	12.69	2.37	99.52
9S	21E	33	09S21E33	4	0.12	42			7.55	7.85	0.02	6.66	1.06	0.55	4.99	4.50	0.18	4.87	1.05	79.94	12.54	12.34	0.20	11.53	2.12	80.49
9S	21E	34	09S21E34	4	0.12	46			7.55	7.85	0.02	6.66	1.06	0.55	5.47	4.93	0.20	5.33	1.15	87.55	13.02	12.77	0.22	11.99	2.22	88.10
9S	21E	35	09S21E35	4	0.12	46	1	1	7.55	7.85	0.02	6.66	1.06	0.55	11.75	5.80	0.26	5.53	1.35	95.91	19.29	13.65	0.28	12.19	2.42	96.46
9S	21E	36	09S21E36	4	0.12	44			7.55	7.85	0.02	6.66	1.06	0.55	5.23	4.71	0.19	5.10	1.10	83.74	12.78	12.56	0.21	11.76	2.17	84.30
9S	22E	6	09S22E06	4	0.12	42			7.55	7.85	0.02	6.66	1.06	0.55	4.99	4.50	0.18	4.87	1.05	79.94	12.54	12.34	0.20	11.53	2.12	80.49
9S	22E	7	09S22E07	4	0.12	39			7.55	7.85	0.02	6.66	1.06	0.55	4.64	4.18	0.17	4.52	0.98	74.23	12.18	12.02	0.19	11.18	2.04	74.78
9S	22E	15	09S22E15	-	-	5			-	-	-	-	-	-	0.59	0.54	0.02	0.58	0.13	9.52	0.59	0.54	0.02	0.58	0.13	9.52
9S	22E	18	09S22E18	4	0.12	38			7.55	7.85	0.02	6.66	1.06	0.55	4.52	4.07	0.16	4.40	0.95	72.32	12.06	11.91	0.18	11.06	2.02	72.88
9S	22E	19	09S22E19	4	0.12	50			7.55	7.85	0.02	6.66	1.06	0.55	5.95	5.35	0.21	5.80	1.25	95.16	13.49	13.20	0.24	12.45	2.32	95.71
9S	22E	20	09S22E20	4	0.12	38			7.55	7.85	0.02	6.66	1.06	0.55	4.52	4.07	0.16	4.40	0.95	72.32	12.06	11.91	0.18	11.06	2.02	72.88
9S	22E	29	09S22E29	4	0.12	48			7.55	7.85	0.02	6.66	1.06	0.55	5.71	5.14	0.21	5.56	1.20	91.36	13.25	12.99	0.23	12.22	2.27	91.91
9S	22E	30	09S22E30	4	0.12	46			7.55	7.85	0.02	6.66	1.06	0.55	5.47	4.93	0.20	5.33	1.15	87.55	13.02	12.77	0.22	11.99	2.22	88.10
9S	22E	31	09S22E31	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
9S	22E	32	09S22E32	4	0.12	41			7.55	7.85	0.02	6.66	1.06	0.55	4.88	4.39	0.18	4.75	1.03	78.03	12.42	12.24	0.20	11.41	2.09	78.59
9S	22E	33	09S22E33	2	0.06	42			3.77	3.92	0.01	3.33	0.53	0.28	4.99	4.50	0.18	4.87	1.05	79.94	8.77	8.42	0.19	8.20	1.59	80.21
9S	22E	34	09S22E34	4	0.12	19			7.55	7.85	0.02	6.66	1.06	0.55	2.26	2.03	0.08	2.20	0.48	36.16	9.80	9.88	0.10	8.86	1.54	36.71
9S	22E	35	09S22E35	2	0.06	39			3.77	3.92	0.01	3.33	0.53	0.28	4.64	4.18	0.17	4.52	0.98	74.23	8.41	8.10	0.18	7.85	1.51	74.50
9S	22E	36	09S22E36	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
9S	23E	1	09S23E01	4	0.12	60			7.55	7.85	0.02	6.66	1.06	0.55	7.14	6.42	0.26	6.95	1.51	114.20	14.68	14.27	0.28	13.61	2.57	114.75
9S	23E	2	09S23E02	2	0.06	62			3.77	3.92	0.01	3.33	0.53	0.28	7.37	6.64	0.27	7.19	1.56	118.00	11.15	10.56	0.28	10.52	2.09	118.28
9S	23E	3	09S23E03	4	0.12	59		1	7.55	7.85	0.02	6.66	1.06	0.55	13.29	7.20	0.32	7.04	1.68	113.93	20.84	15.04	0.34	13.70	2.74	114.48
9S	23E	4	09S23E04	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
9S	23E	8	09S23E05	2	0.06	63			3.77	3.92	0.01	3.33	0.53	0.28	7.49	6.75	0.27	7.30	1.58	119.91	11.26	10.67	0.28	10.63	2.11	120.18
9S	23E	9	09S23E06	4	0.12	59			7.55	7.85	0.02	6.66	1.06	0.55	7.02	6.32	0.25	6.84	1.48	112.29	14.56	14.16	0.27	13.50	2.54	112.84
9S	23E	10	09S23E10	2	0.06	45			3.77	3.92	0.01	3.33	0.53	0.28	5.35	4.82	0.19	5.22	1.13	85.65	9.12	8.74	0.20	8.55	1.66	85.92
9S	23E	11	09S23E11	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
9S	23E	12	09S23E12	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
9S	23E	13	09S23E13	2	0.06	59			3.77	3.92	0.01	3.33	0.53	0.28	7.02	6.32	0.25	6.84	1.48	112.29	10.79	10.24	0.26	10.17	2.01	112.57
9S	23E	14	09S23E14	2	0.06	59			3.77	3.92	0.01	3.33	0.53	0.28	7.02	6.32	0.25	6.84	1.48	112.29	10.79	10.24	0.26	10.17	2.01	112.57
9S	23E	15	09S23E15	2	0.06	58			3.77	3.92	0.01	3.33	0.53	0.28	6.90	6.21	0.25	6.72	1.46	110.39	10.67	10.13	0.26	10.05	1.99	110.67
9S	23E	23	09S23E23	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
9S	23E	24	09S23E24	2	0.06	60			3.77	3.92	0.01	3.33	0.53	0.28	7.14	6.42	0.26	6.95	1.51	114.20	10.91	10.35	0.27	10.28	2.04	114.47
9S	23E	25	09S23E25	-	-	65		1	-	-	-	-	-	-	14.01	7.84	0.35	7.73	1.83	125.35	14.01	7.84	0.35	7.73	1.83	125.35
9S	23E	26	09S23E26	6	0.18	35			11.32	11.77	0.03	9.99	1.59	0.83	4.16	3.75	0.15	4.06	0.88	66.62	15.48	15.52	0.18	14.04	2.47	67.44

Table C-2 Spatially Distributed Production and Drilling Emissions for the Optimal Recovery Alternative

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				672	20	12,774	5	23																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
9S	23E	31	09S23E31	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
9S	23E	35	09S23E35	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
9S	23E	36	09S23E36	-	-	49			-	-	-	-	-	-	5.83	5.25	0.21	5.68	1.23	93.26	5.83	5.25	0.21	5.68	1.23	93.26
9S	24E	21	09S24E21	-	-	66			-	-	-	-	-	-	7.85	7.07	0.28	7.65	1.66	125.62	7.85	7.07	0.28	7.65	1.66	125.62
9S	24E	28	09S24E28	-	-	65			-	-	-	-	-	-	7.73	6.96	0.28	7.53	1.63	123.71	7.73	6.96	0.28	7.53	1.63	123.71
9S	24E	29	09S24E29	4	0.12	59			7.55	7.85	0.02	6.66	1.06	0.55	7.02	6.32	0.25	6.84	1.48	112.29	14.56	14.16	0.27	13.50	2.54	112.84
9S	24E	30	09S24E30	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
9S	24E	31	09S24E31	2	0.06	59			3.77	3.92	0.01	3.33	0.53	0.28	7.02	6.32	0.25	6.84	1.48	112.29	10.79	10.24	0.26	10.17	2.01	112.57
9S	24E	32	09S24E32	-	-	66		1	-	-	-	-	-	-	14.13	7.95	0.35	7.85	1.86	127.26	14.13	7.95	0.35	7.85	1.86	127.26
9S	24E	33	09S24E33	-	-	66			-	-	-	-	-	-	7.85	7.07	0.28	7.65	1.66	125.62	7.85	7.07	0.28	7.65	1.66	125.62
9S	24E	34	09S24E34	2	0.06	63			3.77	3.92	0.01	3.33	0.53	0.28	7.49	6.75	0.27	7.30	1.58	119.91	11.26	10.67	0.28	10.63	2.11	120.18
10S	20E	1	10S20E01	2	0.06	53			3.77	3.92	0.01	3.33	0.53	0.28	6.30	5.67	0.23	6.14	1.33	100.87	10.08	9.60	0.24	9.47	1.86	101.15
10S	20E	2	10S20E02	2	0.06	57			3.77	3.92	0.01	3.33	0.53	0.28	6.78	6.10	0.24	6.61	1.43	108.49	10.55	10.03	0.25	9.94	1.96	108.76
10S	20E	11	10S20E11	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
10S	20E	12	10S20E12	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	20E	13	10S20E13	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	20E	14	10S20E14	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
10S	20E	23	10S20E23	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	20E	24	10S20E24	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
10S	20E	25	10S20E25	2	0.06	63			3.77	3.92	0.01	3.33	0.53	0.28	7.49	6.75	0.27	7.30	1.58	119.91	11.26	10.67	0.28	10.63	2.11	120.18
10S	20E	26	10S20E26	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
10S	20E	35	10S20E35	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
10S	20E	36	10S20E36	2	0.06	53			3.77	3.92	0.01	3.33	0.53	0.28	6.30	5.67	0.23	6.14	1.33	100.87	10.08	9.60	0.24	9.47	1.86	101.15
10S	21E	1	10S21E01	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
10S	21E	2	10S21E02	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	21E	3	10S21E03	2	0.06	45			3.77	3.92	0.01	3.33	0.53	0.28	5.35	4.82	0.19	5.22	1.13	85.65	9.12	8.74	0.20	8.55	1.66	85.92
10S	21E	4	10S21E04	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	21E	5	10S21E05	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	21E	6	10S21E06	4	0.12	49			7.55	7.85	0.02	6.66	1.06	0.55	5.83	5.25	0.21	5.68	1.23	93.26	13.37	13.09	0.23	12.34	2.29	93.81
10S	21E	7	10S21E07	2	0.06	55		1	3.77	3.92	0.01	3.33	0.53	0.28	12.82	6.77	0.30	6.57	1.58	106.32	16.59	10.69	0.31	9.90	2.11	106.59
10S	21E	8	10S21E08	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	21E	9	10S21E09	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	21E	10	10S21E10	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	21E	11	10S21E11	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	21E	12	10S21E12	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
10S	21E	13	10S21E13	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	21E	14	10S21E14	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	21E	15	10S21E15	2	0.06	47		1	3.77	3.92	0.01	3.33	0.53	0.28	11.87	5.91	0.27	5.65	1.38	91.09	15.64	9.83	0.28	8.98	1.91	91.37
10S	21E	16	10S21E16	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
10S	21E	17	10S21E17	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	21E	18	10S21E18	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
10S	21E	19	10S21E19	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
10S	21E	20	10S21E20	2	0.06	58			3.77	3.92	0.01	3.33	0.53	0.28	6.90	6.21	0.25	6.72	1.46	110.39	10.67	10.13	0.26	10.05	1.99	110.67
10S	21E	21	10S21E21	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	21E	22	10S21E22	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
10S	21E	23	10S21E23	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	21E	24	10S21E24	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
10S	21E	25	10S21E25	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	21E	26	10S21E26	2	0.06	59			3.77	3.92	0.01	3.33	0.53	0.28	7.02	6.32	0.25	6.84	1.48	112.29	10.79	10.24	0.26	10.17	2.01	112.57
10S	21E	27	10S21E27	6	0.18	58			11.32	11.77	0.03	9.99	1.59	0.83	6.90	6.21	0.25	6.72	1.46	110.39	18.22	17.98	0.28	16.71	3.05	111.22
10S	21E	28	10S21E28	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
10S	21E	29	10S21E29	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	21E	30	10S21E30	2	0.06	54		1	3.77	3.92	0.01	3.33	0.53	0.28	12.70	6.66	0.30	6.46	1.55	104.42	16.47	10.58	0.31	9.79	2.09	104.69

Table C-2 Spatially Distributed Production and Drilling Emissions for the Optimal Recovery Alternative

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				672	20	12,774	5	23																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
10S	21E	31	10S21E31	4	0.12	47			7.55	7.85	0.02	6.66	1.06	0.55	5.59	5.03	0.20	5.45	1.18	89.45	13.13	12.88	0.22	12.11	2.24	90.01
10S	21E	32	10S21E32	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	21E	33	10S21E33	-	-	65			-	-	-	-	-	-	7.73	6.96	0.28	7.53	1.63	123.71	7.73	6.96	0.28	7.53	1.63	123.71
10S	21E	34	10S21E34	2	0.06	60			3.77	3.92	0.01	3.33	0.53	0.28	7.14	6.42	0.26	6.95	1.51	114.20	10.91	10.35	0.27	10.28	2.04	114.47
10S	21E	35	10S21E35	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	21E	36	10S21E36	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	22E	1	10S22E01	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	22E	2	10S22E02	4	0.12	20			7.55	7.85	0.02	6.66	1.06	0.55	2.38	2.14	0.09	2.32	0.50	38.07	9.92	9.99	0.11	8.98	1.56	38.62
10S	22E	3	10S22E03	4	0.12	40			7.55	7.85	0.02	6.66	1.06	0.55	4.76	4.28	0.17	4.64	1.00	76.13	12.30	12.13	0.19	11.30	2.07	76.68
10S	22E	4	10S22E04	4	0.12	11			7.55	7.85	0.02	6.66	1.06	0.55	1.31	1.18	0.05	1.27	0.28	20.94	8.85	9.02	0.07	7.93	1.34	21.49
10S	22E	5	10S22E05	2	0.06	11		1	3.77	3.92	0.01	3.33	0.53	0.28	7.58	2.06	0.11	1.47	0.48	22.57	11.36	5.98	0.12	4.80	1.01	22.85
10S	22E	6	10S22E06	2	0.06	43			3.77	3.92	0.01	3.33	0.53	0.28	5.11	4.60	0.18	4.98	1.08	81.84	8.89	8.53	0.19	8.31	1.61	82.12
10S	22E	7	10S22E07	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	22E	8	10S22E08	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	22E	9	10S22E09	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	22E	10	10S22E10	2	0.06	42			3.77	3.92	0.01	3.33	0.53	0.28	4.99	4.50	0.18	4.87	1.05	79.94	8.77	8.42	0.19	8.20	1.59	80.21
10S	22E	11	10S22E11	4	0.12	25	1	1	7.55	7.85	0.02	6.66	1.06	0.55	9.25	3.56	0.17	3.10	0.83	55.94	16.79	11.40	0.19	9.76	1.89	56.49
10S	22E	12	10S22E12	2	0.06	30			3.77	3.92	0.01	3.33	0.53	0.28	3.57	3.21	0.13	3.48	0.75	57.10	7.34	7.14	0.14	6.81	1.28	57.37
10S	22E	13	10S22E13	2	0.06	33			3.77	3.92	0.01	3.33	0.53	0.28	3.92	3.53	0.14	3.82	0.83	62.81	7.70	7.46	0.15	7.15	1.36	63.08
10S	22E	14	10S22E14	4	0.12	24			7.55	7.85	0.02	6.66	1.06	0.55	2.85	2.57	0.10	2.78	0.60	45.68	10.40	10.42	0.12	9.44	1.66	46.23
10S	22E	15	10S22E15	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
10S	22E	16	10S22E16	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	22E	17	10S22E17	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	22E	18	10S22E18	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
10S	22E	19	10S22E19	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	22E	20	10S22E20	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	22E	21	10S22E21	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	22E	22	10S22E22	2	0.06	53			3.77	3.92	0.01	3.33	0.53	0.28	6.30	5.67	0.23	6.14	1.33	100.87	10.08	9.60	0.24	9.47	1.86	101.15
10S	22E	23	10S22E23	2	0.06	44			3.77	3.92	0.01	3.33	0.53	0.28	5.23	4.71	0.19	5.10	1.10	83.74	9.01	8.63	0.20	8.43	1.64	84.02
10S	22E	24	10S22E24	6	0.18	22			11.32	11.77	0.03	9.99	1.59	0.83	2.62	2.36	0.09	2.55	0.55	41.87	13.93	14.12	0.13	12.54	2.14	42.70
10S	22E	25	10S22E25	6	0.18	57			11.32	11.77	0.03	9.99	1.59	0.83	6.78	6.10	0.24	6.61	1.43	108.49	18.10	17.87	0.28	16.59	3.02	109.31
10S	22E	26	10S22E26	2	0.06	53			3.77	3.92	0.01	3.33	0.53	0.28	6.30	5.67	0.23	6.14	1.33	100.87	10.08	9.60	0.24	9.47	1.86	101.15
10S	22E	27	10S22E27	2	0.06	53			3.77	3.92	0.01	3.33	0.53	0.28	6.30	5.67	0.23	6.14	1.33	100.87	10.08	9.60	0.24	9.47	1.86	101.15
10S	22E	28	10S22E28	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
10S	22E	29	10S22E29	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
10S	22E	30	10S22E30	2	0.06	47	1	1	3.77	3.92	0.01	3.33	0.53	0.28	11.87	5.91	0.27	5.65	1.38	97.81	15.64	9.83	0.28	8.98	1.91	98.09
10S	22E	31	10S22E31	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	22E	32	10S22E32	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	22E	33	10S22E33	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	22E	34	10S22E34	2	0.06	58		1	3.77	3.92	0.01	3.33	0.53	0.28	13.17	7.09	0.32	6.92	1.65	112.03	16.95	11.01	0.33	10.25	2.19	112.30
10S	22E	35	10S22E35	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
10S	22E	36	10S22E36	2	0.06	51			3.77	3.92	0.01	3.33	0.53	0.28	6.07	5.46	0.22	5.91	1.28	97.07	9.84	9.38	0.23	9.24	1.81	97.34
10S	23E	1	10S23E01	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
10S	23E	2	10S23E02	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	23E	3	10S23E03	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	23E	4	10S23E04	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	23E	5	10S23E05	2	0.06	47			3.77	3.92	0.01	3.33	0.53	0.28	5.59	5.03	0.20	5.45	1.18	89.45	9.36	8.96	0.21	8.78	1.71	89.73
10S	23E	6	10S23E06	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	23E	7	10S23E07	2	0.06	46			3.77	3.92	0.01	3.33	0.53	0.28	5.47	4.93	0.20	5.33	1.15	87.55	9.24	8.85	0.21	8.66	1.69	87.83
10S	23E	8	10S23E08	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
10S	23E	9	10S23E09	2	0.06	49	1	1	3.77	3.92	0.01	3.33	0.53	0.28	12.10	6.13	0.28	5.88	1.43	101.62	15.88	10.05	0.29	9.21	1.96	101.90
10S	23E	10	10S23E10	2	0.06	50			3.77	3.92	0.01	3.33	0.53	0.28	5.95	5.35	0.21	5.80	1.25	95.16	9.72	9.28	0.22	9.12	1.79	95.44
10S	23E	11	10S23E11	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63

Table C-2 Spatially Distributed Production and Drilling Emissions for the Optimal Recovery Alternative

Total Planned				Drilling		Production and Operation			Drilling and Completion						Production and Operation						Total					
				672	20	12,774	5	23																		
TN	RG	SE	Model ID	Producing Wellbores	Non-producing	Wells (above	Water Tank	Water Injection	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC
				(number of sites)					(tons per year)						(tons per year)						(tons per year)					
10S	23E	12	10S23E12	8	0.24	26			15.09	15.69	0.04	13.32	2.12	1.10	3.09	2.78	0.11	3.01	0.65	49.49	18.18	18.48	0.15	16.33	2.78	50.59
10S	23E	13	10S23E13	-	-	55			-	-	-	-	-	-	6.54	5.89	0.24	6.37	1.38	104.68	6.54	5.89	0.24	6.37	1.38	104.68
10S	23E	14	10S23E14	4	0.12	37			7.55	7.85	0.02	6.66	1.06	0.55	4.40	3.96	0.16	4.29	0.93	70.42	11.95	11.81	0.18	10.95	1.99	70.97
10S	23E	15	10S23E15	2	0.06	44			3.77	3.92	0.01	3.33	0.53	0.28	5.23	4.71	0.19	5.10	1.10	83.74	9.01	8.63	0.20	8.43	1.64	84.02
10S	23E	16	10S23E16	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
10S	23E	17	10S23E17	2	0.06	43			3.77	3.92	0.01	3.33	0.53	0.28	5.11	4.60	0.18	4.98	1.08	81.84	8.89	8.53	0.19	8.31	1.61	82.12
10S	23E	18	10S23E18	4	0.12	30			7.55	7.85	0.02	6.66	1.06	0.55	3.57	3.21	0.13	3.48	0.75	57.10	11.11	11.06	0.15	10.14	1.81	57.65
10S	23E	22	10S23E22	-	-	55			-	-	-	-	-	-	6.54	5.89	0.24	6.37	1.38	104.68	6.54	5.89	0.24	6.37	1.38	104.68
11S	21E	1	11S21E01	-	-	66			-	-	-	-	-	-	7.85	7.07	0.28	7.65	1.66	125.62	7.85	7.07	0.28	7.65	1.66	125.62
11S	21E	2	11S21E02	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
11S	21E	3	11S21E03	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
11S	21E	4	11S21E04	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
11S	21E	5	11S21E05	2	0.06	55			3.77	3.92	0.01	3.33	0.53	0.28	6.54	5.89	0.24	6.37	1.38	104.68	10.31	9.81	0.25	9.70	1.91	104.96
11S	21E	7	11S21E07	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
11S	21E	8	11S21E08	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
11S	21E	9	11S21E09	2	0.06	54		1	3.77	3.92	0.01	3.33	0.53	0.28	12.70	6.66	0.30	6.46	1.55	104.42	16.47	10.58	0.31	9.79	2.09	104.69
11S	21E	10	11S21E10	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
11S	21E	11	11S21E11	2	0.06	54			3.77	3.92	0.01	3.33	0.53	0.28	6.42	5.78	0.23	6.26	1.36	102.78	10.19	9.70	0.24	9.59	1.89	103.05
11S	21E	12	11S21E12	2	0.06	56		1	3.77	3.92	0.01	3.33	0.53	0.28	12.94	6.87	0.31	6.69	1.60	108.22	16.71	10.80	0.32	10.02	2.14	108.50
11S	21E	13	11S21E13	2	0.06	57			3.77	3.92	0.01	3.33	0.53	0.28	6.78	6.10	0.24	6.61	1.43	108.49	10.55	10.03	0.25	9.94	1.96	108.76
11S	21E	14	11S21E14	2	0.06	58			3.77	3.92	0.01	3.33	0.53	0.28	6.90	6.21	0.25	6.72	1.46	110.39	10.67	10.13	0.26	10.05	1.99	110.67
11S	21E	15	11S21E15	2	0.06	57			3.77	3.92	0.01	3.33	0.53	0.28	6.78	6.10	0.24	6.61	1.43	108.49	10.55	10.03	0.25	9.94	1.96	108.76
11S	21E	16	11S21E16	2	0.06	48			3.77	3.92	0.01	3.33	0.53	0.28	5.71	5.14	0.21	5.56	1.20	91.36	9.48	9.06	0.22	8.89	1.74	91.63
11S	21E	17	11S21E17	2	0.06	55			3.77	3.92	0.01	3.33	0.53	0.28	6.54	5.89	0.24	6.37	1.38	104.68	10.31	9.81	0.25	9.70	1.91	104.96
11S	21E	18	11S21E18	2	0.06	60			3.77	3.92	0.01	3.33	0.53	0.28	7.14	6.42	0.26	6.95	1.51	114.20	10.91	10.35	0.27	10.28	2.04	114.47
11S	21E	24	11S21E24	-	-	5			-	-	-	-	-	-	0.59	0.54	0.02	0.58	0.13	9.52	0.59	0.54	0.02	0.58	0.13	9.52
11S	22E	2	11S22E02	2	0.06	49			3.77	3.92	0.01	3.33	0.53	0.28	5.83	5.25	0.21	5.68	1.23	93.26	9.60	9.17	0.22	9.01	1.76	93.54
11S	22E	3	11S22E03	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
11S	22E	4	11S22E04	2	0.06	58			3.77	3.92	0.01	3.33	0.53	0.28	6.90	6.21	0.25	6.72	1.46	110.39	10.67	10.13	0.26	10.05	1.99	110.67
11S	22E	5	11S22E05	2	0.06	56			3.77	3.92	0.01	3.33	0.53	0.28	6.66	6.00	0.24	6.49	1.41	106.58	10.43	9.92	0.25	9.82	1.94	106.86
11S	22E	6	11S22E06	2	0.06	60			3.77	3.92	0.01	3.33	0.53	0.28	7.14	6.42	0.26	6.95	1.51	114.20	10.91	10.35	0.27	10.28	2.04	114.47
11S	22E	7	11S22E07	-	-	66			-	-	-	-	-	-	7.85	7.07	0.28	7.65	1.66	125.62	7.85	7.07	0.28	7.65	1.66	125.62
11S	22E	8	11S22E08	-	-	66		1	-	-	-	-	-	-	14.13	7.95	0.35	7.85	1.86	127.26	14.13	7.95	0.35	7.85	1.86	127.26
11S	22E	9	11S22E09	2	0.06	62			3.77	3.92	0.01	3.33	0.53	0.28	7.37	6.64	0.27	7.19	1.56	118.00	11.15	10.56	0.28	10.52	2.09	118.28
11S	22E	10	11S22E10	6	0.18	53			11.32	11.77	0.03	9.99	1.59	0.83	6.30	5.67	0.23	6.14	1.33	100.87	17.62	17.44	0.26	16.13	2.92	101.70
11S	22E	15	11S22E15	-	-	57			-	-	-	-	-	-	6.78	6.10	0.24	6.61	1.43	108.49	6.78	6.10	0.24	6.61	1.43	108.49
11S	22E	16	11S22E16	2	0.06	62			3.77	3.92	0.01	3.33	0.53	0.28	7.37	6.64	0.27	7.19	1.56	118.00	11.15	10.56	0.28	10.52	2.09	118.28
11S	22E	17	11S22E17	6	0.18	56			11.32	11.77	0.03	9.99	1.59	0.83	6.66	6.00	0.24	6.49	1.41	106.58	17.98	17.77	0.27	16.48	3.00	107.41
11S	22E	18	11S22E18	2	0.06	52			3.77	3.92	0.01	3.33	0.53	0.28	6.18	5.57	0.22	6.03	1.31	98.97	9.96	9.49	0.23	9.36	1.84	99.25
11S	22E	19	11S22E19	2	0.06	59			3.77	3.92	0.01	3.33	0.53	0.28	7.02	6.32	0.25	6.84	1.48	112.29	10.79	10.24	0.26	10.17	2.01	112.57
11S	22E	20	11S22E20	4	0.12	59			7.55	7.85	0.02	6.66	1.06	0.55	7.02	6.32	0.25	6.84	1.48	112.29	14.56	14.16	0.27	13.50	2.54	112.84
11S	22E	21	11S22E21	2	0.06	59			3.77	3.92	0.01	3.33	0.53	0.28	7.02	6.32	0.25	6.84	1.48	112.29	10.79	10.24	0.26	10.17	2.01	112.57
11S	22E	22	11S22E22	2	0.06	62		1	3.77	3.92	0.01	3.33	0.53	0.28	13.65	7.52	0.33	7.39	1.76	119.64	17.42	11.44	0.34	10.71	2.29	119.92
11S	22E	23	11S22E23	-	-	62			-	-	-	-	-	-	7.37	6.64	0.27	7.19	1.56	118.00	7.37	6.64	0.27	7.19	1.56	118.00
				672	20.2	12774	5	23	1,267.6	1,318.1	3.5	1,118.7	178.4	92.5	1,663.5	1,388.0	56.3	1,485.2	325.2	24,383.9	2,931.1	2,706.1	59.8	2,603.8	503.6	24,476.4