APPENDIX B

Air Quality Technical Support Document (AQTSD)

AIR QUALITY TECHNICAL SUPPORT DOCUMENT for the PROPOSED MONUMENT BUTTE OIL AND GAS DEVELOPMENT PROJECT

September 23, 2013

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AIR QUALITY TECHNICAL SUPPORT DOCUMENT for the PROPOSED MONUMENT BUTTE OIL AND GAS DEVELOPMENT PROJECT

Kleinfelder Job No. 116133-3

Prepared by:

Russell E. Erbes, CCM
Senior Principal Air Quality Scientist

Reviewed by:

Michele Steyskal
Air Quality Project Professional

KLEINFELDER
300 E. Mineral Avenue, Suite 7
Littleton, CO 80122
303.781.8211
FAX: 303.781.1167

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1 EXECUTIVE SUMMARY

This Air Quality Technical Support Document (AQTSD) describes the process used to conduct an air quality impact assessment (AQIA) for the proposed Newfield Exploration Company (Newfield) Monument Butte Oil and Gas Development project.

1.1 Introduction to the Project and AQIA

The proposed project will be implemented in the Monument Butte Project Area (MBPA) which is located within the Greater Monument Butte Unit in southeast Duchesne County and southwest Uintah County in the state of Utah. The MBPA is shown on Figure 1-1, which is located at the end of this Section.

There are four alternatives for the proposed project:

- Alternative A: Proposed Action
- Alternative B: No Action
- Alternative C: Field-Wide Electrification
- Alternative D: Resource Protection (Agency Preferred Alternative)

The Proposed Action (Alternative A) is to drill, develop, and operate up to 5,750 oil and gas wells in the MBPA, along with the required infrastructure. In summary, the Proposed Action includes:

- Drill, develop, and operate up to 3,250 Green River oil wells and 2,500 deep gas wells on existing and new well pads
- Construct additional roads and pipelines to serve the wells
- Construct 20 new gas compressor stations to serve the deep gas wells
- Expand 3 existing compressor stations and add one new compressor station to serve the oil wells
- Construct a new 50 million standard cubic feet per day (MMscf/d) centralized gas processing plant
- Construct 7 new and expand 6 water treatment and injection facilities
- Construct up to 12 new gas oil separation plants (GOSPs) for oil and produced water collection

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- Develop one fresh water collector well for water flood operations and add 6 water pump stations

The Proposed Action includes a large number of Applicant Committed Environmental Protection Measures (ACEPMs) that reduce overall environmental impact and the potential air quality impacts. The ACEPMs are listed in Section 2.

Under the No Action Alternative, the proposed project would not be implemented but oil and gas development in the MBPA would continue to occur on private and state lands and on Bureau of Land Management (BLM) administered lands as previously authorized through other Environmental Impact Statement (EIS) Records of Decision (RODs). A total of 788 wells (579 oil wells and 209 gas wells) would be developed under the No Action Alternative. The ACEPMs and other measures that would be taken by Newfield under the Proposed Action would not occur under the No Action Alternative. However, promulgated regulatory requirements apply to both the Proposed Action and No Action Alternatives.

Under Alternative C, Newfield would implement field-wide electrification of various well field components (e.g., pumpjack engines). This Alternative would include the same oil and gas operations as Alternative A, but add 11 substations that consist of two 20 megawatt electric (MWe) gas turbine generators and one 10 MWe steam turbine generator at each substation (50 MWe per substation) for a total generation capacity in the MBPA of 550 MWe. Overhead transmission and distribution lines would also be added to distribute the electrical energy from the substations to the end use.

Alternative D is similar to Alternative A, but reduces the number of well pads and wells in order to protect sensitive areas within the MBPA. Alternative D would result in a total of 5,058 wells being drilled, developed, and operated (3,519 oil and 1,539 deep gas).

The Proposed Action and Alternatives are further described in Section 2 of this AQTSD.

In order to conduct the AQIA, first the existing background air quality was determined along with the evaluation criteria that will be used to evaluate the potential ambient air quality impact of the Proposed Action and Alternatives. Then emission estimates of criteria and key hazardous air pollutants were developed for each of the Alternatives. For Alternative A, not only were emission estimates developed for the maximum impact year when all of the proposed wells

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were developed and operating, annual development emission estimates were made for a ten-year period, 2012 through 2022.

Once the emissions were determined, dispersion models were used to evaluate the potential impact in the near field (less than 50 kilometers (km) from the sources) and far field (i.e., potential impacts at distant Class I areas, Class II areas, and sensitive lakes).

The evaluation criteria were the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, toxic screening levels and other reference concentrations for hazardous air pollutants, and air quality related value (AQRV) thresholds specified by the Federal Land Managers for the Class I areas, sensitive Class II areas, and sensitive lakes. The evaluation criteria are discussed in detail in Section 3. Section 3 also presents the pre-project, background ambient air quality conditions in the MBPA.

1.2 Proposed Project and Alternatives Emissions

Table 1-1 summarizes the emissions for the four alternatives. Details are provided in Section 4 and the appendices.

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Table 1-1
Proposed Action and Alternatives Emissions

Pollutant	Alternative A: Proposed Action (tpy)	Alternative A: Proposed Action Only through 2022[a] (tpy)	Alternative B: No Action (tpy)	Alternative C: Field-Wide Electrification (tpy)	Alternative D: Resource Protection (tpy)
Criteria Pollutants					
NO_x	5,690.1	744.7	1,817.3	1,994.8	4,900.9
CO	8,523.8	----	1,497.4	1,949.3	7,062.1
VOC	10,360.9	4833.0	2,116.9	8,366.2	9,480.2
SO_2	14.4	----	2.8	9.4	12.5
PM_{10}	2,903.6	----	810.1	2,709.0	2,687.3
$PM_{2.5}$	617.0	----	157.0	422.3	573.0
Hazardous Air Pollutants					
Benzene	62.57	----	13.75	53.27	51.39
Toluene	75.90	----	28.04	72.44	56.81
Xylene	44.67	----	43.26	43.78	30.51
Formal-dehyde	380.99	----	49.80	9.79	338.73
Acrolein	45.60	----	6.33	0.087	41.97
Total HAPs	1,004.73	----	227.61	480.17	920.71
Greenhouse Gases					
CO_2	2,830,690	----	461,805	3,134,441	2,448,615
CH_4	12,587	----	1,686	12,582	9,943
N_2O	6.13	----	1.45	6.71	5.25
GWP	3,096,936	----	497,665	3,400,752	2,659,049

[a] Only NOx and VOC emissions were calculated for the annual emission analysis.

1.3 Substantial Increase in Emissions Assessment

As indicated, under the No Action Alternative, oil and gas development will continue in the MBPA under previously authorized RODs on federal mineral estates and on state and private lands. For purposes of assessing potential ozone impacts, the Proposed Action emissions were compared to the No Action Alternative emissions to determine if there would be a substantial increase in ozone precursor (NOx and VOC) emissions. For purposes of this document, "substantial increase" is defined as emissions from the Proposed Action that are greater than emissions from the No Action Alternative. As shown in Table 1-1, annual development of the Proposed Action can occur until approximately early calendar year 2021 without total NO_x and VOC emissions exceeding emissions that would occur under the No Action Alternative. As shown in Section 4 and discussed in Section 6, by calendar year 2021 there could be a net

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increase of over 1,000 oil and gas wells in the MBPA and not cause NO_x plus VOC emissions to exceed the No Action Alternative emissions. There would be no substantial increase in NOx emissions alone through 2022. There could be a substantial increase of VOC emissions by late 2019 (i.e., VOC emission increases from annual development of the Proposed Action could exceed emission increases under the No Action Alternative). This level of development can occur because Newfield will implement a number of emission reducing measures and ACEPMs in order to reduce emissions from existing and future oil and gas wells, and because the existing level of infrastructure can service the additional wells.

1.4 Near Field Dispersion Modeling and Results

For near field impacts, five different source configurations were developed in order to assess the maximum potential impact of construction and development emissions as well as operation (production) emissions. The modeling scenarios are as follows and are discussed in detail in Section 5:

- Alternative A – Proposed Action: Well construction and development
- Alternative A – Proposed Action: 20-acre downhole spacing oil well operations
- Alternative A – Proposed Action: 40-acre surface spacing gas well operations
- Alternative C – Field Wide Electrification: 20-acre downhole spacing oil well operations
- Alternative C – Field Wide Electrification: 40-acre surface spacing gas well operations

Construction and development activities are essentially the same under all of the Alternatives and thus only one modeling scenario is needed to assess the impact of construction and development emissions.

The United States Environmental Protection Agency (USEPA) recommended AERMOD dispersion model was used with five years of meteorological data (2005 – 2009) collected at Vernal Utah, and obtained from the Utah Department of Environmental Quality – Division of Air Quality (UDAQ). The impact modeling methodology is further described in Section 5 and the results are presented in Section 7.

The maximum near field impacts for the criteria pollutants are shown in Table 1-2. The maximum impacts for all except PM_{10} and $PM_{2.5}$ were from well or infrastructure operations. The maximum short term PM_{10} and $PM_{2.5}$ impacts were from construction and development of the well field. The maximum CO 1-hour impacts are from the 40-acre surface spacing gas well

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operations from Alternative A modeling scenario, while the CO 8-hour, NO_2 and SO_2 impacts are from the 20-acre downhole spacing oil well operations from Alternative A.

Table 1-2
Maximum Potential Project Impacts

Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)			
		Maximum Modeled Impact	Background	Total	NAAQS
CO	1-hour	265	2,641	2,906	40,000
	8-hour	137	1,657	1,794	10,000
NO_2	1-hour	106.9 [a]	57.7	164.6	188
	Annual	16.5	7.3	23.8	100
SO_2	1-hour	0.7	20.1	20.8	196
	3-hour	0.6	14.3	14.9	1,300
PM_{10}	24-hour	72.5	18.7	91.2	150
$PM_{2.5}$	24-hour	14.3	17.8	32.1	35
	Annual	1.4	8.0	9.4	12

[a] Assumes NO to NO_2 conversion of 80%

The maximum air toxics near field impacts for non-carcinogenic impacts are shown in Table 1-3 and potential carcinogenic impacts are shown in Table 1-4. The maximum impacts for 1-hour acrolein, annual acrolein, annual formaldehyde, and annual benzene are from well operations in the 20-acre downhole spacing oil well operations scenario from Alternative A. The maximum impacts for 1-hour formaldehyde and 1-hour benzene are from the 40-acre surface spacing gas well operations from Alternative A modeling scenario. The impacts of acrolein, benzene, and formaldehyde are the greatest with respect to the RELs and RfCs, and thus are the only three reported in Table 1-3. However, emissions from all hazardous air pollutants are quantified.

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Table 1-3
Maximum Potential Non-Carcinogenic REL and RfC Impacts

HAP	Modeled Maximum 1-Hour Impact ($\mu g/m^3$)	REL ($\mu g/m^3$)	1-Hour Toxic Screening Levels [a] ($\mu g/m^3$)	Modeled Maximum Annual Impact ($\mu g/m^3$)	RfC ($\mu g/m^3$)	Annual Toxic Screening Levels [b] ($\mu g/m^3$)
Acrolein	1.50	2.5	23	0.18	0.35	--
Benzene	5.55	1,300	18	0.30	30	--
Formaldehyde	12.32	55	37	1.27	9.8	--

[a] The TSL for benzene is a 24-hour average, but the 1-hour concentration is conservatively compared to the TSL.
[b] The TSLs do not exist for annual averages.

Table 1-4
Maximum Potential Carcinogenic Risk

Exposure Scenario	HAP	Modeled Annual Impact ($\mu g/m^3$)	Cancer Risk
MLE	Benzene	0.30	6.2×10^{-08} to 2.2×10^{-07}
	Formaldehyde	1.27	1.6×10^{-06}
	TOTAL MLE RISK		**1.8×10^{-6}**
MEI	Benzene	0.30	3.8×10^{-07} to 1.3×10^{-06}
	Formaldehyde	1.27	9.4×10^{-06}
	TOTAL MEI RISK		**1.1×10^{-05}**

1.5 Far Field Dispersion Modeling Results

Section 5 describes the details of the far field impact assessment methodology. The CALPUFF system of dispersion models was used for the far field assessment. One modeling scenario, Alternative A – Proposed Action, was modeled as this scenario has the maximum non-particulate emissions. The Class I and sensitive Class II areas evaluated include the following:

National Park Service (NPS) Class I Areas

- Arches National Park
- Black Canyon of the Gunnison National Park
- Canyonlands National Park
- Capitol Reef National Park
- Great Sand Dunes National Park and Preserve
- Mesa Verde National Park

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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 Uintas 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

Potential impacts in the noted Class I and sensitive Class II areas for criteria pollutants, regional haze, and acid deposition were assessed. In addition, potential change in acid neutralizing capacity (ANC) for sensitive lakes within these areas was also evaluated. Criteria pollutant impacts were compared to Prevention of Significant Deterioration (PSD) increments only as a point of information. The PSD program is a regulatory program implemented by the state of Utah, and the Proposed Action is not subject to the PSD program.

As discussed in Section 8, none of the far field impacts exceeded the PSD Class I and II increment evaluation criteria. Acid deposition at the sensitive lakes exceeded the Deposition Analysis Thresholds (which represent deposition in the absence of any anthropogenic activity and are used by Federal Land Managers to make project-specific decisions regarding adverse impacts); but none of the impacts exceeded the deposition impact thresholds. Regional haze impact evaluation thresholds were exceeded in the closest sensitive Class II areas. The largest impact was at Dinosaur National Monument where there were 131 days where the change in

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light extinction exceeded 0.5 deciviews (dV) The 98th percentile change in light extinction was 3.2 in Dinosaur National Monument. There was also one day in the Class I area of Arches National Park where the maximum change in light extinction exceeded 1.0 dV, but the 8th-high (98th percentile) was less than 1.0 dV.

1.6 Cumulative Impacts and Project Specific Ozone Modeling

The BLM is developing a Uinta Basin specific photochemical modeling platform as part of its air resource management strategy (ARMS) for the Uinta Basin. The ARMS modeling platform will replace CALPUFF modeling for far field project specific and cumulative impact analyses. The ARMS platform will also become the standard photochemical modeling system for assessing project specific and cumulative impacts on both near and far field ozone concentrations. Accordingly, this AQIA did not explicitly model the far field cumulative potential impacts of the Proposed Action and Alternatives or the project-specific impact on local and distant ozone concentrations. Rather, the cumulative and ozone impact assessment conducted as part of the Greater Natural Buttes (GNB) Final Environmental Impact Statement (BLM 2012) was incorporated into the Newfield Monument Butte Oil and Gas Development Project EIS by reference. The GNB cumulative and ozone impact assessment evaluated the impacts of not only the proposed GNB project, but also the impacts of reasonable future development (RFD) in the Uinta Basin, and the RFD analyzed in the GNB FEIS explicitly included the Newfield Monument Butte Proposed Action. Accordingly, until the ARMS modeling platform becomes available, reviewing and incorporating the GNB analysis is the most appropriate method to evaluate potential ozone impacts and cumulative impacts of the Proposed Action and Alternatives. The results from GNB are not included in this AQTSD, but are summarized in the text of the Newfield Monument Butte EIS.

1.7 Adaptive Management Strategy for Potential Ozone Impacts

The No Action and Proposed Action emissions inventories demonstrated that although emissions from the Proposed Action will eventually exceed emissions that would occur under the No Action Alternative; for the first several years of the project, emissions associated with the No Action Alternative would be greater than any of the Action Alternatives (A, C, or D). Despite the fact that GNB assessed potential ozone formation for emissions including the Newfield Proposed Project and that No Action emissions would be greater than the Action Alternatives for the first few years of the Project; the fact that the Action Alternative emissions will eventually exceed the No Action emissions requires implementation of an Adaptive Management Strategy

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to mitigate the potential for adverse ozone formation. Details of the Adaptive Management Strategy are discussed in Section 6 of this AQTSD, but the Strategy includes the following major elements that will be implemented under all three of the Action Alternatives:

- Newfield will conduct an annual emissions inventory and compare the inventory to the emissions estimates contained in this Environmental Impact Statement.

- Regional photochemical modeling will be conducted that includes emissions for the selected alternative within one year of the ROD for this project or one year of the BLM Air Resources Management Strategy (ARMS) modeling platform becoming available; whichever occurs first. If modeled impacts show that the National Ambient Air Quality Standards (NAAQS) or applicable thresholds for air quality related values may be exceeded, BLM will require additional mitigation measures within BLM's authority to prevent exceedances.

1.8 Summary

In summary, all of the evaluated potential air quality impacts of the Proposed Action and Alternatives are less than the evaluation criteria except for regional haze impacts in two sensitive Class II areas and one day in Arches National Park. The Federal Land Managers have not published thresholds for Class II areas.

No project specific ozone impact modeling was conducted due to the unavailability of a modeling assessment platform. When the Proposed Action Annual Development is compared to emissions that would occur under the No Action Alternative, it is found that annual development of the Proposed Action can continue through approximately early calendar year 2021 without causing a substantial increase in total ozone precursor emissions, or late 2019 for VOC emissions alone. This is due to the extensive ACEPMs and other emission reducing measures that Newfield will implement as future development in the MBPA proceeds under the Proposed Action or Alternatives C and D. Nevertheless, an Adaptive Management Strategy to mitigate potential ozone formation will be implemented under any of the Action Alternatives.

Section 2 describes the Proposed Action and Alternatives, Section 3 the pre-project background air quality, Section 4 the emissions, and Section 5 the impact assessment methodology. Sections 6, 7 and 8 describe the evaluation results. The Appendices contain hard copies of the emission inventories and electronic copies of the modeling input and output files.

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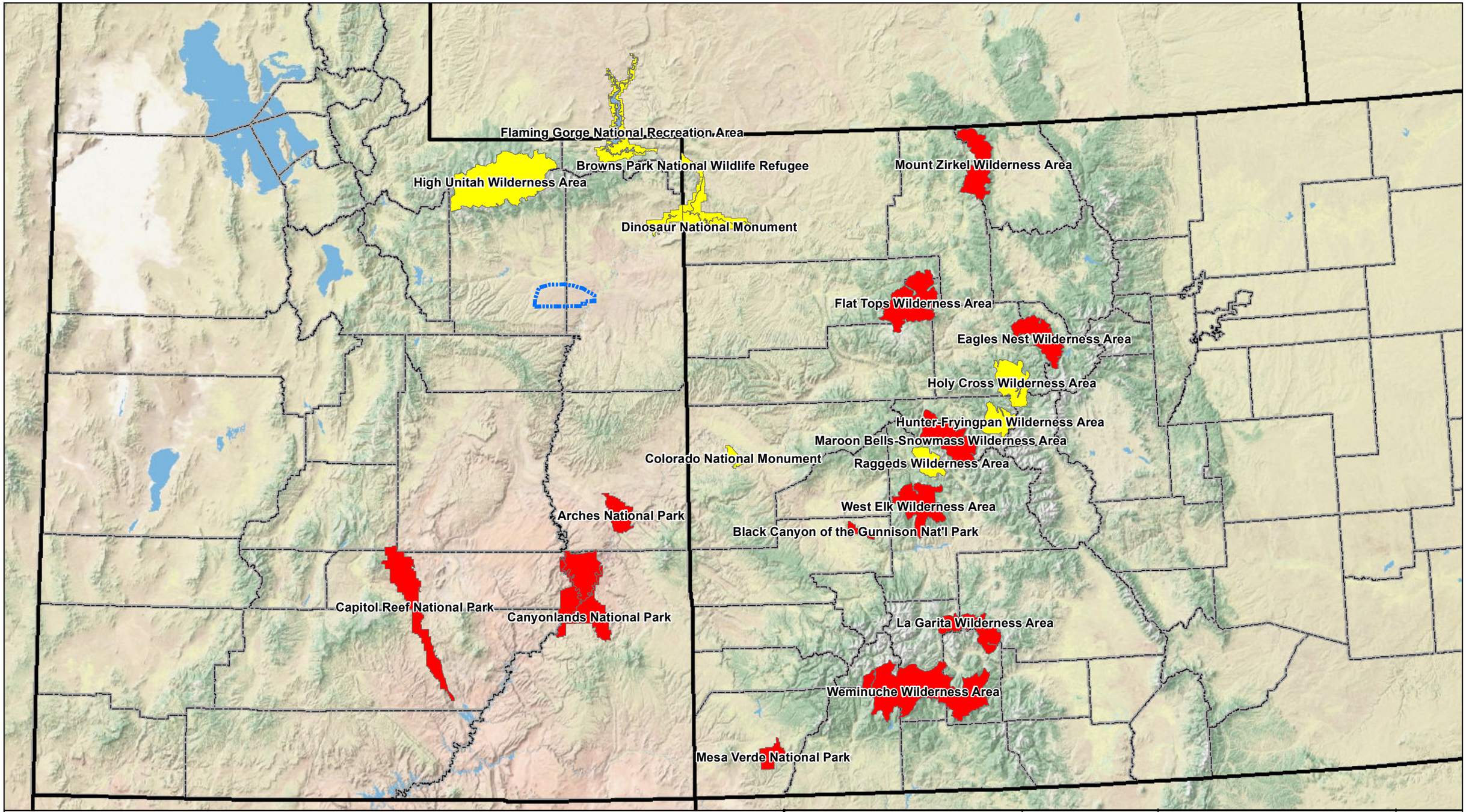

Legend

- Class I Areas
- Class II Areas
- Project Boundary
- State Boundary
- County Boundary

0 12.5 25 50 Miles

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Monument Butte EIS

Newfield Production Company
Alternative A - Proposed Action Location

FIGURE
1-1

2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 Alternative A – Proposed Action

The Proposed Action involves drilling and operations of up to 3,250 oil wells and 2,500 gas wells in the MBPA, including associated infrastructure. The Proposed Action includes the following primary components:

- Development of up to 750 Green River oil wells on 40-acre surface and downhole spacing drilled from new 2-acre well pads, all of which would be converted into water-flood injection wells within approximately 3 years;
- Development of up to 2,500 Green River oil wells on 20-acre downhole spacing that would be vertically, directionally, or horizontally drilled from existing and/or proposed 40-acre surface spaced Green River oil well pads, consistent with current State spacing requirements;
- Development of up to 2,500 vertical deep gas wells on 40-acre surface and downhole spacing drilled from new 3-acre well pads, which would be constructed adjacent to Green River oil well pads in order to reduce new surface disturbance and utilize existing utility infrastructure and access roads;
- Construction of approximately 243 miles of new 100-foot wide ROW that would be used for new road construction (40-foot width) and pipeline installation (60-foot width). Up to 70-foot wide expansion along approximately 363 miles of existing access road ROW that would be used for road upgrade (10-foot width) and pipeline installation (60-foot width);
- Construction of 20 new compressor stations for deep gas well development;
- Expansion of three (3) existing Green River oil well compressor stations and construction of one (1) new compressor station for gas associated with Green River oil well development;
- Construction of a 50 million standard cubic feet per day (MMscf/d) centralized gas processing plant;
- Construction of seven (7) new and expansion of six (6) existing water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to 12 Gas Oil Separation Plants (GOSPs) for oil and produced water collection;
- Development of one (1) fresh water collector well for water-flood operations; and
- Construction of six (6) water pump stations.

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Newfield currently operates approximately 3,395 oil and gas wells in the MBPA, and proposes to drill additional wells at an average rate of approximately 360 wells per year until the resource base is fully developed. Under this drilling scenario, construction, drilling, and completion of up to 5,750 wells would occur in approximately 16 years. The total number of wells drilled would depend largely on outside factors such as production success, engineering technology, reservoir characteristics, economic factors, commodity prices, rig availability, and lease stipulations. The anticipated life of an individual well is 20 to 30 years, and the anticipated time it would take for field abandonment and final reclamation is 5 years. Therefore, the anticipated life of project (LOP) under the Proposed Action would be from 41 to 51 years.

The Proposed Action and Alternatives include applicant committed environmental protection measures (ACEPMs). The ACEPMs relevant to reducing potential air quality impacts are summarized as follows:

General

- Newfield would use water or other BLM-approved dust suppressants as needed during drilling, completion, and high traffic production operations for dust abatement.
- Newfield employees would comply with posted speed limits on unpaved county roads used for access and would use safe vehicle speeds on other unpaved access roads. Newfield would instruct contractors to comply with posted speed limits.
- The use of carpooling would be encouraged to minimize vehicle traffic and related emissions and Newfield will implement a vehicle policy to minimize idling while also recognizing safety concerns.
- Newfield would conduct a pilot test to evaluate the feasibility for converting fleet vehicles to cleaner burning compressed natural gas (CNG) or liquefied natural gas (LNG) fuels. The results of the pilot test would be submitted to the AO.

Drilling / Completion Operations

- Newfield would use Tier II diesel drill rig engines or equivalent with the phase-in of Tier IV engines or equivalent emission reduction technology by 2018.
- Newfield would employ reduced emission completion practices, including storing or re-injecting recovered liquids and routing recovered gas into a well or using the recovered gas as fuel for another useful purpose when feasible; routing all saleable quality gas to a flow line as soon as practicable; and safely maximizing resource recovery and minimizing potential VOC emissions from hydraulically fractured, high pressure gas well

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flowback operations. If flowback emissions cannot be routed to a flow line, they will be captured and routed to a completion combustion device unless such device will result in a fire or explosion hazard.

Production Operations

- Newfield would utilize low or intermittent bleed pneumatic devices to minimize VOC emissions. High bleed devices may be allowed for critical safety and/or process purposes. Intermittent pneumatic devices will be operated such that average emissions are no greater than for a low bleed device.
- High bleed pneumatic devices at existing Newfield facilities would be replaced/retrofitted with low or intermittent bleed devices when repair or replacement is warranted, and no later than six (6) months after the ROD is signed. High bleed devices may be allowed to remain in service for critical safety and/or process purposes.
- Newfield would employ glycol dehydrator still vent emission controls with a control efficiency of 95 percent or greater.
- Newfield would conduct a study to evaluate the feasibility for the implementation of "low emission" glycol dehydrators. The results of this study would be submitted to the AO.
- Newfield would install emission controls with an efficiency of 95 percent on the following:
    - New oil and condensate storage tanks
    - Tanks that have been modified or re-constructed after August 23, 2011, with the potential to emit greater than 6 tons per year (tpy) VOC
    - All other tanks with the potential to emit greater than 20 tpy within 24 months of signing the ROD.
- Newfield would implement a telemetry monitoring system where feasible to provide for the effective management of production exceptions while reducing the number of vehicle trips and miles traveled.

Central Facilities

- Newfield would install electric motor driven compression where feasible. Where electrification is not feasible, Newfield would utilize lean-burn natural gas fired compressor engines or equivalent rich-burn engines with catalysts. Lean-burn engines would be fitted with oxidation catalysts to minimize carbon monoxide and VOC emissions.
- Newfield would maximize the use of central compression thereby reducing the need for smaller and less efficient (higher emission) well site compressor units.

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- Newfield would periodically replace rod packing systems on reciprocating compressors and use only dry seals on centrifugal compressors to minimize the loss of VOC.
- Newfield would employ glycol dehydrator still vent emission controls with a control efficiency of 95 percent or greater.
- Newfield would install emission controls with an efficiency of 95 percent or greater on stock tanks that have the potential to emit VOC greater than 6 tons per year (tpy).

GOSP Implementation

- Where feasible, Newfield would implement Green River oil gathering systems and construct GOSPs. With GOSP implementation, the majority of the stock tanks, produced water tanks and related tank heaters at affected existing well sites would be removed from service. New wells served by a GOSP would be constructed without tank batteries thereby eliminating tank battery and related tanker truck emissions.
- The GOSP facilities would be specifically designed to minimize the emission of VOC. Storage tank emissions would be captured and reused within the facility process or sold as product. Vapors from truck loading operations would be controlled by 95 percent.

Monitoring Programs

- Newfield would annually evaluate the deep gas gathering system to identify opportunities for pressure optimization resulting in reduced flash emissions from condensate storage tanks.
- Newfield would implement visual inspections of thief hatch seals and pressure relief valves on condensate tanks to ensure proper operation and minimize losses of VOCs. Inspections will be conducted at least annually during a routine maintenance visit. If for some reason monitoring does not occur within 12 months, the visual inspection will be conducted at the next scheduled maintenance visit.

Adaptive Management

- Newfield would implement an adaptive management program that would evaluate project specific emissions on an annual basis and identify opportunities to further reduce emissions.

Cooperative Efforts and Outreach

- Newfield would encourage and lend technical support to scientific research efforts focused on improving the understanding of ozone formation chemistry within the Uinta Basin, emission inventory enhancements, source apportionment studies, ozone

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precursor transport studies, precursor sensitivity studies, and evaluations of cost effective control strategies.

- Newfield would incorporate ozone awareness and specific actions for reducing ozone precursor emissions into the current employee training program.

In addition to the ACEPMs, Newfield will implement an Adaptive Management Strategy to mitigate potential adverse ozone formation as described in Section 6 of this AQTSD.

2.2 Alternative B – No Action

Under the No Action Alternative, the proposed oil and gas infill development project on public land surface and/or federal mineral estates as described in the Proposed Action would not be implemented. However, proposed oil well development would likely continue on State and private lands within the Monument Butte Field, subject to the approval of UDOGM or the appropriate private land owner. Reasonable access across BLM-administered surface to proposed well pads and facilities on State and private lands could also occur under the No Action Alternative, as allowed by Federal regulations. Development, production, and maintenance activities for wells approved under the August 2005 Record of Decision (ROD) for the Castle Peak and Eight Mile Flat Oil and Gas Expansion EIS and approved Master Development Plans (MDPs) would also continue on BLM-administered lands. The No Action Alternative would result in an additional 788 oil and gas wells being drilled and placed into production in the MBPA. Further details related to emissions associated with the No Action Alternative are discussed in Section 4.

2.3 Alternative C – Field-Wide Electrification

This alternative was developed in response to air quality issues raised during the public and agency scoping process. The principal component of this alternative entails a phased field-wide electrification system that would be integrated in the MBPA over an estimated 7 year period. This alternative would incorporate the same construction and operation components for the Proposed Action, except that gas-driven motors would be converted to electric motors as field electrification is phased into the Project Area. The electrical energy would be supplied either from substations built by Newfield or from commercial power.

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Under Alternative C, the same number (5,750) of oil and gas wells as the Proposed Action would be developed in the MBPA. Alternative C includes all of the Proposed Action components plus the following if the electrical power is provided by Newfield substations:

- Phased field-wide electrification consisting of construction of approximately 34 miles of overhead, cross-country 69kV transmission line, 156 miles of distribution lines, and construction of 11 substations;
- Installation of two 20 megawatt electric (MWe) gas turbine generators and one 10 MWe steam turbine for a combined generation of 50 MWe at each of the 11 substations (550 MWe throughout the MBPA);
- Replacement of all 3,250 pumpjack engines with electric motors;
- Replacement of all compressor engines with electric motors; and
- Removal of on-site gas-fueled electrical generators.

If commercial power provides the electrical energy, the gas turbine generators and steam turbine generators would not be built. The electrical substations would likely still be needed, however.

Under Alternative C, both the ACEPMS and the Adaptive Management Strategy of the Proposed Action (Alternative A) will also be implemented.

2.4 Alternative D – Resource Protection (Agency Preferred Alternative)

Alternative D, the Resource Protection Alternative, is the Agency Preferred Alternative. Alternative D was developed to respond to sensitive resource and land use issues in the Project Area expressed during public and agency scoping. For the MBPA, the primary objective of the Resource Protection Alternative is to meet the purpose and need for the Project while avoiding new surface disturbance within the Pariette ACEC, minimizing the amount of new surface disturbance within USFWS proposed Level 1 and 2 Core Conservation areas (for two federally-listed plant species: the Uinta Basin hookless cactus [Sclerocactus wetlandicus] and Pariette cactus [Sclerocactus brevispinus], and minimizing the amount of new surface disturbance in other portions of the MBPA through the use of directional drilling technology.

Under Alternative D, the most restrictive conditions for oil and gas development would occur within the Pariette ACEC, where no new surface disturbance would be allowed. In order to access the hydrocarbon reserves beneath the Pariette ACEC, directional wells would be drilled

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from both new multi-well pads and existing well pads located adjacent to, but outside of, the ACEC. Recent advancements in horizontal drilling technology have increased the maximum horizontal displacement to distances of up to 2,500 feet without insurmountable technical and economic challenges. While a substantial portion of the hydrocarbon reserves could be recovered under the Pariette ACEC as a result of directional drilling, it is estimated that approximately 6,605 acres of hydrocarbon reserves beneath the Pariette ACEC (62 percent of the total area of the Pariette ACEC) would be unrecoverable.

This alternative would incorporate the same construction and operation components as the Proposed Action and Alternative C, but with fewer well pad locations and a substantially greater number of multiple directional wells drilled from single well pads. Under Alternative D, approximately 5,058 oil and gas wells would be developed on BLM, State, and private lands in the MBPA. Newfield proposes to drill the wells at an average rate of approximately 360 wells per year until the resource base is fully completed, requiring about 16 years for full development. (For purposes of this AQIA, the drilling rate was assumed to be 360 wells per year for 14 years; 3,519 of the wells would be oil and 1,539 of the wells would be deep gas.)

Alternative D includes the following primary components:

- Development of up to a total of 3,519 Green River oil wells with various surface spacing and placed on new and existing well pads.
- Development of up to 1,539 vertical deep gas wells
- Construction of up to 17 new compressor stations for deep gas well development;
- Construction of up to one (1) 50 MMscf/d centralized Green River oil well gas processing plant;
- Construction of up to five (5) new and expansion of five (5) existing gas driven water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to eight (8) GOSPs for oil and produced water collection;
- Development of one (1) fresh water collector well for water-flood operations; and
- Construction of four (4) water pump stations.

Under Alternative D, both the ACEPMS and the Adaptive Management Strategy of the Proposed Action (Alternative A) will also be implemented.

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3 PRE-PROJECT AMBIENT AIR QUALITY AND STANDARDS

Potential impacts of the proposed project are compared to the National and State Ambient Air Quality Standards, Prevention of Significant Deterioration (PSD) increments, and thresholds of concern as described in the following paragraphs.

3.1 Ambient Air Quality Standards and PSD Increments

Utah and National Ambient Air Quality Standards (UAAQS and NAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. Pollutants for which standards have been determined include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) and lead (Pb). In Utah, the State and National Ambient Air Quality standards are the same and are shown in Table 3-1.

The PSD program establishes allowable incremental increases in ambient concentrations of certain pollutants. All of the land areas of the US are currently classified as either Class I or Class II. Class I areas include many national parks and wilderness areas and some Native American lands. Areas not designated Class I are designated Class II. Class I areas and sensitive Class II areas of interest for the Proposed Project are discussed in Section 5. The PSD increments are shown in Table 3-1.

Throughout this impact analysis, all comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during the permitting process, and are the responsibility of the State of Utah with USEPA oversight. The Proposed Project is not subject to the PSD program.

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Table 3-1
National and State Ambient Air Quality Standards and PSD Increments

Pollutant	Averaging Period(s)	NAAQS [a]	PSD Class I Increment [a]	PSD Class II Increment [a]
CO	1-hour 8-hour	35 ppm (40,000 μg/m^3) [b] 9 ppm (10,000 μg/m^3) [b]	-- --	-- --
NO_2	1-hour Annual	100 ppb (188 μg/m^3) [c] 0.053 ppm (100 μg/m^3) [d]	-- 2.5 μg/m^3	-- 25 μg/m^3
PM_{10}	24-hour Annual	150 μg/m^3 [e] -----	8 μg/m^3 4 μg/m^3	30 μg/m^3 17 μg/m^3
$PM_{2.5}$	24-hour Annual	35 μg/m^3 [c] 12 μg/m^3 [f]	2 μg/m^3 1 μg/m^3	9 μg/m^3 4 μg/m^3
O_3	8-hour	0.075 ppm [g]	--	--
SO_2	1-hour 3-hour 24-hour Annual	75 ppb (196 μg/m^3) [h] 0.5 ppm (1,300 μg/m^3) [b] ----- -----	-- 25 μg/m^3 5 μg/m^3 2 μg/m^3	-- 512 μg/m^3 91 μg/m^3 20 μg/m^3
Lead	Rolling 3 month	0.15 μg/m^3 [i]	--	--

[a] Source: 40 CFR Part 50 and 51
[b] Not to be exceeded more than once per year.
[c] 98th percentile averaged over 3 years.
[d] Annual mean.
[e] Not to be exceeded more than once per year on average over 3 years.
[f] Annual mean, averaged over three years.
[g] Annual fourth-highest daily maximum 8-hour concentration averaged over 3 years.
[h] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.
[i] Not to be exceeded.

3.2 Pre-Project Background Ambient Air Quality

Table 3-2 presents the background, pre-project, ambient air quality in the MBPA for the criteria pollutants and averaging times for which a NAAQS has been established. Available data from the most recent 6 years are presented. The data in Table 3-2 comes from the Greater Natural Buttes FEIS (BLM 2012) and the USEPA Air Quality Statistics web site (USEPA, 2013a). The data from Table 3-2 were used to select a single value for each NAAQS pollutant and averaging time to be used in the air quality impact assessment as the background pre-project values. The selected values and the rationale for the selection are presented in Table 3-3.

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Table 3-2
Pre-Project Background Ambient Air Quality in the Uinta Basin

Criteria Pollutant	Average	Rank [a]	Year [b]	Value [c] (µg/m^3)	Criteria Pollutant	Average	Rank [a]	Year [b]	Value [c] (µg/m^3)	Station [d]
CO	1-hour	H2H	2007	4,350	CO	8-hour	H2H	2007	2,796	Grand Junction, CO
			2008	10,564				2008	2,641	
			2009	3,573				2009	2,175	
			2010	2,641				2010	1,709	
			2011	2,796				2011	1,709	
			2012	2,486				2012	1,554	
NO_2	1-hour	H8H	2009/ 2010	69.6 [e]	NO_2	Annual	H	2009/ 2010	9.0 [e]	Ouray, UT
			2010/ 2011	52.7 [e]				2010/ 2011	6.8 [e]	
			2011/ 2012	50.8				2011/ 2012	6.2	
NO_2	1-hour	H8H	2009/ 2010	58.3 [e]	NO_2	Annual	H	2009/ 2010	7.8 [e]	Redwash, UT
			2010/ 2011	60.2 [e]				2010/ 2011	8.1 [e]	
			2011/ 2012	54.5				2011/ 2012	7.9	
PM_{10}	24-hour	H2H	2004	19.0						Myton, UT [f]
			2005	20.0						
			2006	17.0						
			2012 [f]	48.0						
$PM_{2.5}$	24-hour	H8H	2009/ 2010	19.5 [e]	$PM_{2.5}$	Annual	H	2009/ 2010	7.3 [e]	Ouray
			2010/ 2011	23.6 [e]				2010/ 2011	12.3 [e]	
			2011/ 2012	18.5				2011/ 2012	6.9	
$PM_{2.5}$	24-hour	H8H	2009/ 2010	16.3 [e]	$PM_{2.5}$	Annual	H	2009/ 2010	6.3 [e]	Redwash
			2010/ 2011	17.8 [e]				2010/ 2011	9.4 [e]	
			2011/ 2012	11.3				2011/ 2012	5.5	

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Table 3-2 (cont.)
Pre-Project Background Ambient Air Quality in the Uinta Basin

Criteria Pollutant	Average	Rank [a]	Year [b]	Value [c] ($\mu g/m^3$)	Criteria Pollutant	Average	Rank [a]	Year [b]	Value [c] ($\mu g/m^3$)	Station [d]
O_3	8-hour	H4H	2009/ 2010	117 ppb [e]						Ouray
			2010/ 2011	116 ppb [e]						
			2011/ 2012	68 ppb						
			2012/ 2013	>75 ppb [g]						
	8-hour	H4H	2009/ 2010	98 ppb [d]						Redwash
			2010/ 2011	100 ppb [d]						
			2011/ 2012	65 ppb						
			2012/ 2013	>75 ppb [g]						
SO_2	1-hour	H4H	2007	21.7 [e]	SO_2	3-hour	H2H	2007	16.0 [e]	Sweet-water, WY [h]
			2008	19.7 [e]				2008	16.7 [e]	
			2009	19.0 [e]				2009	10.1 [e]	
			2012 [h]	2.6				2012 [g]	0.9	

[a] Rank: H2H = High, 2nd high for NAAQS not to be exceeded more than once per year. H8H = 98th percentile. H4H = 99th percentile. H = maximum value for period.

[b] Calendar year, except when two years for the same value (e.g., 2007/2008) the period is July 1 through June 30. The July 1/June 30 periods were chosen due to lack of full calendar year data.

[c] Data are from the USEPA Air Quality Statistics web site (USEPA 2013a) except as noted. Conversion of CO and NO_2 from monitored ppm to ug/m^3 made at 1 atmosphere and 25 degrees C.

[d] Monitor location is the monitor closest to the Proposed Project area for which data are available in the USEPA AQS database. Grand Junction is Station ID 08-077-0018, Ouray is Station ID 49-047-2003, Redwash is Station ID 49047-2002, Myton is Station ID 49-013-7011, Sweetwater is Station ID 56-037-0200.

[e] Data reported in the Greater Natural Buttes Final Environmental Impact Statement (GNB FEIS) (BLM 2012).

[f] The Myton PM_{10} monitor collected data only through 2006. There is a new monitor in Roosevelt, UT located approximately 35 miles west-northwest of the Proposed Project area, Station ID 49-013-0002, which has PM_{10} data available from January 1, 2012 through August 30, 2012, and only those data are reported for 2012.

[g] Data from the winter of 2012/2013 are not yet available. However, raw data that have not yet been quality assured or summarized indicated that the NAAQS for ozone was exceeded at both the Ouray and Redwash monitors during the winter.

[h] The 2007 through 2009 data are from the Wamsutter Monitoring Station in Sweetwater County (Station ID 56-037-0200 as reported in the GNB FEIS (BLM 2012). There is a new monitor in Roosevelt, UT located approximately 35 miles west-northwest of the Proposed Project area, Station ID 49-013-0002, which has SO_2 data available from May 1, through June 30, 2012, and only those data are reported for 2012.

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Table 3-3
Pre-Project Background Ambient Air Quality Values Used in AQIA

Criteria Pollutant	Average	Value ($\mu g/m^3$)	Rationale for Selection
CO	1-hour	2,641	Average of the most recent three years (2010 – 2012) of second-high values from the Grand Junction, CO monitor.
	8-hour	1,657	
NO_2	1-hour	57.7	Average of the most recent three years available (July 1, 2009 – June 30, 2012) of eighth-high values (98th percentile) for both the Ouray and Redwash monitors.
	Annual	7.3	Average of the most recent three years available (July 1, 2009 - June 30, 2012) for both the Ouray and Redwash monitors.
O_3	8-hour	184 (94 ppb)	Average of the most recent three years available (July 1, 2009 – June 30, 2012) of fourth-high values for both the Ouray and Redwash monitors. Data from the 2012/2013 winter season are not available yet.
PM_{10}	24-hour	18.7	Average of the most recent three years available (2004 – 2006) of the Myton monitor. The Roosevelt monitor is not used as that monitor is located in a disturbed area in the City.
$PM_{2.5}$	24-hour	17.8	Average of the most recent three years available (July 1, 2009 – June 30, 2012) of eighth-high values (98th percentile) for both the Ouray and Redwash monitors.
	Annual	8.0	Average of the most recent three years available (July 1, 2009 - June 30, 2012) for both the Ouray and Redwash monitors.
SO_2	1-hour	20.1	Average of the most recent three years available (2007 – 2009) of fourth-high (99th percentile) values from the Sweetwater monitor. Although the Roosevelt monitor is more representative of the Uinta Basin, the data are not complete (only two months) and is not used.
	3-hour	14.3	Average of the most recent three years available (2007 – 2009) of second-high values from the Sweetwater monitor. Although the Roosevelt monitor is more representative of the Uinta Basin, the data are not complete (only two months) and is not used.

3.3 Acute and Chronic Hazardous Air Pollutants Exposure Thresholds

Hazardous Air Pollutants (HAPs) predicted to be released in meaningful quantities associated with the Proposed Action project include benzene, toluene, xylene, formaldehyde, and acrolein. Hydrogen sulfide (H_2S) is not expected to constitute a meaningful portion of the gas stream and therefore was not assessed. Since there are no applicable federal ambient air quality standards for HAPs, Reference Concentrations (RfC) for chronic inhalation exposure and Reference

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Exposure Levels (REL) for acute inhalation exposures are used as evaluation criteria. The RfCs represent an estimate of the continuous (i.e. annual average) inhalation exposure rate to the human population (including sensitive subgroups such as children and the elderly) without adverse health effects. The RELs represent the acute (i.e. one-hour average) concentration at or below which no adverse health effects are expected. Both the RfC and REL guideline values are for non-cancer effects.

Values for the RfCs and RELs are provided in Table 3-4. The values in Table 3-4 are from the USEPA Air Toxics Database, Tables 1 and 2 (USEPA 2011a and USEPA 2012), except for acrolein. There is a wide range of RfCs published for acrolein, ranging from 0.02 µg/m^3 (USEPA 2012) to 250 µg/m^3 (OSHA 2013). Acrolein in air is rapidly removed by reacting with photochemically generated hydroxyl radicals, and the primary environmental exposure to acrolein comes from smoking and heating of fats and vegetable oils at high temperatures (ATSDR 2013). Acrolein is also present naturally in the body (ATSDR 2013). The USEPA RfC of 0.02 µg/m^3 was extrapolated from a Lowest Observed Adverse Effect Level (LOAEL) of 900 µg/m^3 (USEPA 2009) and the USEPA indicated that there is at least an order of magnitude uncertainty in the extrapolation. The California Office of Environmental Health Hazard Assessment (OEHHA) has thoroughly reviewed the toxicity of acrolein and published an RfC of 0.35 µg/m^3 (OEHHA 2013). Since the OEHHA value is near the lower end of the range of published RfCs and is not as uncertain as the USEPA value, the OEHHA value is used.

Table 3-4
HAP Reference Exposure Levels and Reference Concentrations

Hazardous Air Pollutant (HAP)	Reference Exposure Level [REL 1-hr Average] (µg/m^3)	Reference Concentration [RfC Annual Average] (µg/m^3)
Benzene	1,300	30
Toluene	37,000	5,000
Xylenes	22,000	100
Formaldehyde	55	9.8
Acrolein	2.5	0.35

In addition to the RELs and RfCs, the State of Utah has adopted Toxic Screening Levels (TSLs) which are used during the air permitting process to assist in the evaluation of hazardous air pollutants released into the atmosphere (Utah Department of Environmental Quality- Division of Air Quality, UDAQ 2011). The TSLs are derived from Threshold Limit Values (TLVs) published

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in the American Conference of Governmental Industrial Hygienists (ACGIH) – "Threshold Limit Values for Chemical Substances and Physical Agents" (American Conference of Governmental Industrial Hygienists 2012). These levels are not standards that must be met, but screening thresholds which if exceeded, would suggest that additional information is needed to evaluate potential health and environmental impacts. The TSLs are compared against modeled concentrations for averaging periods of 1-hour (short-term) and 24-hour (chronic).

Table 3-5 lists the TSLs for each applicable HAP. The TSLs in Table 3-5 are published by the Utah Department of Environmental Quality – Utah Division of Air Quality (UDAQ 2012).

Table 3-5
Utah Toxic Screening Levels (TSLs)

Pollutant and Averaging Time	Toxic Screening Levels ($\mu g/m^3$)
Benzene (24-hour)	18
Toluene (24-hour)	2,512
Xylenes (24-hour)	14,473
Formaldehyde (1-hour)	37
Acrolein (1-hour)	23

3.4 Incremental Cancer Risk

To assess long-term exposure from carcinogenic HAP emissions, traditional risk assessment methods are applied and the risk for the maximally exposed individual (MEI) and most likely exposure (MLE) are compared to the generally acceptable risk range of one additional cancer per one million exposed persons (1×10^{-6}) to one additional cancer per ten thousand exposed persons (1×10^{-4}) or 100 in a million (USEPA 1993). For the MEI risk, it is assumed that a person is exposed continuously (24 hours per day, 365 days per year) for the life of project. For the MLE risk, an adjustment was made for the amount of time a family stays at a residence (nine years) and for the portion of time spent away from the home (64 percent of the day) (USEPA 1997). It is further assumed that households are exposed to one-quarter of the maximum concentration the remaining (36 percent) of the time. Exposure adjustment factors of 0.571 for the MEI (40/70) and 0.095 for the MLE [(9/70)*((0.64*1) + (0.36*0.25))] are applied to the estimated cancer risk to account for the actual time that an individual could be exposed during a 70-year lifetime.

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In addition to the exposure assumption, unit risk factors (URFs) are used to assess potential carcinogenic risk. The URFs are multiplied times the annual average concentration of the potentially carcinogenic HAP and the exposure adjustment factor to calculate the potential cancer risk. URFs are derived for a continuous 70-year exposure, and that is why the exposure adjustment factors must be used. URFs are based on the USEPA guidelines on carcinogen risk assessment that assume cancer risks exist at any dose, the so-called zero threshold assumption (USEPA 1986). More recent data show that there are some exceptions to this zero threshold assumption and thus URFs are over-stated; however it is still the default assumption (USEPA 2007). Therefore the URFs provide an upper bound carcinogenic risk.

The chronic inhalation cancer risk factors for benzene and formaldehyde are presented in Table 3-6.

Table 3-6
Carcinogenic Unit Risk Factors

Hazardous Air Pollutant	Carcinogenic Unit Risk Factor [Annual Inhalation Exposure] ($1/\mu g/m^3$)
Formaldehyde [a]	1.3×10^{-5}
Benzene [a]	2.2×10^{-6} to 7.8×10^{-6}

[a] USEPA Integrated Risk Information System (IRIS) database (USEPA 2008). A range of risk factors is published for benzene.

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4 EMISSIONS

Five sets of emissions were calculated as part of the AQIA: Proposed Action Ultimate Development (Alternative A), Proposed Action Annual Development (Alternative A), No Action Alternative (Alternative B), Field-Wide Electrification (Alternative C), and Resource Protection (Alternative D).

Emissions occur during two primary phases of the Proposed Action and Alternatives: the development phase and the operations phase. The development phase includes emissions from the following activities:

- Construction
- Drilling
- Completion
- Interim Reclamation
- Wind Erosion

The operations or production phase includes emissions from:

- Pump unit engines
- Production heaters
- Well-site tanks
- Pneumatic controllers
- Fugitive emissions of volatile organic compounds
- Well-site truck loading emissions
- Well-site flares
- Operations vehicle fugitive dust and tailpipe emissions

In addition to the development and the operations phases, infrastructure must be built to serve the operating wells. Infrastructure emissions include emissions from the following activities:

- Water treatment facility oil tanks, fugitive emissions of volatile organic compounds and emissions from gas generators
- Gas Oil Separation Plants (GOSPs), including truck loading emissions

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- Compressor station emissions, including engines, tanks, dehydrators, flares and fugitives
- Gas processing plant

In the following subsections, emissions from these activities are summarized by the development, production, and infrastructure phases. Details for emissions from the activities within these phases and details for how the emissions were calculated, including assumptions, are shown in the Appendices as noted. In the summary tables presented below, only the criteria pollutants, greenhouse gas pollutants (including global warming potential, GWP), and key hazardous air pollutants for which evaluation criteria have been established as discussed in Section 3 (i.e., benzene, toluene, xylene, formaldehyde, acrolein) and total HAPs are reported. However, all of the HAP emissions are shown in the referenced appendices. The emission estimates account for the ACEPMs and other environmental protection measures that Newfield will implement. All of the emissions are reported in short tons (2,000 pounds per ton). GWP is calculated with a value of 1.0 for carbon dioxide, 21 for methane, and 310 for nitrous oxide.

4.1 Alternative A: Proposed Action Ultimate Development

The Proposed Action will result in up to 5,750 oil and gas wells (3,250 oil, 2,500 gas) being developed and operated along with the required infrastructure as described in Section 2. In order to assess the ambient air quality impacts of the Proposed Action, a maximum emissions year calculation was prepared, assuming normal well drilling frequency (approximately 360 wells per year), and full production from all 5,750 wells and operation of the entire Proposed Action infrastructure. This emissions scenario is termed the Proposed Action Ultimate Development.

Table 4-1 summarizes the emissions for the Proposed Action Ultimate Development. Appendix A shows how the emissions were calculated, including the detailed calculation formulas and assumptions. Appendix A-1 shows emissions for the oil wells; Appendix A-2 shows emissions for the gas wells. The emission inventory for the Proposed Action includes the benefit of the ACEPMs and regulatory requirements under the recently promulgated (August 16, 2012) New Source Performance Standard for oil and gas operations (Oil and Gas NSPS) published as 40 CFR 60 Subpart OOOO. The emissions do not include the benefit of emission reductions that may be required under the State of Utah permitting guidance and State or Federal Implementation Plans (SIP or FIP) for the Uinta Basin, tribal New Source Review (NSR) programs that will be promulgated in the near future (late 2013 or 2014), nor additional

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mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation. These programs will likely require additional emission reduction measures for the Proposed Action.

Table 4-1
Proposed Action Ultimate Development Emissions

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	129.6	1,809.7	981.0	2,920.2	668.6	511.1	1,590.2	2,769.9	5,690.1
CO	106.0	2,290.7	1,782.8	4,179.6	594.3	523.1	3,226.8	4,344.2	8,523.8
VOC	12.1	3,929.0	1,109.2	5,050.3	35.9	3,795.8	1,479.0	5,310.6	10,360.9
SO_2	0.2	3.9	2.8	6.9	1.2	2.9	3.4	7.5	14.4
PM_{10}	423.3	570.3	393.2	1,386.7	1,145.1	283.0	88.8	1,516.9	2,903.6
$PM_{2.5}$	46.0	224.1	95.6	365.8	128.4	61.8	60.9	251.2	617.0
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	16.25	5.61	21.95	0.52	26.15	13.95	40.62	62.57
Toluene	0.031	12.01	3.93	15.98	0.19	48.84	10.89	59.92	75.90
Xylene	0.020	3.63	1.08	4.73	0.13	37.30	2.51	39.94	44.67
Formal-dehyde	0.0080	182.68	49.38	232.07	0.053	0.36	148.50	148.92	380.99
Acrolein	0.00080	25.71	5.40	31.12	0.0053	---	14.47	14.48	45.60
Total HAPs	0.26	446.77	107.16	554.19	1.05	211.21	238.28	450.54	1,004.73
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,776	780,830	597,890	1,397,495	116,923	602,127	714,145	1,433,195	2,830,690
CH_4	18.81	3,816	668	4,502	4.60	7,152	928	8,085	12,587
N_2O	0.15	1.47	1.11	2.73	0.93	1.13	1.34	3.40	6.13
GWP	19,218	861,421	612,256	1,492,895	117,308	752,679	734,054	1,604,041	3,096,936

4.2 Alternative A: Proposed Action Annual Development

It will require approximately 16 years for the Proposed Action Development to be completed. Accordingly, not only was an assessment made for the Proposed Action Ultimate Development,

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emissions were assessed on an annual basis for development after December 31, 2011 through December 31, 2022. This yields a ten-year view of how emissions will change on an annual basis. For the annual development assessment, only NO_x and VOC emissions were evaluated because the purpose of the Proposed Action Annual Development analysis was to determine when or if emissions of ozone precursors in the MBPA would substantially increase as the result of the Proposed Action compared to emissions of ozone precursors in the MBPA that would otherwise occur under the No Action Alternative.

Table 4-2 shows the annual development emission increases in the MBPA. The details for these emission calculations are shown in Appendix B. The emissions shown include the benefit of the Oil and Gas NSPS and the ACEPMs but do not include emission reductions that may be required under a SIP, FIP, or NSR programs that may be promulgated in the near future nor mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation.

Table 4-2
Proposed Action Annual Development Emission Increases

1	2	3	4	5	6	7	8
Calendar Year	**Cumulative Net Change in NO_x from December 31, 2011** (tpy)	**Cumulative Net Change in VOC from December 31, 2011** (tpy)	**Cumulative Net Change in NO_x plus VOC from December 31, 2011** (tpy) (2+3)	**Cumulative Number of Oil Wells Added**	**Cumulative Number of Gas Wells Added**	**Cumulative Wells Shut In or Converted to Water Injection**	**Cumulative Net Change in Number of Oil and Gas Producing Wells from December 31, 2011** (5+6-7)
2012	-53	25	-28	187	0	200	-13
2013	-172	-603	-775	363	0	400	-37
2014	-311	-684	-995	559	0	600	-41
2015	-387	-545	-932	794	0	800	-6
2016	-320	-99	-415	1,038	0	950	88
2017	-149	580	431	1,281	0	950	331
2018	-16	1,383	1,367	1,524	0	950	574
2019	194	2,213	2,407	1,767	12	950	829
2020	378	3,086	3,464	2,010	24	950	1,084
2021	561	3,959	4,520	2,253	36	950	1,339
2022	745	4,833	5,578	2,496	48	950	1,594

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4.3 Alternative B: No Action Alternative

Under the No Action Alternative, oil and gas development and production in the MBPA will continue to occur on state, private, and federal lands. An analysis date of December 31, 2012 was chosen to forecast how many additional wells would be developed in the MBPA. Such development includes 218 additional oil wells yet to be drilled and placed into production in the Castle Peak and Eight Mile Flat Oil and Gas Expansion (Castle Peak) project area, 23 additional oil wells to be developed under approved Master Development Plans (MDP) Numbers 17 through 22 and 25 that are outside the Castle Peak project area, and an additional 547 oil and gas wells (209 gas, 338 oil) to be developed on state and private land; for a total of 788 oil and gas wells to be developed after December 31, 2012.

The number of wells yet to be developed in the Castle Peak project area is based on the following:

- The EIS analyzed a total of 973 wells, but assumed that 150 would be converted into water injection wells, for a net of 823 producing oil wells.
- The August 2005 Record of Decision (ROD) only authorized a net total of 778 producing oil wells.
- As of December 31, 2011, Newfield reported that there were 560 producing oil wells in the Castle Peak project area (Newfield, 2012).
- Newfield reported that in the entire MBPA (which is a much greater area than the Castle Peak project area), in calendar year 2012, there would be a net reduction of approximately 17 wells (net of new wells and wells shut-in or converted to water injection). This is out of a total of several thousand wells in the MBPA.
- Therefore, it was assumed that the number of wells in the Castle Peak project area would remain unchanged in Calendar year 2012.
- Accordingly, there is a total of a net of 218 oil wells to be developed in the Castle Peak project area (778 authorized by the ROD minus 560 developed as of December 31, 2012).

The number of wells to be developed under the MDPs was calculated from the fact that MDPs 17 through 22 and 25 authorized a total of 146 wells to be developed after December 31, 2012, but all but 23 of those wells are in the Castle Peak project area and are included in those numbers. Thus only 23 additional wells will be developed under the MDPs.

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Table 4-3 shows the emissions that could occur under the No Action Alternative and details for how the emissions were calculated are in Appendix C.

Table 4-3
No Action Alternative Emissions

Pollutant	Well Development (tpy)	Well Production (tpy)	Infrastructure (tpy)	Total Project Emissions (tpy)
Criteria Pollutants				
NO_x	931.2	661.4	224.7	1,817.3
CO	498.7	558.1	440.5	1,497.4
VOC	178.1	1,707.2	231.6	2,116.9
SO_2	1.0	1.3	0.5	2.8
PM_{10}	598.7	169.6	41.8	810.1
$PM_{2.5}$	89.6	53.4	13.9	157.0
Hazardous Air Pollutants				
Benzene	0.43	11.16	2.17	13.75
Toluene	0.16	26.29	1.60	28.04
Xylene	0.10	42.79	0.37	43.26
Formaldehyde	0.043	32.89	16.87	49.80
Acrolein	0.0043	4.62	1.70	6.33
Total HAPs	0.98	196.07	30.55	227.61
Greenhouse Gases				
CO_2	94,746	249,841	117,217	461,805
CH_4	27.21	1,503	156	1,686
N_2O	0.76	0.47	0.22	1.45
GWP	95,553	281,549	120,563	497,665

The emissions shown for the No Action Alternative do not include the benefit of the ACEPMs that Newfield will implement associated with the Proposed Action Alternative nor potential emission reductions under the Adaptive Management Strategy to mitigate potential adverse ozone formation because those measures will not be implemented if the No Action Alternative is selected. The estimates do include the benefit of the Oil and Gas NSPS as that regulation is applicable to future development. However, one of the main benefits of the NSPS is control on storage tanks with the potential to emit greater than 6 tons per year. Under the No Action Alternative, in the MBPA, if none of the ACEPMs contemplated under the Proposed Action are implemented, the storage tanks would have emissions less than the 6 tpy threshold and thus no controls would be applied. As in the case of the Proposed Action, the emission estimates

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shown in Table 4-3 do not include benefits from future SIP, FIP, and NSR programs that may be implemented in the region in the near future.

4.4 Alternative C: Field-Wide Electrification

In Alternative C, Newfield would implement field-wide electrification which would be phased in over an approximate 7-year period. The electrification would result in replacing natural gas fired pumpjack engines, compressor engines, and generators with electric motors. Emission estimates for the Proposed Action (i.e., 5,750 wells) when Alternative C has been completely implemented are shown in Table 4-4, with details shown in Appendix D. The infrastructure emissions in Table 4-4 include the 550 MWe of electrical generation that Newfield proposed to build under Alternative C. If commercial electrical energy is used, the emissions will decrease to the values shown in Table 4-5. As is the case for the Proposed Action, the emissions for Alternative C include the benefit of ACEPMs and the Oil and Gas NSPS, but do not include emission reductions that may be required under a SIP, FIP, or NSR programs that may be promulgated in the near future nor mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation.

4.5 Alternative D: Resource Protection (Agency Preferred Alternative)

In Alternative D, 5,058 oil and gas wells would be developed in the MBPA. For purposes of analysis, it was assumed that 3,519 of the wells would be oil wells and 1,539 would be deep gas wells. Drilling and development would still occur at an average rate of 360 wells per year until the resource base is fully completed, approximately 14 years. Emission estimates for Alternative D are shown in Table 4-6, with details shown in Appendix E. Appendix E-1 shows the oil well emissions and E-2 the gas well emissions. As is the case for the Proposed Action, the emissions for Alternative D include the benefit of ACEPMs and the Oil and Gas NSPS, but do not include emission reductions that may be required under a SIP, FIP, or NSR programs that may be promulgated in the near future nor mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation.

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Table 4-4
Development Emissions Under Alternative C Field-Wide Electrification and Self-Generated Electrical Energy

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	129.6	344.6	250.1	724.3	668.6	511.1	90.8	1,270.5	1,994.8
CO	106.0	290.9	269.2	666.1	594.3	523.1	165.9	1,283.2	1,949.3
VOC	12.1	3,532.4	580.8	4,125.3	35.9	3,795.8	409.2	4,240.9	8,366.2
SO_2	0.2	2.0	2.0	4.1	1.2	2.9	1.2	5.3	9.4
PM_{10}	423.3	410.6	376.7	1,210.6	1,145.1	283.0	70.3	1,498.4	2,709.0
$PM_{2.5}$	46.0	64.4	79.1	189.6	128.4	61.8	42.4	232.7	422.3
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	9.84	3.92	13.84	0.519	26.15	12.76	39.43	53.27
Toluene	0.031	8.83	3.91	12.78	0.188	48.84	10.63	59.66	72.44
Xylene	0.020	2.74	1.16	3.92	0.1290	37.30	2.44	39.86	43.78
Formal-dehyde	0.0080	0.25	4.21	4.47	0.0527	0.36	4.91	5.32	9.79
Acrolein	0.00080	---	0.037	0.038	0.00527	---	0.044	0.049	0.087
Total HAPs	0.26	183.91	41.53	225.69	1.05	211.21	42.23	254.48	480.17
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,776	394,514	1,018,246	1,431,536	116,923	602,127	983,856	1,702,905	3,134,441
CH_4	18.81	3,809	665	4,492	4.60	7,152	933	8,090	12,582
N_2O	0.15	0.74	1.90	2.80	0.93	1.13	1.85	3.91	6.71
GWP	19,218	474,727	1,032,792	1,526,737	117,308	752,679	1,004,029	1,874,015	3,400,752

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Table 4-5
Development Emissions Under Alternative C Field-Wide Electrification with Commercial Electrical Energy

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	129.6	344.6	202.5	676.7	668.6	511.1	33.7	1,213.3	1,890.0
CO	106.0	290.9	225.8	622.6	594.3	523.1	113.7	1,231.1	1,853.7
VOC	12.1	3,532.4	564.2	4,108.7	35.9	3,795.8	389.4	4,221.1	8,329.8
SO_2	0.2	2.0	1.0	3.2	1.2	2.9	0.1	4.2	7.4
PM_{10}	423.3	410.6	344.8	1,178.7	1,145.1	283.0	32.1	1,460.2	2,638.9
$PM_{2.5}$	46.0	64.4	47.3	157.8	128.4	61.8	4.2	194.5	352.3
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	9.84	3.85	13.77	0.519	26.15	12.68	39.35	53.12
Toluene	0.031	8.83	3.17	12.03	0.188	48.84	9.74	58.76	70.79
Xylene	0.020	2.74	0.79	3.55	0.1290	37.30	1.99	39.42	42.97
Formal-dehyde	0.0080	0.25	0.13	0.38	0.0527	0.36	0.01	0.43	0.81
Acrolein	0.00080	---	0.000	0.001	0.00527	---	0.000	0.005	0.006
Total HAPs	0.26	183.91	35.62	219.79	1.05	211.21	35.14	247.39	467.18
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,776	394,514	242,780	656,070	116,923	602,127	53,296	772,345	1,428,415
CH_4	18.81	3,809	650	4,477	4.60	7,152	916	8,073	12,550
N_2O	0.15	0.74	0.44	1.33	0.93	1.13	0.09	2.16	3.49
GWP	19,218	474,727	256,565	750,510	117,308	752,679	72,556	942,543	1,693,053

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Table 4-6
Development Emissions Under Alternative D Resource Protection

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	153.3	2,137.3	468.8	2,759.4	472.8	315.0	1,353.7	2,141.5	4,900.9
CO	128.2	2,630.5	812.2	3,570.9	419.5	324.5	2,747.1	3,491.2	7,062.1
VOC	14.4	5,250.8	592.7	5,857.8	25.4	2,336.8	1,260.2	3,622.4	9,480.2
SO_2	0.2	5.3	1.5	7.0	0.9	1.8	2.9	5.5	12.5
PM_{10}	511.8	830.8	253.1	1,595.7	807.8	208.7	75.1	1,091.6	2,687.3
$PM_{2.5}$	55.0	276.1	57.8	388.8	90.7	41.5	51.9	184.2	573.0
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.10	20.74	2.14	22.98	0.37	16.10	11.95	28.41	51.39
Toluene	0.039	15.91	1.34	17.29	0.13	30.06	9.32	39.52	56.81
Xylene	0.024	4.85	0.43	5.31	0.09	22.96	2.15	25.20	30.51
Formal-dehyde	0.0098	197.93	14.23	212.17	0.037	0.22	126.30	126.56	338.73
Acrolein	0.00098	27.84	1.81	29.66	0.0037	---	12.31	12.31	41.97
Total HAPs	0.32	543.44	43.33	587.09	0.74	130.02	202.86	333.62	920.71
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	22,950	1,049,077	315,150	1,387,177	82,477	370,729	608,232	1,061,438	2,448,615
CH_4	23.14	4,377	343	4,743	3.24	4,403	794	5,200	9,943
N_2O	0.189	1.98	0.58	2.75	0.657	0.70	1.14	2.50	5.25
GWP	23,495	1,141,609	322,527	1,487,631	82,749	463,409	625,260	1,171,418	2,659,049

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5 IMPACT ASSESSMENT METHODOLOGY

Three different air quality impact assessments were conducted: Substantial Increase in Emissions Analysis, Near Field AQIA, and Far Field AQIA.

5.1 Substantial Increase in Emissions Analysis

In order to determine if implementation of the Proposed Action will result in a substantial increase in ozone precursor emissions, annual development emission increases in the MBPA for the Proposed Action were compared to emissions that would occur under the No Action Alternative in the MBPA. This analysis is discussed in Section 6 of this AQTSD.

5.2 Near Field AQIA

5.2.1 Dispersion Modeling

A dispersion model impact assessment was conducted to analyze the potential ambient air quality impacts of the Ultimate Proposed Action and Alternatives within 50 kilometers (km) of the project area, termed near field impacts. In order to conduct this analysis, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) version 12345, promulgated through the USEPA Guideline on Air Quality Models, was used as the primary dispersion model for assessing near-field impacts (40 CFR Part 51, Appendix W). The AERMOD system contains three primary components: AERMOD (dispersion model with prime building downwash algorithms), AERMAP (terrain preprocessor), and AERMET (meteorological preprocessor). A special feature of AERMOD includes the capability to represent boundary layer meteorology and dynamics. The USEPA Guideline on Air Quality Models (40 CFR Part 51, Appendix W) specifies that impacts calculated with steady-state Gaussian plume models (AERMOD) are recommended at distances up to 50 km from the origin of the emission source.

The AERMET system utilizes both surface and upper air measurements in order to estimate profiles of wind, turbulence, and temperature in the planetary boundary layer. Minimum meteorological data requirements in the surface and upper air data files for successful execution of AERMET include horizontal wind speed, horizontal wind direction, ambient temperature, cloud cover, and a morning upper air sounding. The recent version of the model, however, has incorporated the Bulk Richardson Number scheme which removes the model dependence on

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cloud cover if Solar Radiation and Temperature Change with Height (SRDT) data are available. This is especially important in areas where cloud cover data are unavailable or considered to be non-representative. After entering the surface and upper air data into AERMET, the surface characteristics that pertain to the meteorological data are required, including; Albedo, Bowen Ratio and Surface Roughness.

Another requirement for model performance is representative meteorological data of the conditions affecting the transport and dispersion of pollutants within the modeling domain. Generally, this means that the surface characteristics surrounding the meteorological monitoring site should be similar to those within the modeling domain. While a degree of similarity may correlate with proximity of the monitoring site to the project site, meteorological data measured at more distant sites may be considered representative as long as it adequately represents the meteorology and surface characteristics of the modeling domain.

In consideration of these limitations, this analysis utilized five recent calendar years of surface meteorological data from Vernal, Utah. The data were supplied by the Utah Department of Environmental Quality – Division of Air Quality (UDAQ) and consist of surface measurements collected in Vernal, Utah for the years 2005-2009 combined with upper air data recorded in Grand Junction, Colorado for the same years.

The data were created by UDAQ by using the AERMET processing program which utilized the surface and upper air data to produce two types of finished data files for each meteorological year for use by AERMOD; surface scalar parameters and vertical profiles. A profile base elevation of 1,608 m (5,276 ft.) was used with the meteorological data for the execution of AERMOD.

The wind rose for the processed meteorological data is shown on Figure 5-1 (all figures for Section 5 are located at the end of the Section).

Different emissions source configurations were used to evaluate the maximum potential near field impacts of the Proposed Action and Alternatives: one set for PM_{10} and $PM_{2.5}$ emissions and another set for NO_x, CO, SO_2, and HAPs emissions. The PM_{10} and $PM_{2.5}$ scenario is termed the Construction and Development Scenario as maximum particulate emissions occur during construction of well pads and roads in close proximity to operating wells. The NO_x, CO, SO_2 and HAPs emissions scenarios are termed Operations Scenarios since the potential maximum impacts of those emissions occurs when there is a combination of drilling and wells

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and infrastructure operating in close proximity. One set of the Operations Scenarios is based on 40-acre surface spacing of the gas well operations with associated infrastructure located in close proximity to the wells. Another set of Operations Scenarios is based on 40-acre surface spacing but 20-acre downhole spacing (i.e., two oil wells per pad) of oil well operations in close proximity to associated infrastructure. It is possible to have one oil well and one gas well on the same pad, however, the worst case configuration is two oil wells per pad.

In all three of the near field modeling scenarios, building downwash and terrain elevations were ignored (i.e., flat terrain was assumed) because of uncertainty in location and orientation of each source. This assumption is consistent with the fact that maximum impacts occur very close to the sources (since the sources are mostly ground level releases) and the terrain in the immediate vicinity of a source will be relatively flat. There are also relatively few buildings associated with these sources, so building downwash is not an issue.

Since most of the nitrogen oxide (NO_x) emissions are nitrogen monoxide (NO) rather than nitrogen dioxide (NO_2), an assumption regarding conversion of NO to NO_2 must be made. For the 1-hour NO_2 impact, the Tier 2 analytical method as described in the USEPA March 1, 2011 memorandum (USEPA 2011b) was used. The Tier 2 method assumes a constant 80 percent conversion of the emitted NO. For the annual NO_2 impact, 100 percent conversion of NO to NO_2 was assumed.

5.2.2 Proposed Action and Alternatives Evaluation

Five different modeling scenarios were evaluated in order to assess the potential ambient air quality impacts of the Proposed Action and Alternatives. The modeling scenarios were as follows:

- Alternative A – Proposed Action: Well construction and development
- Alternative A – Proposed Action: 20-acre downhole spacing oil well operations
- Alternative A – Proposed Action: 40-acre surface spacing gas well operations
- Alternative C – Field Wide Electrification: 20-acre downhole spacing oil well operations
- Alternative C – Field Wide Electrification: 40-acre surface spacing gas well operations

Construction and well development emissions are the same under all of the Action Alternatives, so only one modeling scenario is needed. Under the No Action Alternative (Alternative B), well

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construction, development and operations could still occur, but the emissions and sources would be similar to Alternative A, and the near field impacts would be the similar.

5.2.3 Construction and Development Modeling Scenario

The construction and development modeling scenario focuses on particulate matter emissions, PM_{10} and $PM_{2.5}$, primarily generated by earth-moving and traffic activities. In this scenario, a section of the well field is modeled as shown in Figure 5-2. This scenario is a worst-case configuration and is not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. The scenario contains a portion of unpaved road with six (6) road branches. At the end of one branch is well pad construction, another branch contains well development (drilling) and the rest contain producing wells.

The point source release parameters used in the Construction and Development scenario are shown in Table 5-1. Well pad construction was modeled as an area source with dimensions of 75 meters by 108 meters for oil wells (2 acres) and dimensions of 110 meters by 110 meters for gas wells (3 acres). Unpaved road emission sources were modeled as volume sources assuming a 6.7 meter wide road. Table 5-1 shows the area and volume source release parameters.

Table 5-1
Source Release Parameters for Construction and Development

Activity	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Drill Rigs	6.1	800	50	0.2
Producing Well site	3.05	700	3.8	0.1
Activity	**Release Height (m)**	**Initial Horizontal Dimension (m)**	**Initial Vertical Dimension (m)**	
Well Pad Construction	3.05	N/A	1.5	
Unpaved Road Segments	4.6	7.79	2.13	

The emission rates for each of the sources were calculated differently for short term and annual impacts. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the

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maximum annual emissions by the number of seconds in a year. Table 5-2 shows the modeled emission rates.

Table 5-2
Emission Rates for Construction and Development Sources

Equipment	PM_{10} Hourly (g/sec)	$PM_{2.5}$ Hourly (g/sec)	$PM_{2.5}$ Annual (g/sec)
Drill Rigs – Oil Wells	7.575E-03	7.575E-03	1.245E-04
Drill Rigs – Gas Wells	7.575E-03	7.575E-03	1.141E-03
Producing Wellsite – Oil Wells	1.977E-03	1.977E-03	1.977E-03
Producing Wellsite – Gas Wells	4.225E-04	4.225E-04	4.225E-04
Well Pad Construction – Oil Wells	4.742E-02	2.607E-02	2.157E-04
Well Pad Construction – Gas Wells	4.742E-02	2.607E-02	2.166E-04
Unpaved Road Segments – Oil Wells	3.611E-03	3.611E-04	8.062E-05
Unpaved Road Segments – Gas Wells	2.887E-03	2.887E-04	7.235E-05

5.2.4 Modeling Scenario for 20-Acre Downhole Spacing Oil Operations, Alternative A

The 20-acre downhole spacing modeling scenario for oil well operations is shown in Figure 5-3. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain two producing wells; however the four well pads in the center of the grid contain one well being drilled and one producing well. Additionally, the grid contains one compressor station and one GOSP facility just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-3, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-4. For the HAP scenario either a GOSP or a Water Treatment Facility was placed in the grid depending on which facility would have higher emissions for a specific HAP.

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Table 5-3
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Compressor Engines	10.67	730	49.7	0.305
Compressor Station Heater	3.66	570	3.8	0.2
Compressor Station and GOSP Flares	6.10	1273	2.0	0.61
GOSP Generator	9.14	755	27.0	0.305
GOSP Heater	7.32	570	2.6	0.61
Drill Rigs	6.10	800	50.0	0.2
Producing Well sites	3.05	700	3.8	0.1

Table 5-4
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well sites	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Compressor Engines	10.67	730	49.7	0.305
Compressor Station Tanks, Fugitives, Dehydrator	6.10	1273	2	0.61
Compressor Station Heater	3.66	570	3.8	0.2
GOSP Generator	9.14	755	27	0.305
GOSP Fugitives, Loading	1.52	350	0.5	0.1
GOSP Heater	7.32	570	2.6	0.61
Water Treatment Generator	9.14	755	27.0	0.305
Water Treatment Tanks, Fugitives	8.23	350	0.5	0.1

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were

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calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-5 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-6 presents the modeled emission rates for HAPs.

Table 5-5
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Compressor Engines	2.222	2.222	4.444	0.00474
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111
Compressor Station and GOSP Flares	0.0257	0.0257	0.140	----
GOSP Generator	0.540	0.540	1.081	0.00130
GOSP Heater	0.408	0.408	0.342	0.00245
Drill Rigs	0.0108	0.656	0.656	0.00139
Producing Well sites	0.0205	0.0205	0.0247	0.0000617

Table 5-6
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Producing Well sites	3.134E-04	1.620E-03	2.276E-04
Drill Rigs	6.221E-04	6.325E-05	6.317E-06
Compressor Engines	1.774E-03	2.129E-01	2.072E-02
Compressor Station Tanks, Fugitives, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----
GOSP Generator	1.742E-03	2.261E-02	2.900E-03
GOSP Fugitives, Loading	1.186E-03	----	----
GOSP Heater	8.560E-06	3.057E-04	----
Water Treatment Generator	1.742E-03	2.261E-02	2.900E-03
Water Treatment Tanks, Fugitives	2.052E-03	----	----

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5.2.5 Modeling Scenario for 40-Acre Surface Spacing Gas Operations, Alternative A

The 40-acre surface spacing modeling scenario for gas well operations is shown in Figure 5-4. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain one producing well; however the four well pads in the center of the grid contain one well being drilled. Additionally, the grid contains one compressor station and one gas processing facility just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-7, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-8.

Table 5-7
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rig	6.10	800	50.0	0.2
Compressor Engines	10.67	730	49.7	0.305
Compressor Station Heater	3.66	570	3.8	0.2
Compressor Station and Gas Plant Flares	6.10	1273	2.0	0.61
Gas Plant Engines	7.32	1013	35.2	0.15
Gas Plant Heater	3.66	570	3.8	0.2

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Table 5-8
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Compressor Engines	10.67	730	49.7	0.305
Comp Station Tanks, Fugitives, Dehydrator	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2
Gas Plant Engines	7.32	1013	35.2	0.15
Gas Plant Dehydrator, Fugitives	6.10	1273	2.0	0.61
Gas Plant Heater	3.66	570	3.8	0.2

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-9 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-10 presents the modeled emission rates for HAPs.

Table 5-9
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Producing Well	0.00579	0.00579	0.00593	0.0000334
Drill Rig	0.0989	0.656	0.656	0.00139
Compressor Engines	2.222	2.222	4.444	0.00474
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111
Compressor Station and Gas Plant Flares	0.0257	0.0257	0.140	----
Gas Plant Engines	0.333	0.333	0.167	0.000200
Gas Plant Heater	0.0185	0.0185	0.0156	0.000111

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Table 5-10
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Producing Well	3.009E-04	4.169E-06	----
Drill Rigs	6.221E-04	6.325E-05	6.317E-06
Compressor Engines	1.774E-03	2.129E-01	2.072E-02
Compressor Station Tanks, Fugitives, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----
Gas Plant Engines	1.075E-03	1.395E-02	1.789E-03
Gas Plant Dehydrator, Fugitives	1.613E-02	----	----
Gas Plant Heater	3.891E-07	1.390E-05	----

5.2.6 Modeling Scenario for 20-Acre Downhole Spacing Oil Operations, Alternative C

The 20-acre downhole spacing modeling scenario for oil well operations is shown in Figure 5-5. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain two producing wells; however the four well pads in the center of the grid contain one well being drilled and one producing well. Additionally, the grid contains one compressor station, one GOSP facility, and one electric substation just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-11, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-12. For the HAP scenario either a GOSP or a Water Treatment Facility was placed in the grid depending on which facility would have higher emissions for a specific HAP.

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Table 5-11
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Turbines	9.14	736	50.2	1.07
GOSP Heater	7.32	570	2.6	0.61
Compressor Station and GOSP Flares	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2

Table 5-12
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Turbines	9.14	736	50.2	1.07
Producing Well	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Compressor Station Tanks, Fugitives, Dehydrator	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2
GOSP Fugitives, Loading	1.52	350	0.5	0.1
GOSP Heater	7.32	570	2.6	0.61
WT Tanks, Fugitives	8.23	350	0.5	0.1

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-13 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-14 presents the modeled emission rates for HAPs.

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Table 5-13
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Producing Well	0.00755	0.00755	0.00698	0.0000445
Drill Rigs	0.0108	0.656	0.656	0.00139
Turbines	0.274	0.274	0.250	0.00534
GOSP Heater	0.408	0.408	0.342	0.00245
Compressor Station and GOSP Flares	0.0257	0.0257	0.140	----
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111

Table 5-14
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Turbines	3.970E-04	2.349E-02	2.118E-04
Producing Well	2.567E-04	5.559E-06	----
Drill Rigs	6.221E-04	6.325E-05	6.317E-06
Compressor Station Tanks, Fugitives, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----
GOSP Fugitives, Loading	1.186E-03	----	----
GOSP Heater	8.560E-06	3.057E-04	----
WT Tanks, Fugitives	2.052E-03	----	----

5.2.7 Modeling Scenario for 40-Acre Surface Spacing Gas Operations, Alternative C

The 40-acre surface spacing modeling scenario for gas well operations is shown in Figure 5-6. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain one producing well; however the four well pads in the center of the grid contain one well

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being drilled. Additionally, the grid contains one compressor station, one gas processing facility, and one electric substation just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-15, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-16.

Table 5-15
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rig	6.10	800	50.0	0.2
Turbines	9.14	736	50.2	1.07
Gas Plant Heater	3.66	570	3.8	0.2
Compressor Station and Gas Plant Flare	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2

Table 5-16
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rig	6.10	800	50.0	0.2
Turbines	9.14	735.93	50.2	1.07
Gas Plant Heater	3.66	570	3.8	0.2
Gas Plant Dehydrator, Fugitives	6.10	1273	2.0	0.61
Compressor Station Tanks, Fugitive, Dehydrator	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For

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HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-17 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-18 presents the modeled emission rates for HAPs.

Table 5-17
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Producing Well	0.00579	0.00579	0.00593	0.0000334
Drill Rig	0.0989	0.656	0.656	0.00139
Turbines	0.274	0.274	0.250	0.00534
Gas Plant Heater	0.0185	0.0185	0.0156	0.000111
Compressor Station and Gas Plant Flare	0.0257	0.0257	0.140	----
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111

Table 5-18
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Producing Well	3.009E-04	4.169E-06	----
Drill Rig	6.221E-04	6.325E-05	6.317E-06
Turbines	3.970E-04	2.349E-02	2.118E-04
Gas Plant Heater	3.891E-07	1.390E-05	----
Gas Plant Dehydrator, Fugitives	1.613E-02	----	----
Compressor Station Tanks, Fugitive, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----

5.2.8 Near Field Evaluation Criteria

The modeled impacts for criteria pollutants were added to the pre-project background concentrations shown in Table 3-3 and compared to the NAAQS shown in Table 3-1. The

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modeled impacts for potential non-carcinogenic HAPs were compared to the RELs and RfCs shown in Table 3-4 and the State of Utah TSLs shown in Table 3-5. Potential carcinogenic risk was calculated as discussed in Section 3.4 and compared to the standard acceptable risk range of 1 to 100 in a million. As shown in Tables 3-4 and 3-5, the three HAPs with the most stringent REL and RfCs are benzene, formaldehyde, and acrolein; and only benzene and formaldehyde are potentially carcinogenic. Accordingly, only benzene, formaldehyde, and acrolein impacts were modeled in the Near Field assessment; although all of the HAP emissions were quantified and are included in the Appendices.

5.3 Far Field AQIA

5.3.1 Dispersion Modeling

To assess the potential impacts of the Proposed Action and Alternatives on distant (i.e., greater than 50 km) receptors at Class I areas, sensitive Class II areas, and sensitive lakes, the CALPUFF modeling system (Version 5.8) was used. The CALPUFF modeling system consists of three major modules, CALMET, CALPUFF, and CALPOST. For the far field AQIA, only the CALPUFF (Version 5.8, Level 070623) and CALPOST (Version 6.221, Level 080724) modules were used. The CALMET module was not needed as the WRF (Weather Research and Forecasting meteorological model) meteorological data prepared for the Air Resource Management Strategy (ARMS) photochemical modeling project currently being conducted by the BLM were used. When appropriate, the CALPUFF and CALPOST modeling procedures in the Federal Land Manager's Air Quality Related Values Work Group (FLAG) October 2010 guidance (FLAG 2010) were used, including the updated Method 8 equations for regional haze impact assessments. Default settings were used in CALPUFF and CALPOST if not otherwise specified by the FLAG guidance. The WRF data were made "CALPUFF ready" by processing with the MMIF processor (Version 2.3). The MMIF processor simply re-formats the meteorological data to be useable in CALPUFF without any adjustments or supplementary meteorological observations.

The CALPUFF modeling domain covered eastern Utah and western Colorado as shown in Figure 5-7. The modeling domain was the same as used in the Greater Natural Buttes FEIS (BLM 2012) and extended 672 km east-west and 552 km north-south. The central reference point for the Lambert Conformal Projection (LCP) was 97 degrees west, 40 degrees north. The LCP standard parallels were 33 and 45 degrees north. The southwest corner of the modeling

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domain was located 1,392 km west of the central reference point and 312 km south of the central reference point. The modeling domain was a 4 km grid with 168 x 138 grid cells.

The WRF meteorological data utilize two different domains, a 4 km domain and a 12 km domain. The WRF 4 km domain does not include all of the Class I, sensitive Class II, and sensitive lake receptors evaluated herein. Accordingly, the far field impact assessment was completed with the 12 km domain. However, the 12 km domain results for visibility and NO_2 impacts for Arches National Park and Dinosaur National Monument were compared to the 4 km domain results and it was found that the 4 km domain results were the same or slightly lower than the 12 km domain results. Therefore, the 12 km domain was used for all of the far field impact assessments.

The list of Class I areas, sensitive Class II areas, and sensitive lakes are shown in Table 5-19. Locations of these areas with respect to the MBPA are shown in Figure 5-8.

The receptor grids for the Class I areas were those specified by the Federal Land Managers. Receptor grids were developed for the sensitive Class II areas based on the boundary of the area and a rectangular receptor grid at approximately 1.5 km spacing within the area. Single receptors at the center of each the sensitive lakes was used. Elevations for the receptors were developed where necessary from the USGS Shuttle Radar Topography Mission data with 30 meter with 90 meter resolution (USGS 2013).

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Table 5-19
Class I Areas, Sensitive Class II Areas, and Sensitive Lakes Evaluated

Class I and Sensitive Class II Areas	Sensitive Lakes	
National Park Service (NPS) Class I Areas	**Eagles Nest Wilderness**	**High Uintas Wilderness**
Arches National Park	Booth Lake	Dean Lake
Black Canyon of the Gunnison National Park	Upper Willow Lake	Fish Lake
Canyonlands National Park	**Flat Tops Wilderness**	**Raggeds Wilderness**
Capitol Reef National Park	Ned Wilson Lake	Deep Creek Lake
Great Sand Dunes National Park and Preserve	Trappers Lake	Island Lake
Mesa Verde National Park	Upper Ned Wilson Lake	
USFS Class I Areas	**La Garita Wilderness**	
Eagles Nest Wilderness Area	Small Lake Above U-Shaped Lake	
Flat Tops Wilderness Area	U-Shaped Lake	
La Garita Wilderness Area	**Maroon Bells-Snowmass Wilderness**	
Maroon Bells-Snowmass Wilderness Area	Avalanche Lake	
Mount Zirkel Wilderness Area	Capitol Lake	
Weminuche Wilderness Area	Moon Lake (Upper)	
West Elk Wilderness Area	**Mount Zirkel Wilderness**	
NPS Class II Areas	Lake Elbert	
Colorado National Monument	Summit Lake	
Dinosaur National Monument	**Weminuche Wilderness**	
USFS Class II Areas	Big Eldorado Lake	
Flaming Gorge National Recreation Area	Little Eldorado Lake	
High Uintas Wilderness Area	Lower Sunlight Lake	
Holy Cross Wilderness Area	Upper Grizzly Lake	
Hunter/Frying Pan Wilderness Area	Upper Sunlight Lake	
Raggeds Wilderness Area	White Dome Lake	
U.S. Fish and Wildlife Service Class II Areas	**West Elk Wilderness**	
Browns Park National Wildlife Refuge	South Golden Lake	

5.3.2 Proposed Action and Alternatives Evaluation

The far field impact analysis included only NO_x, SO_2, PM_{10}, and $PM_{2.5}$. CO was not modeled because there are no PSD increments for CO and CO impacts are a local, near field issue. Similarly for HAP emissions, the impact of interest is local. For the far field impact evaluation only Alternative A was modeled. This Alternative has the largest emissions of any of the Alternatives and thus yields the maximum impact of any of the Alternatives.

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Since the Class I areas, sensitive Class II areas and sensitive lakes are all located a considerable distance from the MBPA, the emissions for the entire Alternative A were placed into a single rectangular area source that can be fit within the MBPA. This is a rectangular source of 11 km by 13 km. The emissions were then calculated as grams per second per square meter (g/sec-m^2) by dividing the maximum tons per year by the number of seconds in a year and the area of the source. A single set of emission rates can be used for both short and long term impacts because most of the sources emit continuously at the same rate (e.g., a pumpjack engine runs continuously at the same load). The sources emit at essentially ground level, so the release height for the area source was set as ground level at the average elevation of the MBPA, 1432 meters above mean sea level. The modeled emission rates are shown in Table 5-20.

Table 5-20
Far Field Modeling Emission Rates

	NO_x (g/sec-m^2)	**SO_2** (g/sec-m^2)	**PM_{10}** (g/sec-m^2)	**$PM_{2.5}$** (g/sec-m^2)
CALPUFF Modeled Emission Rates	4.8E-07	1.20E-09	2.45E-07	5.20E-08

5.3.3 Far Field Evaluation Criteria

As a point of information only, the impacts of the Proposed Action in the Class I and sensitive Class II areas were compared to the PSD increments for the pollutants and averaging times for which increments have been established by the USEPA as shown in Table 3-1. As indicated in Section 3, comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis

For regional haze, the potential change in light extinction (b_{ext}) in terms of change in deciviews (dV) was evaluated using the CALPUFF Method 8 and the regional haze equations suggested by FLAG in the 2010 guidance (FLAG 2010). Method 8 and the FLAG 2010 guidance treat large sulfate and small sulfate separately because large and small particles affect light extinction differently. The modeled impacts were evaluated by calculating the number of days in each area that exceeded the 0.5 dV and 1.0 dV thresholds of concern used by USEPA in its Regional Haze regulations and the eighth-high (98th percentile) change in bext compared to the 0.5 dV threshold published by the Federal Land Managers (FLAG 2010).

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Acid deposition was evaluated by calculating total sulfur and nitrogen deposition (dry plus wet) from the CALPUFF model output (in terms of kilograms sulfur or nitrogen per hectare per year, kg/ha-yr). The deposition was compared to the 3 kg/ha-yr and 5 kg/ha-yr thresholds for nitrogen and sulfur, respectively.

For sensitive lakes, the change in acid neutralizing capacity (ANC) was calculated using the methodology suggested by the US Forest Service (USFS 2000). The method is to calculate hydrogen ion deposition (H_{dep}) in terms of micro equivalents per liter (μeq/l) from the watershed area and total sulfur and nitrogen deposition of all species output by CALPUFF. The watershed areas were those used in the GNB analysis (BLM 2012) and were provided by the Federal Land Managers. H_{dep} is compared to the baseline ANC (ANC(o)), also reported in the GNB analysis as provided by the Federal Land Managers. The change in ANC was compared to the threshold of a 10 percent change in ANC for lakes with background ANC values greater than 25 μeq/l and no more than a 1 μeq/l change in ANC for lakes with background ANC values equal to or less than 25 μeq/l.

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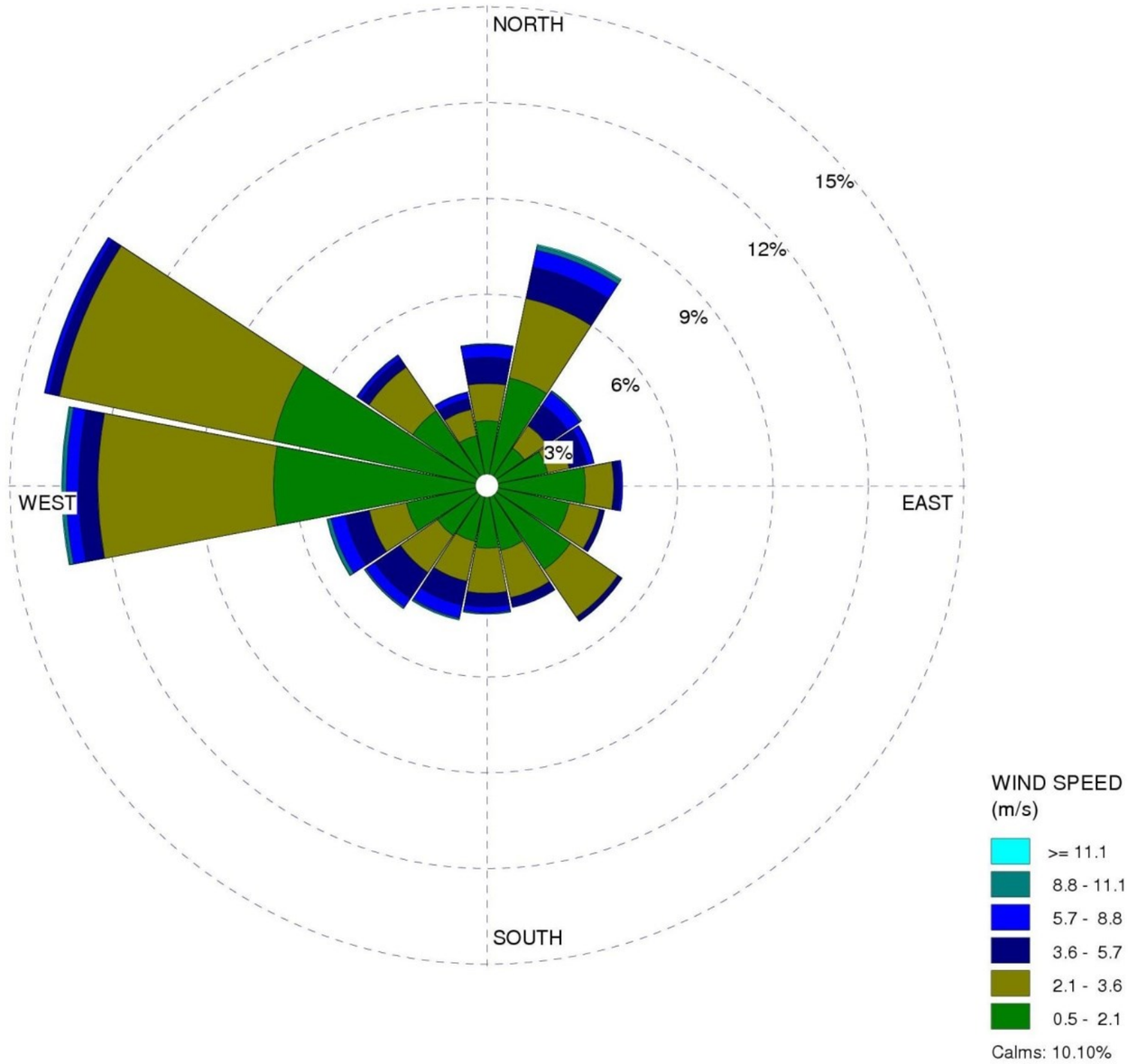

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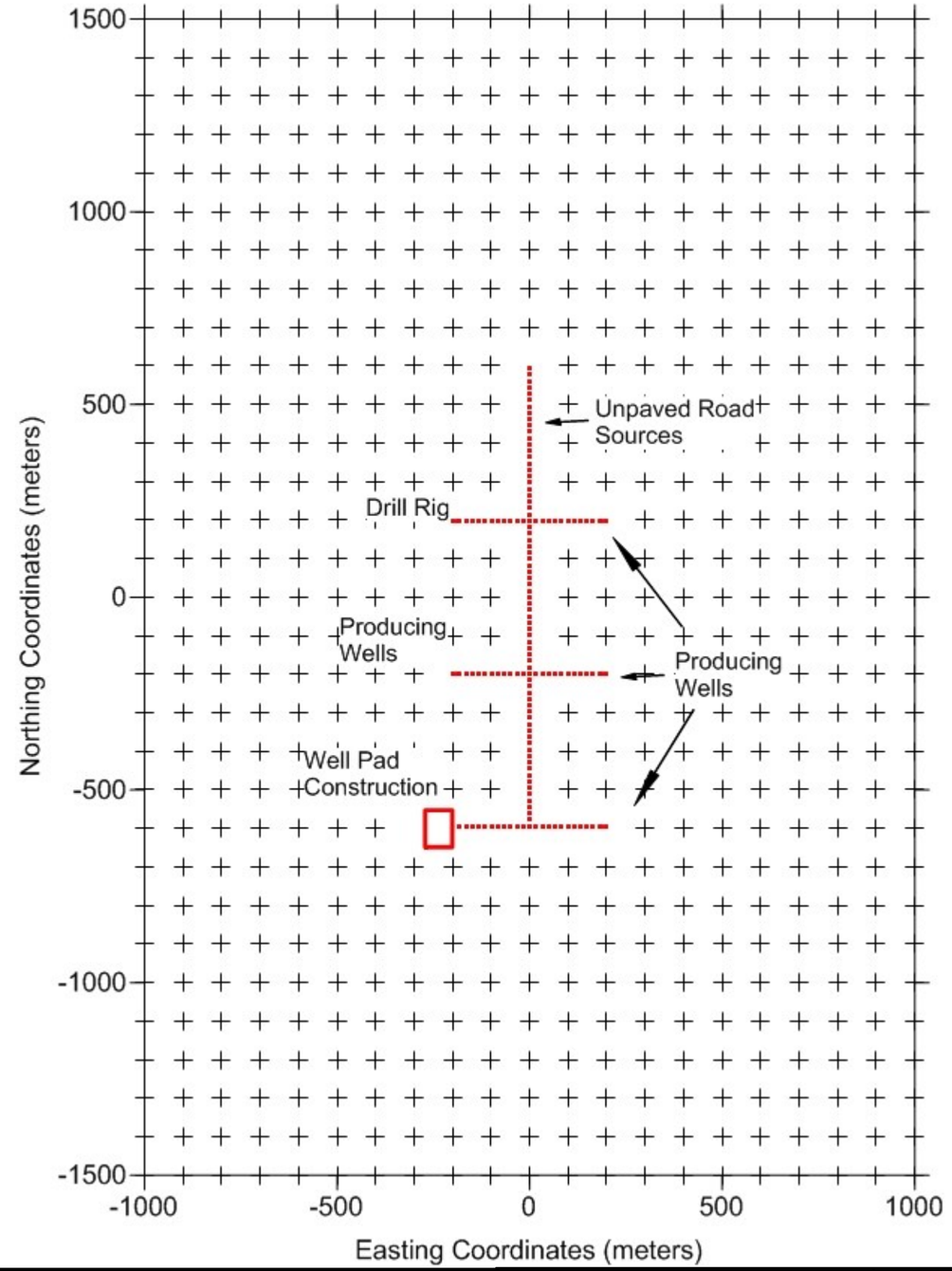
Newfield Exploration Company
Monument Butte

Wind Rose for Vernal, Utah
2005-2009 Data

FIGURE
5-1



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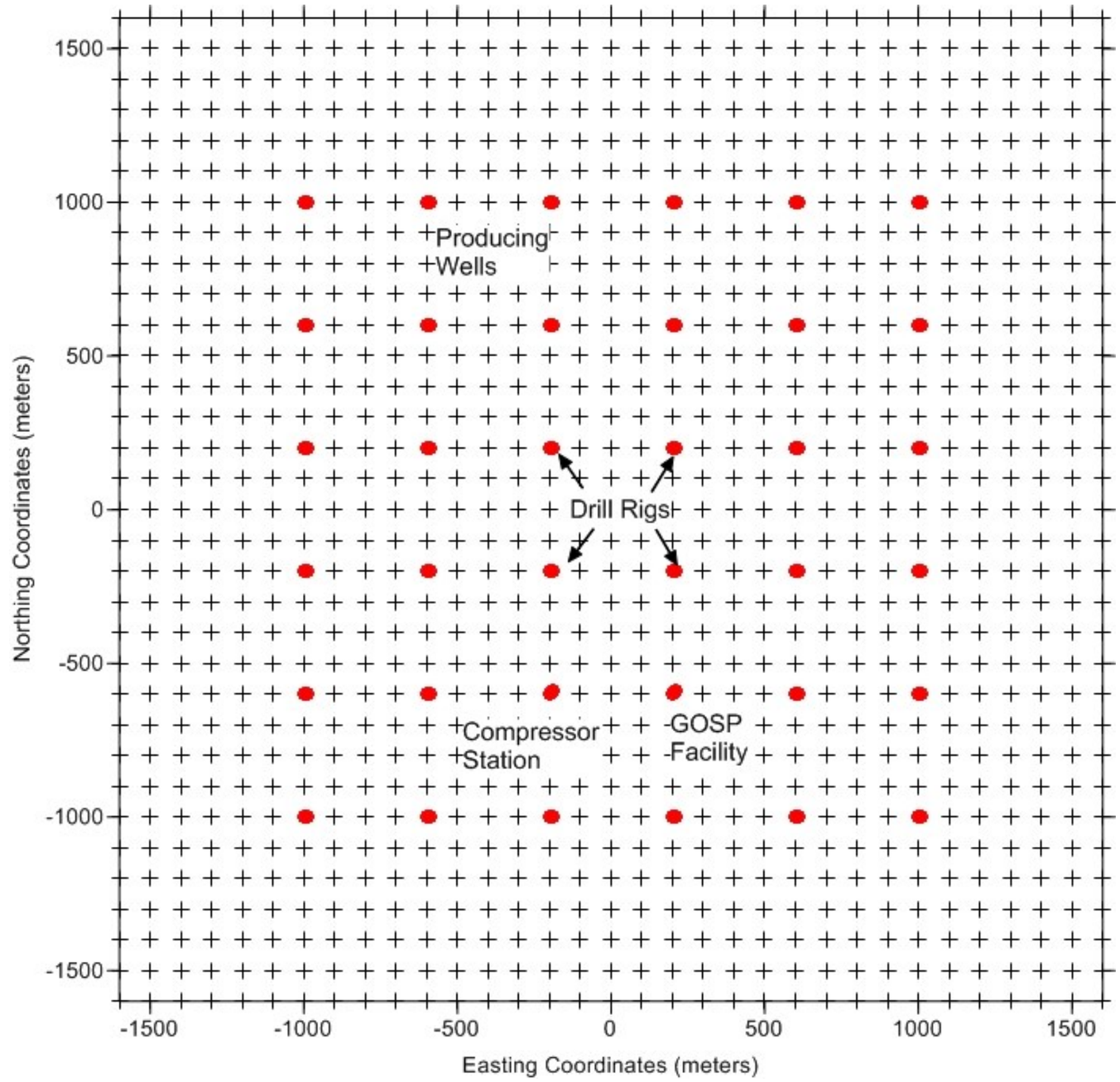
Newfield Exploration Company
Monument Butte

Construction and Development
Modeling Scenario Configuration

FIGURE
5-2



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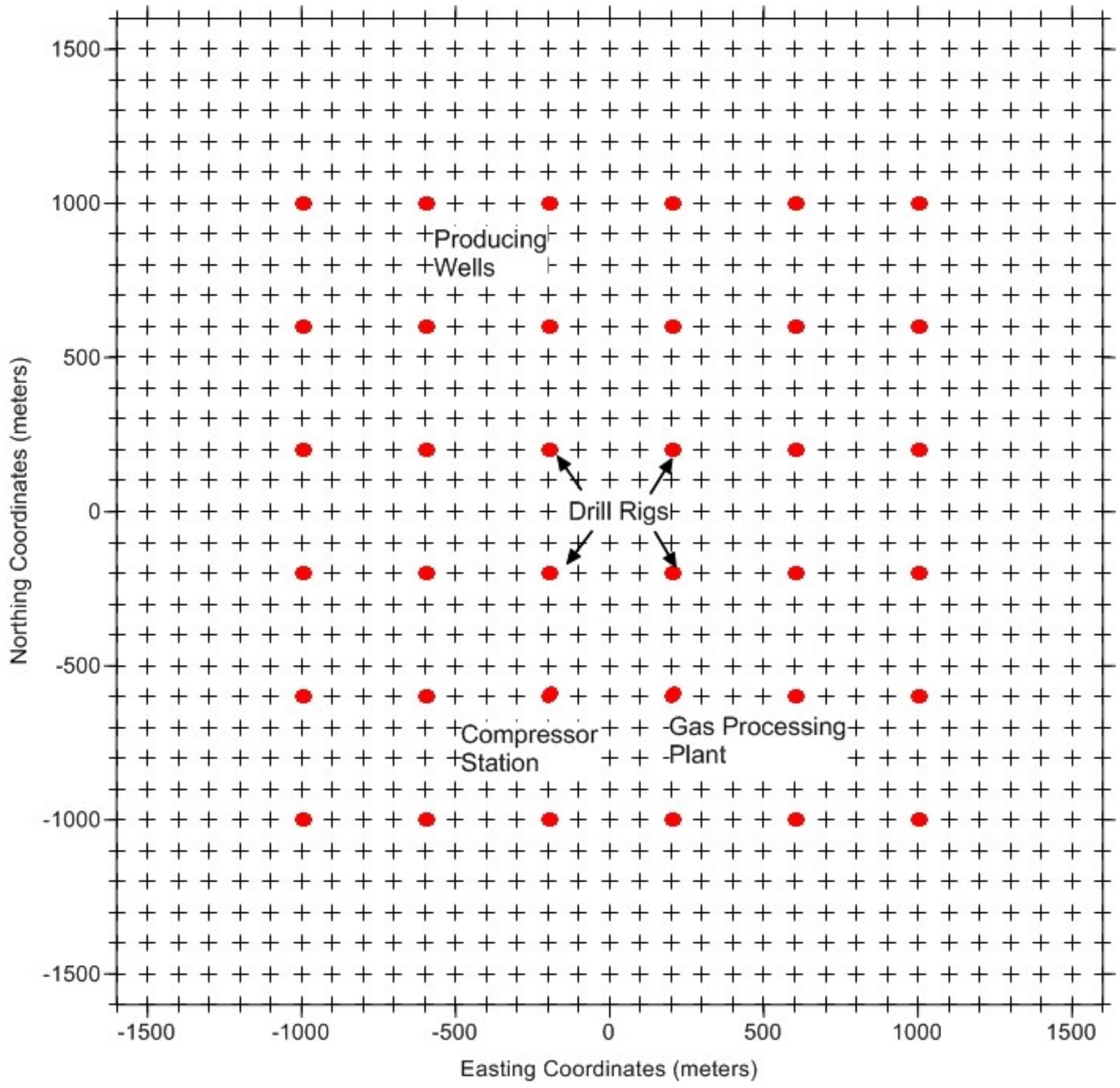
Monument Butte

Alternative A
20-acre Downhole Spacing (40-acre Surface Spacing)
Oil Well Modeling Scenario Configuration

FIGURE
5-3



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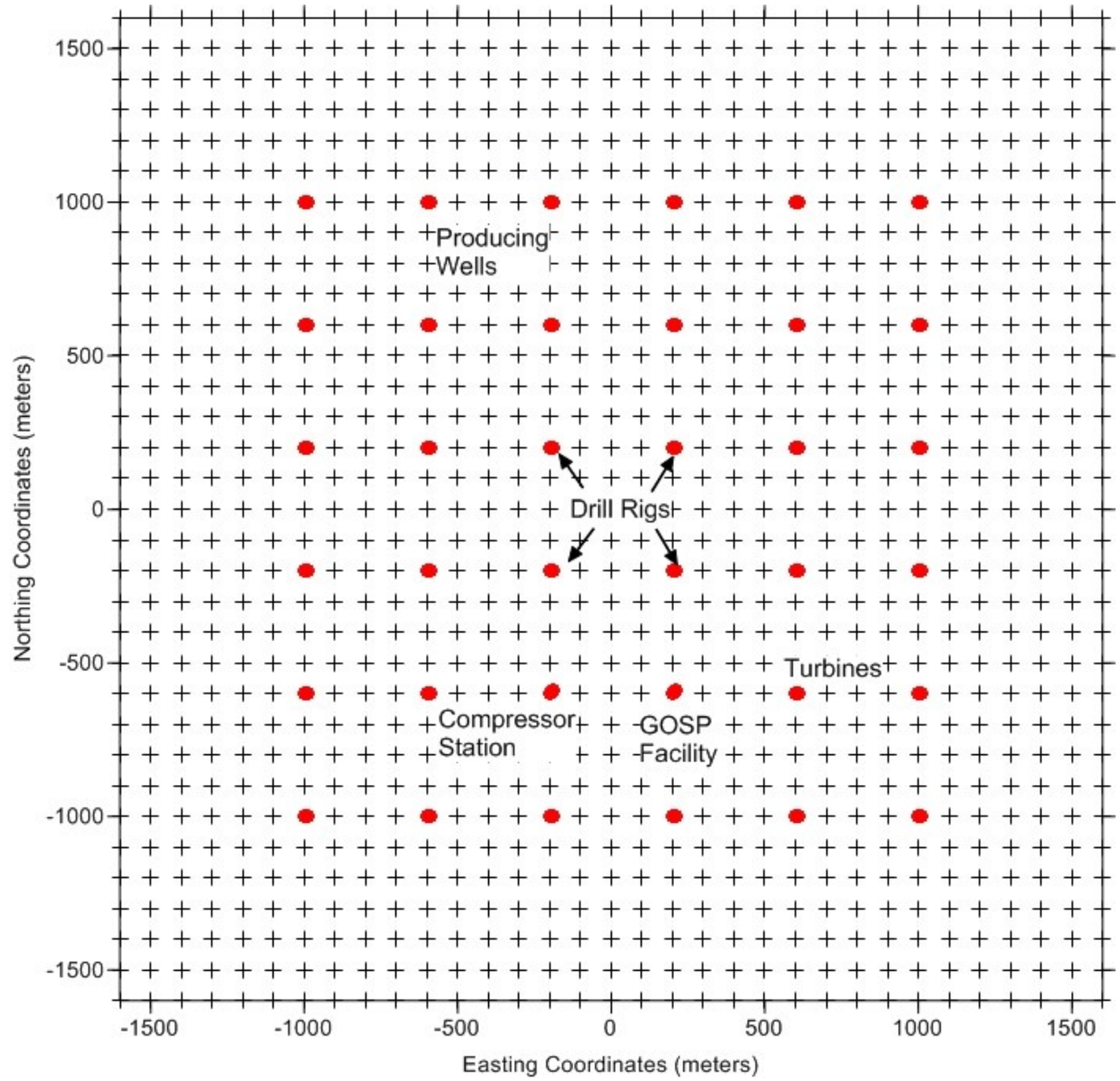
Newfield Exploration Company
Monument Butte

Alternative A
40-acre Surface Spacing Gas Well
Modeling Scenario

FIGURE
5-4



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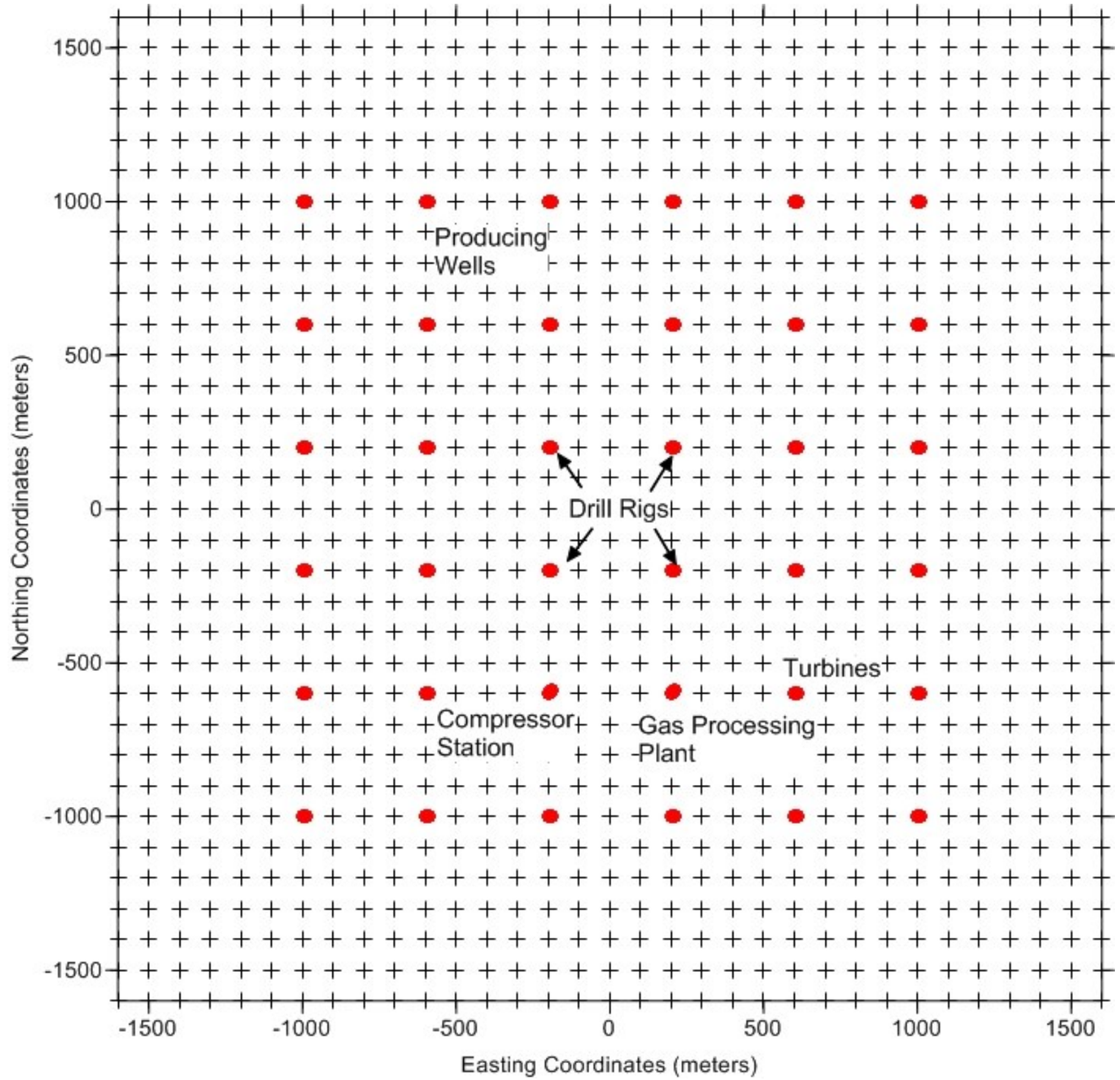
Newfield Exploration Company
Monument Butte

Alternative C
20-acre Downhole Spacing (40-acre Surface Spacing)
Oil Well Modeling Scenario Configuration

FIGURE
5-5



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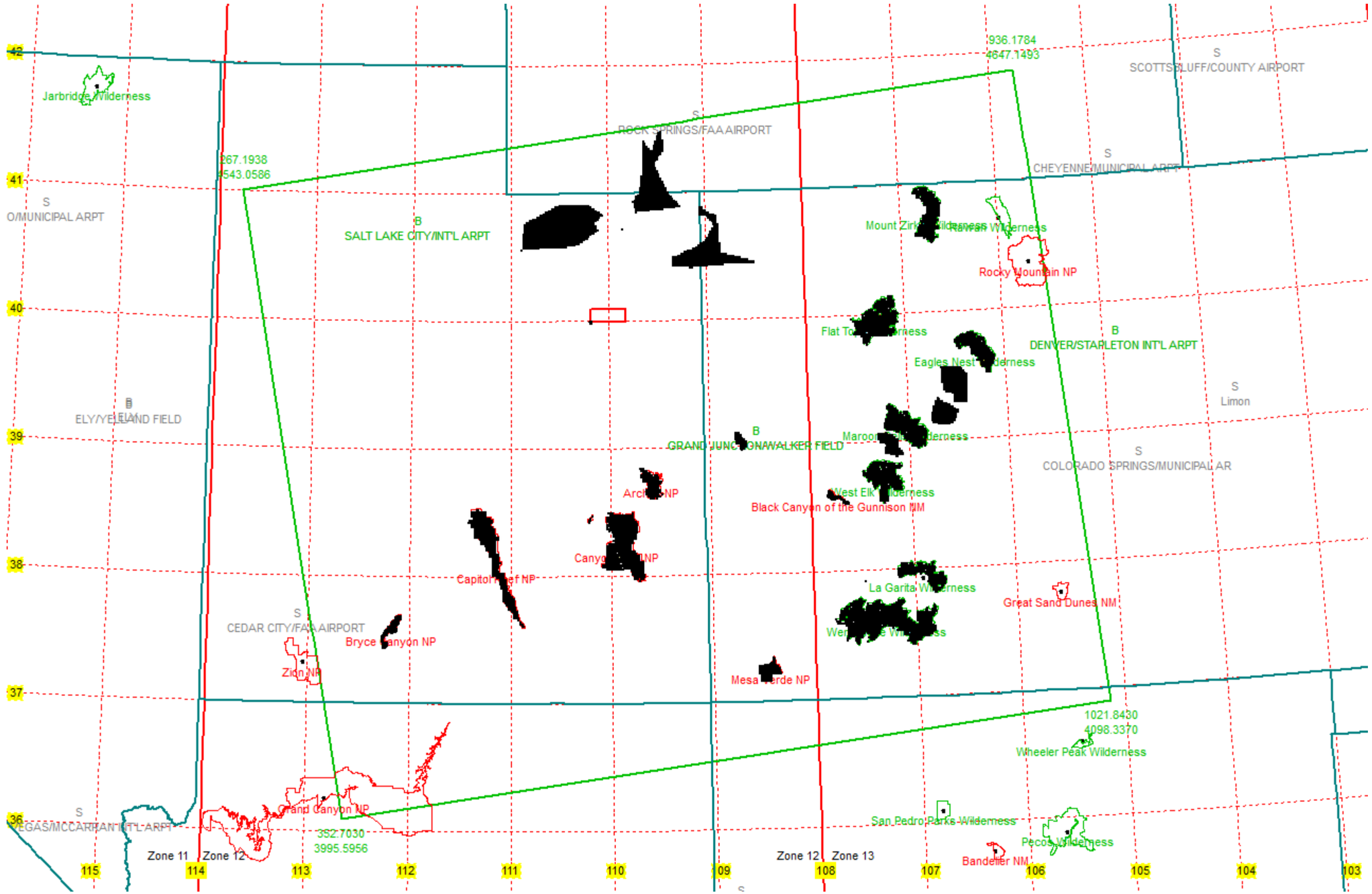
Newfield Exploration Company
Monument Butte

Alternative C
40-acre Surface Spacing Gas Well
Modeling Scenario

FIGURE
5-6



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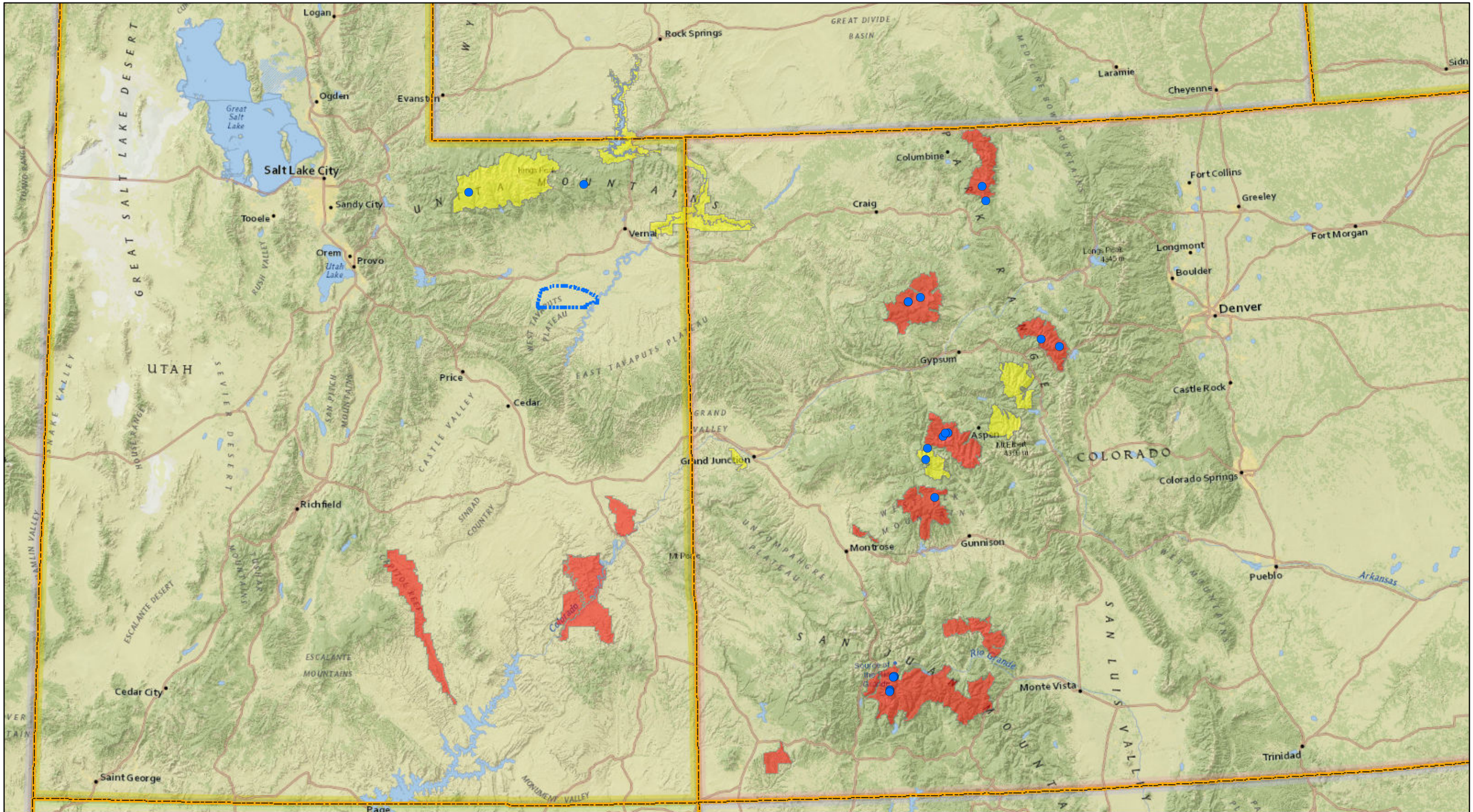
Newfield Exploration Company
Monument Butte

CALPUFF Modeling Domain
Colorado and Utah

FIGURE
5-7



Legend

- Sensitive Lakes
- Class I Areas
- GMBU Project Boundary
- State Boundary
- Class II Areas

0 12.5 25 50 Miles

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Newfield Exploration Company
Monument Butte

Location of Class I and Class II
Sensitive Lakes
Colorado and Utah

FIGURE
5-8

6 SUBSTANTIAL INCREASE IN EMISSIONS EVALUATION

6.1 Emission Increases

To determine if the Proposed Action and Alternatives could result in a substantial increase in ozone precursor emissions, the projected annual development emissions in Table 4-2 were compared to the No Action Alternative emissions shown in Table 4-3. The results are summarized in Table 6-1 and shown graphically in Figures 6-1 through 6-3 which are located at the end of this Section. Figure 6-1 shows this comparison for the projected NO_x emissions, Figure 6-2 shows the projected VOC emissions, and Figure 6-3 shows the sum of NO_x plus VOC emissions.

Table 6-1
Comparison of Annual Proposed Action Development Emission Increases Compared to No Action Development Emission Increases
(tons per year)

Year	Annual Development Proposed Action Projected Annual NO_x Increases	NO_x Emission Increases under No Action Alternative (from Table 4-3) [a]	Annual Development Proposed Action Projected Annual VOC Increases	VOC Emission Increases under No Action Alternative (from Table 4-3) [a]	Annual Development Proposed Action Projected Annual NO_x + VOC Increases	NO_x + VOC Emission Increases under No Action Alternative (from Table 4-3) [a]
2012	-53	1,817 [b]	25	2,117 [b]	-28	3,934 [b]
2013	-172		-603		-775	
2014	-311		-684		-995	
2015	-387		-545		-932	
2016	-320		-99		-415	
2017	-149		580		431	
2018	-16		1,383		1,367	
2019	194		2,213		2,407	
2020	378		3,086		3,464	
2021	561		3,959		4,520	
2022	745		4,833		5,578	

[a] The No Action Alternative analysis date was chosen as December 31, 2012. The annual development projections provided by Newfield used an analysis date of December 31, 2011. However, as the table shows, there is essentially no difference in emissions for calendar year 2012 (less than 0.5 percent of the total NOx plus VOC).
[b] The No Action Alternative emissions increase will occur during the first two to three years and then remain constant (because no more wells could be developed under the No Action Alternative). It is not known what the rate of emission increases could be under the No Action Alternative, thus the emission increases have been presented as a single value in the Table.

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By December 31, 2022, Newfield could develop up to a net of 1,594 additional oil and gas wells in the MBPA. Table 6-2 shows the emissions and activities for the Proposed Action development by calendar 2022 compared to the No Action Alternative. Development of the Proposed Action can continue into approximately early calendar year 2021 for total ozone precursor (NOx plus VOC) emissions, late 2019 for VOC emissions alone, and beyond 2022 for NOx emissions alone without causing an increase greater than the No Action Alternative. Under the Proposed Action, emissions of NOx will decrease until about calendar year 2019 and then increase but will remain less than the No Action Alternative until at least 2022. VOC emissions will also decrease under the Proposed Action through about 2016, but by about 2019 will exceed emissions that would occur under the No Action Alternative. The reason development of this magnitude could occur without a substantial increase in total ozone precursor emissions is because Newfield will implement a number of emission reducing measures in the MBPA that reduce emissions from existing and future oil and gas wells. These measures include the Applicant Committed Environmental Protection Measures (ACEPMs) and the following:

- By year 2022, it is expected that all of the old pumpjack engines in the MBPA will have been replaced with newer low emitting engines.
- At the end of 2022, it is projected that there will be 1,138 oil wells in the MBPA that will be sharing storage tanks and those tanks will have emission controls.
- A projected total of 150 additional oil wells will be routed to a Gas Oil Separator Plant (GOSP), where emissions from the storage tanks are controlled 100 percent.
- Tier 4 drill rig engines will be used in 2022.
- It is anticipated that gas associated with oil development can be processed by the existing infrastructure through 2022.

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Table 6-2
Annual Development and Production Emissions for Calendar Year 2022 Compared to the No Action Alternative

1	2	3	4	5	6	7	8
	Cumulative Net Change in NO_x from December 31, 2011 (tpy)	**Cumulative Net Change in VOC from December 31, 2011** (tpy)	**Cumulative Net Change in NO_x plus VOC from December 31, 2011** (tpy) (2+3)	**Cumulative Oil Wells Added**	**Cumulative Gas Wells Added**	**Cumulative Wells Shut In or Converted to Water Injection**	**Cumulative Net Change in Number of Oil and Gas Producing Wells from December 31, 2011** (5+6-7)
Annual Development and Production Emission Increases from December 31, 2011 through December 31, 2022 as Projected by Newfield for the MBPA (from Attachment C and Table 6-1)	745	4,833	5,578	2,496 [a]	48 [a]	950	1,594
Development and Production Emission Increases under the No Action Alternative (from Table 6-1 and discussion in Section 4.3) [b]	1,817	2,117	3,934	579	209	Not specified, but wells will be converted or shut in such that there results in a total of 788 oil and gas producing wells.	788 producing oil and gas well increase

[a] The Proposed Action includes development of up to 2,500 deep gas wells. However, through December 31, 2022, Newfield projects that only 48 of those wells will be developed. The Proposed Action also includes up to 1,800 wells served by GOSPs, but through December 31, 2022, Newfield projects only 150 wells going to a GOSP.
[b] The No Action analysis date is December 31, 2012, but as shown in Table 6-1, is essentially no difference in emissions as of December 31, 2011 compared to December 31, 2012.

The emissions from the Proposed Action are much less than would occur without implementation of the Applicant Committed Environmental Protection Measures (ACEPMs). The ACEPMs are applied annually and to the Ultimate Proposed Action. The benefit of the key measures in reducing NO_x and VOC emissions are shown in Table 6-3. The list focuses only on

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NO_x and VOC ACEPMs, although there are other ACEPMs that also reduce other pollutants as well as reduce other potential environmental impacts. Some of the ACEPMs may be required by USEPA regulations; however, the ACEPMs will be implemented even if no regulatory requirement exists.

Table 6-3
Benefit of ACEPMs for NO_x and VOC Emissions for the Ultimate Proposed Action
(tons per year)

Key NOx and VOC ACEPM	NOx without ACEPM	NOx with ACEPM	ACEPM NOx Benefit	Percent NOx Reduction	VOC without ACEPM	VOC with ACEPM	ACEPM VOC Benefit	Percent VOC Reduction
Pumpjack Engines	2,836	1,465	-1,371	48%	827	397	-430	52%
Tank Controls (GOSP, centralization, and/or flares)	0	1.7 (from flares)	+1.7	N/A	8,304	3,488	-4,816	58%
Tier 4 Drill Rig Engines	1,132	613	-519	46%	236	33	-203	86%
Dehydrator Still Vent Emission Control	0	20 (from flares)	+20	N/A	946	47	-899	95%
Convert Wells to Waterflood Injection	1,256	0	-1,256	100%	1,868	0	-1,868	100%
Total	**5,224**	**2,100**	**-3,124**	**60%**	**12,181**	**3,965**	**-8,216**	**67%**

The benefits of the ACEPMs were calculated as follows:

- Pumpjack Engines: The benefit is calculated based on 3,250 new engines (i.e., 100 percent of the 3,250 new oil wells at full development of the Proposed Action) compared to 31 percent new engines (1,007 new engines and 2,243 old engines). The 31 percent value is based on the estimated current (as of December 31, 2012) percentage of new engines in the field.
- Tank Emissions: Emissions from full build out with ACEPMs includes (12 gas and oil separation facilities (GOSPs) receiving produced fluids from 150 oil wells each (1800 total) and an additional 724 oil wells that share 2 oil storage tanks between two wells that are controlled with a vapor combustor with 95% control efficiency. The storage tank vapors at the GOSPs are used in the process or sold as product and are not considered to be emissions. If GOSPs are not feasible, then the 1,800 tanks that would have gone to a GOSP will be controlled by other means (VRU or smokeless combustors). The

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remaining storage tanks that do not go to a GOSP or are not served by a common battery with controls are assumed to be uncontrolled.

- Drill Rig Engines: The benefit is calculated based on drilling 156 gas wells and 204 oil wells (360 total wells per year) with Tier 4 drill rigs versus with Tier 2 drill rigs.
- Dehydrator Still Vent Emissions: The benefit is calculated based on controlling all well-site dehydrators with flares with 95% control efficiency versus not controlling the well-site dehydrators. The dehydrators include 2,500 well-site dehydrators at the gas wells. There are an additional 24 dehydrators at the compressor stations and 1 dehydrator at the gas processing plant, but it is assumed that these 25 dehydrators would have to be controlled under current regulations, thus the emission reduction from those controls are not considered an ACEPM benefit.
- Well Conversions: The benefit is calculated as if 950 oil wells had not been converted to water injection wells. The emissions include all production emissions including storage tank emissions, heaters, pumpjack engines, pneumatics, fugitives, tanker truck loading, and operation vehicle tailpipe. It was assumed that the 950 converted wells were low producers at 2 barrels/day average prior to conversion. For the 950 wells, prior to conversion it was assumed that there were two storage tanks per well and the tanks were not controlled.

6.2 Adaptive Management Strategy for Potential Ozone Impacts

Ozone concentrations in the Uinta Basin have been found to be exceeding National Ambient Air Quality Standards (NAAQS) during periodic winter inversion events. A comprehensive understanding of the chemical pathways, analytical methodologies, and demonstrable control technologies and methods has been lacking to allow for a scientifically based examination of this issue in recent NEPA documents relating to oil and gas production in the Uinta Basin. To address the uncertainty relating to this, BLM has been including adaptive management requirements in both recent and current NEPA documents relating to significant oil and gas development in the Basin. One of the components of these adaptive management prescriptions is the commitment to apply enhanced mitigation for ozone when an exceedance of the ozone NAAQS has been measured and recognized based on criteria in the Clean Air Act that defines how NAAQS determinations are made (40 CFR Part 50). Based on recent studies (citation pending, 2013), BLM believes this adaptive management requirement for enhanced mitigation has been triggered, and that tentative control determinations can be made at this time as an initial start in controlling and preventing winter ozone formation.

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Over the past 3 years significant research had been conducted in the Uinta Basin to further the understanding of winter ozone formation (Martin et. al. 2011). These studies to date are indicating that volatile organic compound (VOC) controls and seasonal response plans are the most promising avenues to address winter ozone formation. BLM, in consultation with the Utah Division of Air Quality (UDAQ) and the U.S Environmental Protection Agency (EPA), has developed a list of enhanced seasonal pollution control measures and work practices specifically aimed at reducing the emissions of VOCs which form winter ozone. These control measures and work practices will be required for all operations approved under this NEPA action, and will be retroactively applied to other recent oil and gas NEPA in the Uinta Basin that have adaptive management requirements.

It is recognized in this adaptive management prescription that additional research and analysis needs to be conducted in the Uinta Basin to more fully understand the mechanics of winter ozone formation, and that specific control and work practice recommendations may change over time. To address the continued scientific uncertainty on this issue, BLM will continue to include an adaptive management requirement in oil and gas NEPA for the Uinta Basin. Once a basin-wide control plan is developed and approved by UDAQ and/or EPA, BLM will review these enhanced mitigation requirements and may add, delete, or otherwise modify these requirement to conform to the requirements or recommendations of a regulatory basin-wide management plan. These adaptive management modifications will be applicable to this NEPA action and all other NEPA actions already approved or to be approved by BLM in the Uinta Basin.

In order to assess and mitigate (if necessary) the potential for adverse ozone formation in the Uinta Basin, an Adaptive Management Strategy will be implemented under all of the action alternatives (i.e., the Proposed Action, Alternative C, and Alternative D). The Adaptive Management Strategy includes the following major elements:

- Newfield will conduct an annual emissions inventory and compare the inventory to the emissions estimates contained in this EIS. The inventory will be conducted annually for the life of the project (LOP) until the EPA/UDEQ/BLM develop an approved basin-wide control plan covering oil and gas development in the Uinta Basin.

- Regional photochemical modeling will be conducted that includes emissions for the selected alternative within one year of the ROD for this project or one year of the BLM Air Resources Management Strategy (ARMS) modeling platform becoming available; whichever occurs first. If modeled impacts show that the National Ambient Air Quality

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Standards (NAAQS) or applicable thresholds for air quality related values may be exceeded, BLM will require additional mitigation measures within BLM's authority to prevent exceedances (for example requiring Newfield to implement an ozone mitigation contingency plan as described below).

The enhanced mitigation requirements to address winter ozone are as follows:

Enhanced Inspection and Maintenance Program

- FLIR/AVO inspections
    - Pneumatic devices / pumps
    - Tanks
    - Fugitives
- Frequency
    - Production sites with tank controls / compressor stations / gas plants
        - Annual FLIR inspection, with at least one inspection during Jan-Mar at highest priority sites based upon PTE (potential to emit) limits considered significant to ozone formation (determined by operator)
        - AVO inspection by operators during any site visits Jan-Mar.
    - Production sites with no tank controls
        - Annual AVO inspections
        - AVO inspection by operators during any site visits Jan-Mar.
- Perform regular maintenance on pneumatic devices, dehydrators, combustors, engines and compressors
- Properly operate and maintain existing installed control equipment

Ozone Training for Operations Personnel – Operations personnel receive training prior to ozone season. Training programs should cover the following:

- Ozone – what it is and how to it impact air quality
- Ozone formation ingredients – NOx, VOCs, and weather conditions
- Ozone attainment status in the Uinta Basin
- Review of applicable regulations
- What can be done to prevent and/or reduce emissions of ozone precursor gases – limit driving, maintain equipment, delay optional activities until after inversion, etc. Emphasize importance of proper maintenance of tank hatches, vapor combustors, and other equipment that reduces emissions.

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Work Practices

- Dehydrators
  - Perform charging of desiccant dehydration units prior to the winter ozone season
  - Reduce glycol dehydration circulation rates throughout entire winter ozone season
- Venting Blow Downs
  - Minimize blow down actions associated with energy recovery and production during the entire winter ozone season
- Venting – compressor startup and shutdown
  - Reduce the number of failed startups by performing regular maintenance of compressor throughout the entire winter ozone season
  - Reduce the number of compressor startups and shutdowns by having operating and maintenance schedules, and performing regular maintenance of compressors only during planned compressor shutdowns as possible throughout the entire winter ozone season
- Episodic Controls
  - Delay optional activities associated with energy recovery and production during periods of UDAQ ozone alert days.
  - Take extra care to ensure proper maintenance and operation of equipment associated with energy recovery and production that may contribute to ozone formation during UDAQ ozone alert days.

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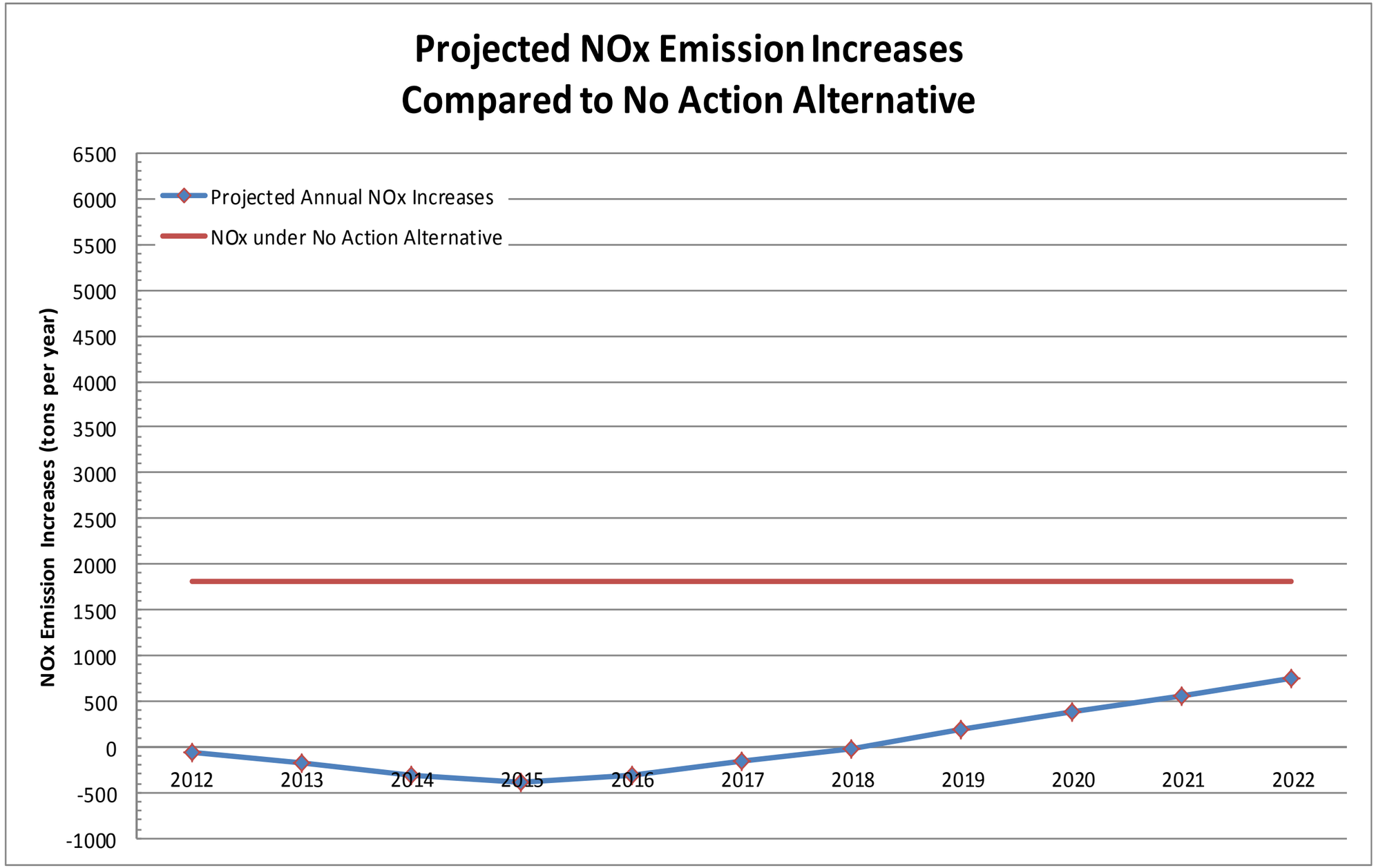

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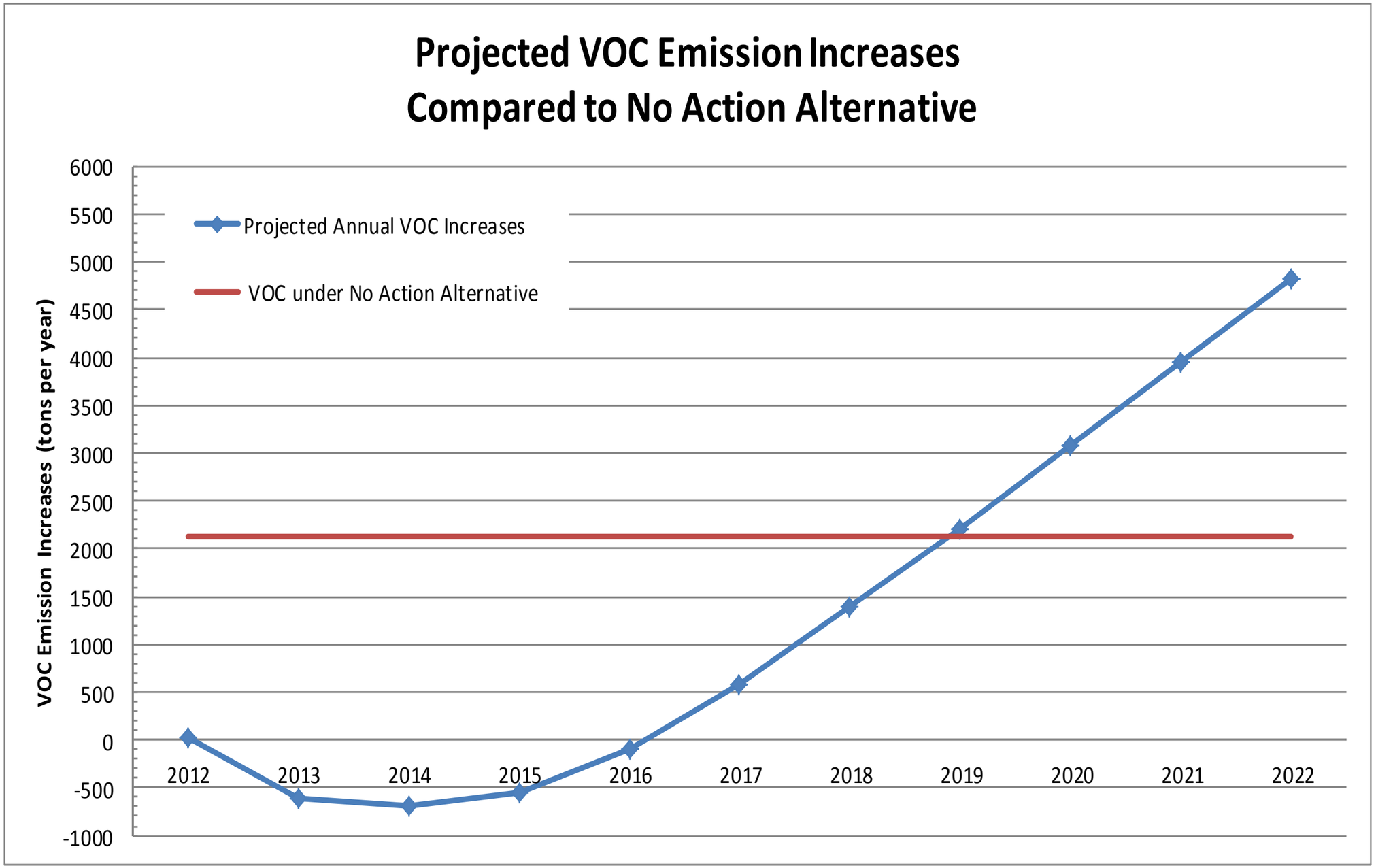
Monument Butte

Projected NOx Emission Increases Compared to No Action Alternative

FIGURE
6-1



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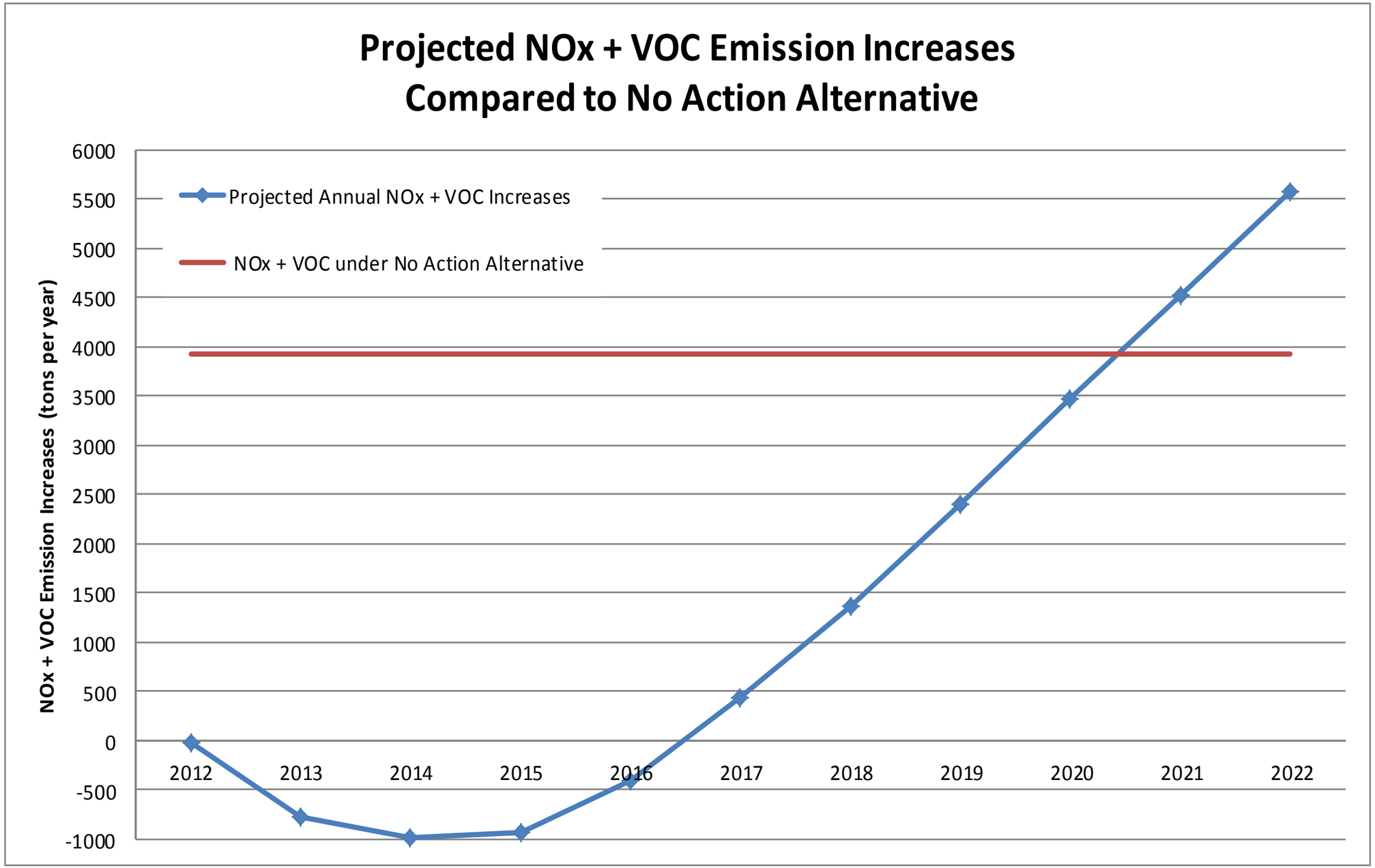
Monument Butte

Projected VOC
Emission Increases Compared to No Action Alternative

FIGURE
6-2



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FILE NAME:	GMBU_Fig 6-3.pdf

Newfield Exploration Company
Monument Butte

Projected NOx + VOC
Emission Increases Compared to No Action Alternative

FIGURE
6-3

7 NEAR FIELD IMPACT EVALUATION

7.1 Construction and Development Emission Impact Results

The construction and development impact modeling scenario includes construction of well pads, drilling of wells, and developing wells on well pad sites located in close proximity to operating wells. Therefore, even though the scenario is called "construction and development", there are operating wells included in the modeling assessment. The construction and development model input and output files (electronic versions) are included in Appendix F. Table 7-1 shows the maximum impact for PM_{10} and $PM_{2.5}$. For PM_{10}, the 24-hour impact value is the high, second high modeled impact across all receptors and from all five years of meteorological data. The $PM_{2.5}$ annual impact value is the highest annual concentration across all receptors for any of the five years of meteorological data modeled. The $PM_{2.5}$ 24-hour impact value is the average of the eighth-high values from each of the modeled meteorological years. As discussed in Section 5, only one modeling scenario, the Proposed Action (Alternative A) was modeled for construction and development as the other Alternatives will have the same near field impact.

Table 7-1
Maximum Potential Construction and Development Impacts

Pollutant	Averaging Period	Ambient Air Concentration (μg/m^3)					
		Year of Maximum Impact	Location of Maximum Impact	Modeled Impact	Background	Total	NAAQS
PM_{10}	24-hour	2007	100 m west of pad construction	72.5	18.7	91.2	150
$PM_{2.5}$	24-hour	NA	200 m SE of pad construction	14.3	17.8	32.1	35
	Annual	2005	100 m east of producing wells	1.4	8.0	9.4	12

7.2 Operations Impact Results

The operations impact modeling scenario includes operations of oil and gas wells and infrastructure sources (e.g., compressor stations, gas processing plants, etc.) located in close proximity. The maximum impact of criteria pollutants for the Operations modeling scenarios occurred under the Alternative A modeling scenarios. All of the results in Table 7-2 are from the oil well modeling scenario as that scenario had greater impacts than the gas well modeling

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scenario except for 1-hour CO which is from the gas well modeling scenario. The maximum impacts and location of those impacts are shown in Table 7-2. To determine whether impacts could be greater for Alternative C than for Alternative A due to the turbine generator emissions at the proposed substations, Alternative C was also modeled for the Operations scenario. The maximum impacts occurred when there were no turbine generators, or Alternative A. The impact of the turbine generators of Alternative C is less than the impact of other compressor engines and well operations of Alternative A. The modeling runs demonstrating this are included in Appendix F and the results shown in Table 7-3. All of the results shown in Table 7-3 are from the oil well scenario.

For CO, the 1-hour and 8-hour impact value is the high second high modeled impact across all receptors and from all five years of meteorological data. The NO_2 annual impact value is the highest annual concentration across all receptors for any of the five years of meteorological data modeled. The NO_2 1-hour impact value is the average of the eighth-high values from each of the modeled meteorological years. The 1-hour SO_2 impact value is the average of the fourth-high values from each of the modeled meteorological years. The 3-hour SO_2 value is the high second high modeled impact across all receptors and from all five years of meteorological data.

Table 7-2
Maximum Potential Operations Impacts – Alternative A

Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)					
		Year of Maximum Impact	Location of Maximum Impact	Modeled Impact	Background	Total	NAAQS
CO	1-hour	2007	140 m NE of compressor station	276	2,641	2,917	40,000
	8-hour	2009	100 m east of GOSP	137	1,657	1,794	10,000
NO_2	24-hour	NA	100 m east of producing wells	106.9 [a]	57.7	164.6	188
	Annual	2005	100 m east of producing wells	16.5	7.3	23.8	100
SO_2	1-hour	NA	100 m east of GOSP	0.7	20.1	20.8	196
	3-hour	2006	100 m south of GOSP	0.6	14.3	14.9	1,300

[a] Assumes NO to NO_2 conversion of 80%

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Table 7-3
Maximum Potential Operations Impacts – Alternative C

Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)					
		Year of Maximum Impact	Location of Maximum Impact	Modeled Impact	Background	Total	NAAQS
CO	1-hour	2007	100 m south of GOSP	139	2,641	2,780	40,000
	8-hour	2009	100 m east of GOSP	80	1,657	1,737	10,000
NO_2	1-hour	NA	100 m south of GOSP	89.5 [a]	57.7	147.2	188
	Annual	2008	100 m south of GOSP	6.8	7.3	14.1	100
SO_2	1-hour	NA	100 m south of GOSP	0.6	20.1	20.7	196
	3-hour	2006	100 m south of GOSP	0.5	14.3	14.8	1,300

[a] Assumes NO to NO_2 conversion of 80%

7.3 Operations Hazardous Air Pollutant Impacts

The maximum impact of HAPs for the Operations modeling scenarios occurred under the Alternative A modeling scenario. Modeled results were compared to the Utah toxic screening levels, and the acute, chronic, and carcinogenic thresholds listed in Section 3.0 for each HAP of interest. Short-term impacts from HAP exposure were assessed by comparing one-hour average impacts to the HAP-specific acute REL (reference exposure level) and annual average impacts to the HAP-specific RfC (reference concentration for continuous inhalation exposure). If impacts are less than the REL and RfC, no short or long long-term non-carcinogenic adverse health effects are expected.

To assess potential carcinogenic impacts, the modeled annual average concentration is multiplied by a HAP specific unit risk factor to estimate the probability of contracting cancer if a person was exposed continuously to the modeled concentration. The unit risk factor is an upper-bound estimate of the probability of one additional person contracting cancer based on continuous exposure to 1-ug/m^3 of the substance over a 70-year lifetime. The risk from long-term exposure to carcinogenic HAP emissions is assessed by comparison to the generally acceptable risk range of one additional cancer per one million exposed persons (1 x 10^{-6}) to one additional cancer per ten thousand exposed persons (1 x 10^{-4}) or 100 in a million (USEPA 1993).

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Since the URFs are based on 70-year exposure, adjustment factors are needed to adjust for maximum exposure durations associated with the project being evaluated. Cancer risk was estimated for two exposure scenarios: the most likely exposure (MLE) that individuals will experience, and the maximally exposed individual (MEI) as described in Section 3.4.

Table 7-4 presents the modeled non-carcinogenic impact results compared to the State of Utah TSLs for averaging periods of 1-hour (short-term). None of the HAPs exceed Utah TSLs. Table 7-5 presents the results compared to RELs and RfCs and none of the impacts exceed the RELs or RfCs.

Table 7-4
Maximum Utah Toxic Screening Level (TSL) Impacts

Pollutant and Averaging Time	Modeled Maximum Impact ($\mu g/m^3$)	Maximum Impact Year	Toxic Screening Levels [b] ($\mu g/m^3$)
Acrolein (1-hour)	1.50	2006	23
Benzene [a] (24-hour)	5.55	2005	18
Formaldehyde (1-hour)	12.32	2007	37

[a] The TSL for benzene is a 24-hour average, but the 1-hour concentration is conservatively compared to the TSL.

Table 7-5
Maximum Non-Carcinogenic REL and RfC Impacts

HAP	Modeled Maximum 1-Hour Impact ($\mu g/m^3$)	Maximum Impact Year	REL ($\mu g/m^3$)	Modeled Maximum Annual Impact ($\mu g/m^3$)	Maximum Impact Year	RfC ($\mu g/m^3$)
Acrolein	1.50	2006	2.50	0.18	2006	0.35
Benzene	5.55	2005	1,300	0.30	2005	30
Formaldehyde	12.32	2007	55	1.27	2006	9.8

Table 7-6 presents the unit risk factor, exposure adjustment factor, and the estimated cancer risk for the MLE and MEI exposure scenarios for the Proposed Action. A range of unit risk factors is available for benzene, and that range is shown in the table. All estimated risks are within the acceptable range of 1 to 100 in a million.

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Table 7-6
Maximum Potential Carcinogenic HAP Risk

Exposure Scenario	HAP	Unit Risk Factor ($1/\mu g/m^3$)	Exposure Adjustment Factor	Modeled Annual Impact ($\mu g/m^3$)	Cancer Risk
MLE	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.095	0.30	6.2×10^{-08} to 2.2×10^{-07}
	Formaldehyde	1.3×10^{-05}	0.095	1.27	1.6×10^{-06}
	TOTAL MLE RISK				**1.8×10^{-06}**
MEI	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.571	0.30	3.8×10^{-07} to 1.3×10^{-06}
	Formaldehyde	1.3×10^{-05}	0.571	1.27	9.4×10^{-06}
	TOTAL MEI RISK				**1.1×10^{-05}**

There is uncertainty associated with adding cancer risk values from different chemicals together, although it is commonly done for carcinogens having similar modes of action or target organs. Both formaldehyde and benzene have been linked to possibly causing leukemia under prolonged and extremely high concentrations (CDC 2013 and NCI 2013). Therefore the cancer risk from benzene and formaldehyde were added together.

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8 FAR FIELD IMPACT EVALUATION

The far field analysis is focused on evaluating air quality related values (AQRVs) at distant Class I areas, sensitive Class II areas, and sensitive lakes as discussed in Section 5. The AQRVs examined were PSD increments, regional haze, change in acid neutralization capacity (ANC), and acid deposition (sulfur and nitrogen). The CALPUFF modeling system was used to evaluate far field impacts. The model input and output files are included in Appendix F. As discussed in Section 5, only Alternative A was modeled to assess far field impacts as all the other Alternatives will have lower impacts than the modeled Alternative.

8.1 PSD Increments

Although impacts of the Proposed Action are compared to PSD increments, all comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during the permitting process, and are the responsibility of the State of Utah with USEPA oversight. The Proposed Action is not subject to the PSD program.

Table 8-1 shows the modeled impacts at the nearest Class I areas and sensitive Class II areas compared to the Class I and II increments. All of the impacts are less than the Class I increments.

8.2 Regional Haze

To assess potential regional haze impacts, the modeled change in light extinction (b_{ext}) was compared to the 5 percent (0.5 deciviews or 0.5 dV) and 10 percent (1.0 dV) change in light extinction thresholds. The number of days exceeding the thresholds were calculated as well as the eighth-high (98th percentile) change in b_{ext}. The results for the nearest Class I and II areas are shown in Table 8-2.

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Table 8-1
Maximum Impacts at Class I and Sensitive Class II Areas Compared to PSD Increments

Class I and Sensitive Class II Areas	NO_2 Annual (ug/m^3)	PM_{10} Annual (ug/m^3)	PM_{10} 24-hr (ug/m^3)	$PM_{2.5}$ Annual (ug/m^3)	$PM_{2.5}$ 24-hr (ug/m^3)	SO_2 3-hr (ug/m^3)	SO_2 24-hr (ug/m^3)	SO_2 Annual (ug/m^3)
PSD Class I Increments	**2.5**	**4**	**8**	**2**	**1**	**25**	**5**	**2**
National Park Service (NPS) Class I Areas								
Arches National Park	0.0016	0.022	0.513	0.0047	0.110	0.005	0.0008	0.00003
NPS Class II Areas								
Dinosaur National Monument	0.0491	0.2334	4.55	0.0496	0.966	0.1053	0.0135	0.0005
U.S. Forest Service Class II Areas								
Flaming Gorge National Recreation Area	0.0029	0.067	0.549	0.0142	0.117	0.011	0.0014	0.00011
High Uintas Wilderness Area	0.0058	0.0913	0.779	0.0194	0.1655	0.021	0.0028	0.00016
U.S. Fish and Wildlife Service Class II Areas								
Browns Park National Wildlife Refuge	0.0046	0.0614	0.583	0.0130	0.1236	0.0130	0.0017	0.00011
PSD Class II Increments	**25**	**17**	**30**	**9**	**4**	**512**	**91**	**20**

Table 8-2
Regional Haze Impacts at Class I and Sensitive Class II Areas

Class I and Sensitive Class II Areas	Number of Days > 0.5 dV Change	Number of Days >1.0 dV Change	Max Change in b_{ext} (dV)	Eighth-High Change in b_{ext} (dV)
National Park Service (NPS) Class I Areas				
Arches National Park	17	1	2.01	0.75
NPS Class II Areas				
Dinosaur National Monument	131	89	8.12	3.20
U.S. Forest Service Class II Areas				
Flaming Gorge National Recreation Area	64	27	2.22	1.60
High Uintas Wilderness Area	85	52	3.32	2.22
U.S. Fish and Wildlife Service Class II Areas				
Browns Park National Wildlife Refuge	63	16	1.73	1.11

All the nearest areas analyzed have multiple days with a change in b_{ext} greater than 0.5 dV, and a single day with a maximum change greater than 1.0 dV at Arches National Park (although the

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98th percentile or 8th-high change is less than 1.0 dV). The Federal Land Managers have not promulgated thresholds of concern for sensitive Class II areas.

8.3 Acid Deposition Impacts

To assess potential acid deposition impacts at Class I and sensitive Class II areas, sulfur and nitrogen deposition was compared to the 3 kilogram per hectare per year (kg/ha-yr) threshold for nitrogen and 5 kg/ha-yr for sulfur deposition and to the Deposition Analysis Threshold (DAT) of 0.005 kg/ha-yr for both nitrogen and sulfur species promulgated by the Federal Land Managers (FLAG 2010) for western areas. The DATs do not represent an adverse impact threshold, but rather an estimate of the naturally occurring deposition that occurred prior to any anthropogenic influences. The DATs are levels below which estimated impacts from a proposed new or modified source are considered negligible. In cases where a source's impact equals or exceeds the DAT, the NPS/FWS will make a project specific assessment of whether the projected increase in deposition would likely result in an "adverse impact" on resources considering existing AQRV conditions, the magnitude of the expected increase, and other factors. The results are shown in Table 8-3. All of the deposition rates are much less than the 3 and 5 kg/ha-year thresholds. The DAT was exceeded at the closest Class I and Class II areas for nitrogen deposition, but not sulfur deposition.

Table 8-3
Acid Deposition Impacts at Class I and Sensitive Class II Areas

Class I and Sensitive Class II Areas	Nitrogen Deposition (kg/ha-yr)	Sulfur Deposition (kg/ha-yr)
National Park Service (NPS) Class I Areas		
Arches National Park	0.0028	0.00002
NPS Class II Areas		
Dinosaur National Monument	0.0279	0.00020
U.S. Forest Service Class II Areas		
Flaming Gorge National Recreation Area	0.0147	0.00008
High Uintas Wilderness Area	0.0150	0.00007
U.S. Fish and Wildlife Service Class II Areas		
Browns Park National Wildlife Refuge	0.0092	0.00006

8.4 Sensitive Lake Impacts

To assess potential impact on sensitive lakes, the change in ANC was calculated from the CALPUFF output for sulfur and nitrogen deposition to estimate potential hydrogen ion

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deposition). The results are shown in Table 8-4. For lakes with background ANC greater than 25 micro equivalents per liter (μeq/l), all of the ANC changes are less than the 10 percent threshold of concern. For lakes with background ANC less than 25 μeq/l, the changes (H_{dep} in terms of ueq/l) are all much less than the 1 μeq/l change threshold.

Table 8-4
Acid Deposition Impacts at Sensitive Lakes

	Back-ground ANC (μeq/l)	Water-shed Area (ha)	Annual Ave Precip (m)	ANC(o) (eq)	H_{dep} eq	Percent ANC Change Hdep/ANC(o) (%)	H_{dep} (μeq/l)
Eagles Nest Wilderness							
Booth Lake	86.4	54.0	0.29	9190.2	9.98	0.11	0.06
Upper Willow Lake	133.2	124.0	0.29	32549.4	20.46	0.06	0.06
Flat Tops Wilderness							
Ned Wilson Lake	39.4	49.2	0.26	3312.0	1.51	0.05	0.01
Trappers Lake [a]	659.4	--	0.26	--	--	--	
Upper Ned Wilson Lake	12.9	3.1	0.26	68.7	0.92	1.35	0.11
Maroon Bells-Snowmass Wilderness							
Avalanche Lake	171.0	358.0	0.24	96575.6	55.93	0.06	0.07
Capitol Lake	186.6	139.0	0.24	40918.0	22.16	0.05	0.07
Moon Lake (Upper)	54.3	117.0	0.24	10018.8	18.52	0.18	0.07
Mount Zirkel Wilderness							
Lake Elbert	53.8	101.0	0.42	15476.4	22.21	0.14	0.05
Summit Lake	48.0	7.8	0.42	1061.9	1.65	0.16	0.05
Weminuche Wilderness							
Big Eldorado Lake	20.4	115.0	0.47	7430.2	5.78	0.08	0.01
Little Eldorado Lake	-3.3	48.7	0.47	-509.3	2.46	-0.48	0.01
Lower Sunlight Lake	85.0	96.6	0.47	26030.9	4.38	0.02	0.01
Upper Grizzly Lake	29.9	30.0	0.47	2840.5	1.96	0.07	0.01
Upper Sunlight Lake	28.0	76.9	0.47	6823.0	3.45	0.05	0.01
White Dome Lake	2.1	38.8	0.47	253.3	1.95	0.77	0.01
West Elk Wilderness							
South Golden Lake	112.6	73.0	0.29	15946.8	7.40	0.05	0.03
High Uintas Wilderness							
Dean Lake	51.4	117.0	0.41	16569.3	72.49	0.44	0.15
Fish Lake [a]	104.5	--	0.41	--	--	--	
Raggeds Wilderness							
Deep Creek Lake	40.0	525.0	0.28	39811.9	70.54	0.18	0.05
Island Lake [b]	--	--	0.28	--	--	--	--

[a] For Trappers and Fish Lakes, ANC calculations could not be made because the watershed area was not available from the USFS.
[b] For Island Lake, ANC calculations could not be made because there was no data in the USFS database.

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APPENDIX A

ALTERNATIVE A -- PROPOSED ACTION ULTIMATE DEVELOPMENT EMISSIONS

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APPENDIX A-1

PROPOSED ACTION OIL WELL EMISSIONS

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Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative A - Oil Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	6.9	2.6	0.6	0.0002	5.8	1.4
	Drilling	83.9	83.9	4.7	0.2	147.4	16.0
	Completion	38.1	18.9	6.8	0.023	265.9	28.1
	Interim Reclamation	0.6	0.7	0.05	0.0006	3.2	0.3
	Wind Erosion	---	---	---	---	1.1	0.2
Wellsite Production Emissions	Pump Unit Engines	1,465.0	1,999.9	396.6	1.9	159.7	159.7
	Production Heaters	327.0	274.6	18.0	2.0	24.8	24.8
	Wellsite Tanks	---	---	1,714.2	---	---	---
	Pneumatics	---	---	397.9	---	---	---
	Fugitives	---	---	1,198.0	---	---	---
	Wellsite Truck Loading	---	---	203.7	---	---	---
	Wellsite Flares	1.7	9.4	---	---	---	---
	Operations Vehicle	15.9	6.8	0.6	0.010	385.8	39.6
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	281.5	---	---	---
	Water Treatment Fugitives	---	---	12.0	---	---	---
	Water Treatment Generator	244.2	488.3	170.9	0.6	19.3	19.3
Gas and Oil Separation Plants	GOSP Heaters	170.0	142.8	9.4	1.0	12.9	12.9
	GOSP Fugitives	---	---	139.3	---	---	---
	GOSP Generators	225.4	450.7	157.8	0.5	17.9	17.9
	GOSP Flare	10.7	58.3	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	15.3	2.9	46.8	0.01	326.5	33.6
Compressor Station Emissions	Compressor Station Engines	309.0	618.0	216.3	0.7	11.2	11.2
	Compressor Station Tanks	---	---	5.2	---	---	---
	Compressor Station Dehydrator	---	---	46.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.3	0.1	11.1	0.0	5.2	0.5
	Compressor Station Dehydrator Heater	2.6	2.2	0.1	0.0	0.2	0.2
	Compressor Station Flare	3.6	19.4	---	---	---	---
	Compressor Station Fugitives	---	---	12.1	---	---	---
	Total Emissions	**2,920.2**	**4,179.6**	**5,050.3**	**6.9**	**1,386.7**	**365.8**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	6.9	83.9	38.1	0.6	---	129.6
CO	2.6	83.9	18.9	0.7	---	106.0
VOC	0.6	4.7	6.8	0.05	---	12.1
SO_2	0.0002	0.2	0.02	0.0006	---	0.2
PM_{10}	5.8	147.4	265.9	3.2	1.1	423.3
$PM_{2.5}$	1.4	16.0	28.1	0.3	0.2	46.0
Hazardous Air Pollutants						
Benzene	---	0.07	0.012	---	---	0.084
Toluene	---	0.03	0.005	---	---	0.031
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.02	0.0018	---	---	0.020
n-Hexane	---	---	0.095	---	---	0.095
Formaldehyde	---	0.007	0.0006	---	---	0.0080
Acetaldehyde	---	0.002	0.00020	---	---	0.0026
Acrolein	---	0.0007	0.00006	---	---	0.00080
Naphthalene	---	0.012	0.0010	---	---	0.013
POM 2	---	0.007	0.0006	---	---	0.0078
POM 5	---	0.00006	0.000005	---	---	0.000061
POM 6	---	0.0002	0.000019	---	---	0.00024
POM 7	---	0.0001	0.000012	---	---	0.00016
Greenhouses Gases						
CO_2	171.7	15,975	2,565	63	---	18,776
CH_4	0.001	0.64	18.17	0.002	---	18.81
N_2O	0.0003	0.13	0.02	0.0007	---	0.15
CO_2e	171.8	16,029	2,954	64	---	19,218

a Assumes maximum development scenario of 204 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Pump Engines	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	1465.0	327.0	---	---	---	---	1.7	15.9	1,809.7
CO	1999.9	274.6	---	---	---	---	9.4	6.8	2,290.7
VOC	396.6	18.0	1714.2	1198.0	203.7	397.9	---	0.6	3,929.0
SO_2	1.9	2.0	---	---	---	---	---	0.010	3.9
PM_{10}	159.7	24.8	---	---	---	---	---	385.8	570.3
$PM_{2.5}$	159.7	24.8	---	---	---	---	---	39.6	224.1
Hazardous Air Pollutants									
Benzene	6.41	0.0069	5.45	3.31	0.65	0.42	---	---	16.25
Toluene	3.18	0.011	5.03	2.97	0.60	0.22	---	---	12.01
Ethylbenzene	0.36	---	0.28	0.16	0.03	---	---	---	0.83
Xylene	0.89	---	1.61	0.92	0.19	0.022	---	---	3.63
n-Hexane	1.47	5.89	85.79	52.55	10.19	7.35	---	---	163.24
Formaldehyde	182.44	0.25	---	---	---	---	---	---	182.68
Acetaldehyde	25.65	---	---	---	---	---	---	---	25.65
Acrolein	25.71	---	---	---	---	---	---	---	25.71
Methanol	8.20	---	---	---	---	---	---	---	8.20
1,1,2,2-Tetrachloroethane	0.22	---	---	---	---	---	---	---	0.22
1,1,2-Trichloroethane	0.17	---	---	---	---	---	---	---	0.17
1,3-Dichloropropene	0.14	---	---	---	---	---	---	---	0.14
1,3-Butadiene	2.71	---	---	---	---	---	---	---	2.71
2,2,4-Trimethylpentane	2.80	---	---	---	---	---	---	---	2.80
Biphenyl	0.013	---	---	---	---	---	---	---	0.013
Carbon Tetrachloride	0.20	---	---	---	---	---	---	---	0.20
Chlorobenzene	0.15	---	---	---	---	---	---	---	0.15
Chloroform	0.16	---	---	---	---	---	---	---	0.16
Dichlorobenzene	---	0.0039	---	---	---	---	---	---	0.0039
Ethylene Dibromide	0.24	---	---	---	---	---	---	---	0.24
Methylene Chloride	0.49	---	---	---	---	---	---	---	0.49
Naphthalene	0.32	0.0020	---	---	---	---	---	---	0.32
Phenol	0.14	---	---	---	---	---	---	---	0.14
Styrene	0.18	---	---	---	---	---	---	---	0.18
Vinyl Chloride	0.082	---	---	---	---	---	---	---	0.082
PAH -POM 1	0.44	---	---	---	---	---	---	---	0.44
POM 2	0.11	0.00019	---	---	---	---	---	---	0.11
POM 3	---	0.000052	---	---	---	---	---	---	0.000052
POM 4	---	0.0000059	---	---	---	---	---	---	0.0000059
POM 5	0.000019	0.0000078	---	---	---	---	---	---	0.000027
POM 6	0.0012	0.000024	---	---	---	---	---	---	0.0012
POM 7	0.0022	0.0000059	---	---	---	---	---	---	0.0022
Greenhouse Gases									
CO_2	386,316	389,813	22.8	16.9	1.58	12.29	3,257	1,391	780,830
CH_4	7.29	7.35	410.5	1929.1	48.78	1,403	10.0	0.0155	3,816
N_2O	0.73	0.74	---	---	---	---	0.0033	0.0035	1.47
CO_2e	386,694	390,195	8,643	40,529	1,026	29,474	3,468	1,392	861,421

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]									
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Generators	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC										
NO_X	172.6	---	---	---	469.5	14.3	---	309.0	15.6	981.0
CO	145.0	---	---	---	939.1	77.8	---	618.0	3.0	1,782.8
VOC	9.5	286.7	163.4	57.4	328.7	---	46.8	216.3	0.5	1,109.2
SO_2	1.0	---	---	---	1.1	---	---	0.7	0.01	2.8
PM_{10}	13.1	---	---	---	37.2	---	---	11.15	331.7	393.2
$PM_{2.5}$	13.1	---	---	---	37.2	---	---	11.15	34.2	95.6
Hazardous Air Pollutants										
Benzene	0.004	0.95	0.41	0.26	1.51	---	2.24	0.25	---	5.61
Toluene	0.006	0.91	0.36	0.32	0.53	---	1.58	0.23	---	3.93
Ethylbenzene	---	0.050	0.018	0.015	0.024	---	---	0.0223	---	0.13
Xylene	---	0.29	0.11	0.11	0.19	---	0.28	0.103	---	1.08
n-Hexane	3.11	14.22	6.30	2.60	---	---	1.36	0.62	---	28.22
Formaldehyde	0.13	---	---	---	19.65	---	---	29.60	---	49.38
Acetaldehyde	---	---	---	---	2.67	---	---	4.69	---	7.36
Acrolein	---	---	---	---	2.52	---	---	2.88	---	5.40
Methanol	---	---	---	---	2.93	---	---	1.40	---	4.33
1,1,2,2-Tetrachloroethane	---	---	---	---	0.024	---	---	0.0224	---	0.047
1,1,2-Trichloroethane	---	---	---	---	0.015	---	---	0.0178	---	0.032
1,3-Dichloropropene	---	---	---	---	0.012	---	---	0.0148	---	0.027
1,3-Butadiene	---	---	---	---	0.64	---	---	0.150	---	0.79
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	0.140	---	0.14
Biphenyl	---	---	---	---	---	---	---	0.119	---	0.12
Carbon Tetrachloride	---	---	---	---	0.017	---	---	0.0206	---	0.038
Chlorobenzene	---	---	---	---	0.012	---	---	0.0170	---	0.029
Chloroform	---	---	---	---	0.013	---	---	0.0160	---	0.029
Dichlorobenzene	0.0021	---	---	---	---	---	---	---	---	0.0021
Ethylene Dibromide	---	---	---	---	0.020	---	---	0.0248	---	0.045
Methylene Chloride	---	---	---	---	0.039	---	---	0.0112	---	0.05
Naphthalene	0.0011	---	---	---	0.093	---	---	0.042	---	0.14
Phenol	---	---	---	---	---	---	---	0.0135	---	0.013
Styrene	---	---	---	---	0.011	---	---	0.0132	---	0.025
Tetrachloroethane	---	---	---	---	---	---	---	0.00139	---	0.0014
Vinyl Chloride	---	---	---	---	0.007	---	---	0.0084	---	0.015
PAH -POM 1	---	---	---	---	0.14	---	---	0.015	---	0.15
POM 2	0.00010	---	---	---	---	---	---	0.033	---	0.033
POM 3	0.000028	---	---	---	---	---	---	---	---	0.000028
POM 4	0.0000031	---	---	---	---	---	---	---	---	0.0000031
POM 5	0.0000041	---	---	---	---	---	---	---	---	0.0000041
POM 6	0.000012	---	---	---	---	---	---	0.000093	---	0.00011
POM 7	0.000003	---	---	---	---	---	---	0.00039	---	0.00039
Greenhouse Gases										
CO_2	205,812	23.25	2.4	2.607	224,045	35,625	---	131,064	1,315	597,890
CH_4	3.88	72.40	278.1	21.74	4.23	228	57.40	2.47	0.008	667.8
N_2O	0.39	---	---	---	0.42	0.05	---	0.25	0.001	1.1
CO_2e	206,013	1,544	5,843	459	224,265	40,418	1,206	131,193	1,316	612,256

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	129.6	1,809.7	981.0	2,920.2
CO	106.0	2,290.7	1,782.8	4,179.6
VOC	12.1	3,929.0	1,109.2	5,050.3
SO_2	0.2	3.9	2.8	6.9
PM_{10}	423.3	570.3	393.2	1,386.7
$PM_{2.5}$	46.0	224.1	95.6	365.8
Hazardous Air Pollutants				
Benzene	0.084	16.25	5.61	21.95
Toluene	0.031	12.01	3.93	15.98
Ethylbenzene	---	0.83	0.13	0.96
Xylene	0.020	3.63	1.08	4.73
n-Hexane	0.095	163.24	28.22	191.55
Formaldehyde	0.0080	182.68	49.38	232.07
Acetaldehyde	0.0026	25.65	7.36	33.01
Acrolein	0.00080	25.71	5.40	31.12
Methanol	---	8.20	4.33	12.53
1,1,2,2-Tetrachloroethane	---	0.219	0.047	0.27
1,1,2-Trichloroethane	---	0.174	0.032	0.21
1,3-Dichloropropene	---	0.145	0.027	0.17
1,3-Butadiene	---	2.71	0.79	3.50
2,2,4-Trimethylpentane	---	2.80	0.14	2.94
Biphenyl	---	0.013	0.12	0.13
Carbon Tetrachloride	---	0.201	0.038	0.24
Chlorobenzene	---	0.147	0.029	0.18
Chloroform	---	0.156	0.029	0.18
Dichlorobenzene	---	0.0039	0.0021	0.0060
Ethylene Dibromide	---	0.243	0.045	0.29
Methylene Chloride	---	0.49	0.051	0.54
Naphthalene	0.0132	0.32	0.14	0.47
Phenol	---	0.139	0.013	0.15
Styrene	---	0.181	0.025	0.21
Vinyl Chloride	---	0.082	0.015	0.10
(PAH) POM 1	---	0.44	0.15	0.59
POM 2	0.0078	0.109	0.033	0.15
POM 3	---	0.000052	0.000028	0.000080
POM 4	---	0.0000059	0.0000031	0.0000090
POM 5	0.000061	0.000027	0.0000041	0.000092
POM 6	0.000240	0.00118	0.00011	0.0015
POM 7	0.000155	0.00223	0.0004	0.0028
Total HAPs	0.26	446.77	107.16	554.19
Greenhouse Gases				
CO_2	18,776	780,830	597,890	1,397,495
CH_4	18.81	3,816	668	4,502.6
N_2O	0.154	1.47	1.11	2.73
CO_2e	19218	861,421	612,256	1,492,896

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	47	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	1.67	1.97	0.035	1.67	3.33
PM_{15}	0.50	0.009	0.42	0.50	0.009	0.42	0.85
PM_{10}	0.38	0.007	0.32	0.38	0.007	0.32	0.64
$PM_{2.5}$	0.21	0.004	0.18	0.21	0.004	0.18	0.35

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	0	well pads/year
Oil well pads	47	well pads/year
Distance graded - Oil well	1.19	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Oil wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	3.21	0.09	0.0016	0.075
PM_{15}	1.53	0.043	0.00077	0.036
PM_{10}	0.92	0.026	0.00046	0.022
$PM_{2.5}$	0.10	0.003	0.000050	0.0023

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	47	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.009	0.41	1.97	0.009	0.41	0.83
PM_{15}	0.50	0.002	0.11	0.50	0.002	0.11	0.21
PM_{10}	0.38	0.002	0.08	0.38	0.002	0.08	0.16
$PM_{2.5}$	0.21	0.0009	0.04	0.21	0.001	0.04	0.087

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.024
PM_{15}	0.48	0.05	0.00024	0.011
PM_{10}	0.29	0.032	0.00014	0.0068
$PM_{2.5}$	0.03	0.003	0.000016	0.00073

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	47	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	1.04	1.97	0.022	1.04	2.07
PM_{15}	0.50	0.006	0.26	0.50	0.006	0.26	0.53
PM_{10}	0.38	0.0042	0.20	0.38	0.0042	0.20	0.40
$PM_{2.5}$	0.21	0.0023	0.11	0.21	0.0023	0.11	0.22

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.00	0.09	0.0010	0.047
PM_{15}	0.96	0.043	0.00048	0.023
PM_{10}	0.58	0.026	0.00029	0.014
$PM_{2.5}$	0.06	0.0028	0.000031	0.0015

a Assumes maximum development scenario

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads

Round Trip Miles 19

Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads

Round Trip Miles 6

Precipitation Days (P) 45 days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	47	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	4.16
$PM_{2.5}$	0.12	0.11	0.56	0.009	0.42

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.02
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.005

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.32	1.16	11.29	0.71	145.36
$PM_{2.5}$	0.13	0.12	1.13	0.07	14.54

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.052	0.0036	0.74
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.18

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	47	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	3.13
$PM_{2.5}$	0.14	0.12	0.42	0.007	0.31

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.02
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.004

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	262.95
$PM_{2.5}$	0.14	0.12	1.75	0.13	26.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.44
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.35

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	415.60	2.21	417.81
$PM_{2.5}$	41.56	0.54	42.10

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	94	acres total disturbance for well pads per year
	380,404	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	2.14	0.00
PM_{10}	1.07	0.00
$PM_{2.5}$	0.16	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	47	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.16
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.29
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.018
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00018
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.008
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.008
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	17.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0008
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0003
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	17.55

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	47	new pads per year
Backhoe miles per pad	0.58	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	2.3	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	2.3	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr) * Horse Power * Hours * Load Factor}}{\text{453.6 (g/lb) * 2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	6.77
CO	1.43	2.26
VOC	0.36	0.58
PM_{10}	0.22	0.35
$PM_{2.5}$	0.22	0.35
Greenhouse Gases		
CO_2	97.50	154.26
CO_2e [e]	97.50	154.26

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of oil wells drilled	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total-Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	7.35
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	7.33
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.56
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0063
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.40
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.39
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	736.83
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.022
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0072
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	739.53

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Number of oil wells	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total_Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	12.80
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	12.18
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	0.94
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.011
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.70
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.68
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1275.16
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.036
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.012
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1279.62

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	204	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.62
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.70
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.051
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00056
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.034
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.032
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	63.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0021
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00070
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	63.71

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	144	hours/oil well
Development Rate	204	oil wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 4)				
Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	0.38	76.53
CO [a]	5.73E-03	5.21	0.38	76.53
VOC [a]	3.09E-04	0.28	0.02	4.12
PM_{10} [a]	6.61E-05	0.06	0.004	0.88
$PM_{2.5}$ [a]	6.61E-05	0.06	0.004	0.88
SO_2 [b]	1.21E-05	0.011	0.00079	0.16
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.00036	0.073
Toluene [c]	1.97E-06	0.0018	0.00013	0.026
Xylenes [c]	1.35E-06	0.0012	0.000088	0.018
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.0074
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.0024
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.00074
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.012
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.0072
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.000056
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.00022
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.00014
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	74.70	15,238
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.62
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.12
CO_2e [m]	---	1040.96	74.95	15,290

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	204	wells/year (oil wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Engine Emissions (lb/hr)	Engine Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.84	0.12	25.32
CO [a]	0.85	5.50E-03	2.62	0.033	6.72
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.79
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.79
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.012
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.0061
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.0022
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.0015
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.00062
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.00020
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.000062
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.0010
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.00061
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.0000048
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.000019
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.000012
Greenhouse Gases					
CO_2 [i]	163.05	1.14	501.6	6.32	1289.9
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.052
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.010
CO_2e [l]	---	---	503.3	6.3	1,294.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	204	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	18.08
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	3.21
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	2.56
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.54
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.00
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.32
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.36
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.16
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.074
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.013
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0014
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00019
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0055
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0028
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00029
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.095
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.24
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.16
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0023
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**5.13**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.10**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**26.82**

a Assumes maximum development scenario

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	575,626	miles/year-all wells
Operation Pickup Truck Mileage:	171,615	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.45	15.43	6.05E-03	0.28	0.52	8.74	15.95
CO	1.02E-02	1.61	2.94	4.48E-02	2.11	3.84	3.71	6.78
VOC [c]	1.55E-03	0.24	0.45	1.61E-03	0.08	0.14	0.32	0.58
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0009	0.0016	0.006	0.010
PM_{10}	2.57E-03	0.41	0.74	1.31E-04	0.006	0.011	0.41	0.75
$PM_{2.5}$	2.50E-03	0.39	0.72	1.21E-04	0.006	0.010	0.40	0.73
Greenhouse Gases								
CO_2	4.520	712.8	1,300.9	1.050	49.4	90.1	762.2	1,391.0
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.004	0.008	0.008	0.016
N_2O	4.01E-06	0.0006	0.0012	2.68E-05	0.0013	0.0023	0.0019	0.0035
CO_2e [c]	---	713.1	1,301.4	---	49.9	91.0	763.0	1392.4

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

19. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	1450	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	63
Light Trucks	8,000	19
Mean Vehicle Weight	36,457	---
Total Round Trips	---	82

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.56	1.37	0.16	0.26	382.52
$PM_{2.5}$	0.16	0.14	0.016	0.026	38.25

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.027	0.027	0.00094	0.0017	2.47
$PM_{2.5}$	0.0066	0.0066	0.00023	0.00042	0.61

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	92,959	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.028	836.80
Hazardous Air Pollutants [b]			
Benzene	0.0018	0.000089	2.66
Toluene	0.0017	0.000083	2.46
Ethylbenzene	0.000092	0.0000046	0.14
Xylenes	0.00053	0.000026	0.78
n-Hexane	0.028	0.0014	41.88
Greenhouse Gases [b]			
CO_2	0.0044	0.0044	9.51
CH_4	0.13	0.0067	200.37
CO_2e	2.83	0.15	4217.32

a Total wellsite working and breathing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 102.39 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	39.82	307.20
Ethane	30.07	16.516	4.97	13.20	16.91	244.55
Propane	44.10	16.909	7.46	19.81	17.31	367.19
i-Butane	58.12	3.694	2.15	5.71	3.78	105.72
n-Butane	58.12	9.044	5.26	13.97	9.26	258.83
i-Pentane	72.15	3.269	2.36	6.27	3.35	116.14
n-Pentane	72.15	4.297	3.10	8.24	4.40	152.66
Cyclopentane	70.10	0.361	0.25	0.67	0.37	12.46
Hexanes	86.18	2.285	1.97	5.23	2.34	96.97
Heptanes	100.20	1.423	1.43	3.79	1.46	70.21
Octanes	114.23	0.403	0.46	1.22	0.41	22.67
Nonanes	128.26	0.076	0.10	0.26	0.078	4.80
Decanes +	142.29	0.026	0.037	0.098	0.027	1.82
Benzene	78.11	0.106	0.083	0.22	0.109	4.08
Toluene	92.14	0.083	0.076	0.20	0.085	3.77
Ethylbenzene	106.17	0.004	0.004	0.011	0.0041	0.21
Xylenes	106.17	0.023	0.024	0.065	0.0236	1.20
n-Hexane	86.18	1.513	1.30	3.46	1.55	64.21
Nitrogen	28.01	0.612	0.17	0.46	0.63	8.44
Carbon Dioxide	44.01	0.460	0.20	0.54	0.47	9.97
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**44.56**	**1282.94**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**1.77**	**73.46**
TOTAL		**100.0**	**37.63**	**100.0**	**102.39**	**1853.10**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	856.08	21.34	877.42
Hazardous Air Pollutants [b]			
Benzene	2.72	0.068	2.79
Toluene	2.51	0.063	2.58
Ethylbenzene	0.14	0.0035	0.14
Xylenes	0.80	0.020	0.82
n-Hexane	42.84	1.07	43.91
Greenhouse Gases [b]			
CO_2	6.65	6.65	13.30
CH_4	204.99	5.11	210.10
CO_2e	4311.40	113.97	4425.4

a Total wellsite flashing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.

22. Oil Truck Loadout

Assumptions:

Oil Well Production Rate	9.1	bbl/day-well
Number of Oil Wells not going to a GOSP	1450	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Oil Loading [a]	0.6	2.8	50	520	2.01	9.1	0.14	203.70

	Oil Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00045	0.65
Toluene	0.00041	0.60
Ethylbenzene	0.000023	0.033
Xylenes	0.00013	0.19
n-Hexane	0.0070	10.19
Greenhouse Gases		
CO2	0.00109	1.58
CH4	0.034	48.78
CO2e	0.71	1025.9

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60° F.

b Assumes maximum development scenario

c Emissions estimated based on flashing analysis weight fractions

23. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	3,250	397.90	1,402.92	12.29	29,474

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine power:	65.0	hp
Number of Wells Requiring Pumping Unit Engines:	3250	wells
Load Factor:	0.38	

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp) * 8760 (hr/yr) * load factor}}{\text{453.6 (g/lb) * 2000 (lb/ton)}}$$

Pollutant	Emission Factor [a] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/well)	Emissions (ton/yr-well)	Total Emissions [h] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [b]	-	1.89	0.10	0.45	1,465.02
CO [b]	-	2.58	0.14	0.62	1,999.87
VOC [a]	0.12	5.12E-01	0.028	0.12	396.60
PM_{10} [a,d]	4.83E-02	2.06E-01	0.011	0.049	159.67
$PM_{2.5}$ [a,d]	4.83E-02	2.06E-01	0.011	0.049	159.67
SO_2 [a]	5.88E-04	2.51E-03	0.00014	0.0006	1.94
Hazardous Air Pollutants [a]					
Benzene	1.94E-03	8.27E-03	0.00045	0.0020	6.41
Toluene	9.63E-04	4.11E-03	0.00022	0.0010	3.18
Ethylbenzene	1.08E-04	4.60E-04	0.000025	0.00011	0.36
Xylenes	2.68E-04	1.14E-03	0.000062	0.00027	0.89
Formaldehyde	5.52E-02	2.35E-01	0.013	0.056	182.44
Acetaldehyde	7.76E-03	3.31E-02	0.0018	0.0079	25.65
Acrolein	7.78E-03	3.32E-02	0.0018	0.0079	25.71
Benzo(a)pyrene/POM5	5.68E-09	2.42E-08	1.32E-09	0.00000001	0.000019
Biphenyl	3.95E-06	1.68E-05	0.0000009	0.0000040	0.013
Methanol	2.48E-03	1.06E-02	0.00058	0.0025	8.20
1,1,2,2-Tetrachloroethane	6.63E-05	2.83E-04	0.000015	0.000067	0.22
1,1,2-Trichloroethane	5.27E-05	2.25E-04	0.000012	0.000054	0.17
1,3-Dichloropropene	4.38E-05	1.87E-04	0.000010	0.000045	0.14
1,3-Butadiene	8.20E-04	3.50E-03	0.00019	0.00083	2.71
2,2,4-Trimethylpentane	8.46E-04	3.61E-03	0.00020	0.00086	2.80
Carbon Tetrachloride	6.07E-05	2.59E-04	0.000014	0.000062	0.20
Chlorobenzene	4.44E-05	1.89E-04	0.000010	0.000045	0.15
Chloroform	4.71E-05	2.01E-04	0.000011	0.000048	0.16
Chrysene/POM7	6.72E-07	2.87E-06	0.00000016	0.0000007	0.0022
Ethylene Dibromide	7.34E-05	3.13E-04	0.000017	0.000075	0.24
Methylene Chloride	1.47E-04	6.27E-04	0.000034	0.00015	0.49
n-Hexane	4.45E-04	1.90E-03	0.00010	0.00045	1.47
Naphthalene	9.63E-05	4.11E-04	0.000022	0.000098	0.32
Phenol	4.21E-05	1.80E-04	0.000010	0.000043	0.14
Styrene	5.48E-05	2.34E-04	0.000013	0.000056	0.18
Vinyl Chloride	2.47E-05	1.05E-04	0.0000057	0.000025	0.082
PAH	1.34E-04	5.71E-04	0.000031	0.00014	0.44
POM -2 [e]	3.28E-05	1.40E-04	0.0000076	0.000033	0.11
POM-6 [f]	3.50E-07	1.49E-06	0.00000008	0.0000004	0.0012
Greenhouse Gases					
CO_2 [g]	117	498	27.14	118.9	386,316
CH_4 [g]	0.002	0.01	0.00051	0.0022	7.29
N_2O [g]	0.0002	0.0009	0.000051	0.00022	0.73
CO_2e [i]	----	----	27.17	118.98	386,694

a AP-42 Table 3.2-1 Uncontrolled Emission Factors for 2-Stroke Lean-Burn Engines, 7/00
b Emission factors (g/hp-hr) from manufacturer specifications
c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d PM = sum of PM filterable and PM condensable
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, benzo(a)fluoranthene, benzo(e)pyrene, fluorene, phenanthrene, perylene, and pyrene.
f POM 6 includes: Benz(a)anthracene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
h Estimated at full project production.
i Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

25. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters	1450	wells
Oil well tanks	2,176	tanks
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Oil Well Separator Heater			Oil Well Tank Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.029	0.13	100	0.029	0.13	74.65	326.95
CO [a]	84	0.025	0.11	84	0.025	0.11	62.70	274.64
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	4.11	17.98
SO_2 [b]	0.6	0.00018	0.00077	0.6	0.00018	0.00077	0.45	1.96
PM_{10} [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	2.10E-03	6.18E-07	2.71E-06	0.0016	0.0069
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	3.40E-03	1.00E-06	4.38E-06	0.0025	0.011
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	1.80E+00	5.29E-04	2.32E-03	1.34	5.89
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	7.50E-02	2.21E-05	9.66E-05	0.056	0.25
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	1.20E-03	3.53E-07	1.55E-06	0.00090	0.0039
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	6.10E-04	1.79E-07	7.86E-07	0.00046	0.0020
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	5.90E-05	1.74E-08	7.60E-08	0.000044	0.00019
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	1.60E-05	4.71E-09	2.06E-08	0.000012	0.000052
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	1.80E-06	5.29E-10	2.32E-09	0.000001	0.000006
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	2.40E-06	7.06E-10	3.09E-09	0.000002	0.000008
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	7.20E-06	2.12E-09	9.28E-09	0.000005	0.000024
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	1.8E-06	5.29E-10	2.32E-09	0.000001	0.000006
Greenhouse Gases								
CO_2 [l]	119,226	35.07	153.59	119,226	35.07	153.59	88,998	389,813
CH_4 [l]	2.25	0.00066	0.0029	2.25	0.00066	0.0029	1.68	7.35
N_2O [l]	0.22	0.000066	0.00029	0.22	0.000066	0.00029	0.17	0.74
CO_2e [m]	---	35.10	153.74	---	35.10	153.74	89,086	390,195

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

26. Oil Well Fugitives

Number of Producting Wells 3250 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1198.00**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	3.31
Toluene Emissions	0.00011	0.0020	2.97
Ethylbenzene Emissions	----	0.00011	0.16
Xylene Emissions	0.000011	0.00065	0.92
n-Hexane Emissions	0.0035	0.035	52.55

Project: GMBU - Alternative A - Oil Wells
Date: 7/15/2013

26. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**1929.15**	**16.88**	**40,529**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

27. Wellsite Flare Emissions

Assumptions:

Number of oil well pads with controls	362	well pads
Vent gas from each well pad	7.66	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.0011	0.005	0.40	1.73
CO [a]	0.37	0.006	0.026	2.15	9.44
Greenhouse Gases					
CO2 [b]	---	2.05	9.00	744	3,257
CH4 [b]	---	0.0063	0.028	2.28	10.00
N2O [b]	---	0.000002	0.000009	0.0008	0.0033
CO2e [b]	---	2.19	9.58	792	3,468

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

28. Compressor Station Engines

Assumptions:

Number of new compressor stations	1	facilities
Number of expanded compressor stations	3	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission Factor (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ g/lb} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions Per Facility (lb/hr-facility)	Emissions Per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	308.99
CO [a]	-	2.0	35.27	154.50	617.99
VOC [a]	-	0.7	12.35	54.07	216.30
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	11.15
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	11.15
SO_2 [b]	5.88E-04	0.002	0.038	0.16	0.66
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	0.25
Toluene	4.08E-04	1.48E-03	0.013	0.057	0.23
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.022
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.10
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	0.62
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	29.60
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	4.69
Acrolein	5.14E-03	1.87E-02	0.16	0.72	2.88
Methanol	2.50E-03	9.07E-03	0.080	0.35	1.40
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.022
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.018
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.015
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.15
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.14
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.12
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.021
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.017
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.016
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.025
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.011
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.042
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.013
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.013
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0014
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.0084
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.015
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.033
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.0000053	0.000023	0.000093
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.00039
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	131,064
CH_4 [g]	0.002	0.0080	0.14	0.62	2.47
N_2O [g]	0.0002	0.00080	0.014	0.062	0.25
CO_2e [h]	---	---	7,488	32,798	131,193

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

29. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :		
Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	4	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	5.21
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.051
Toluene	0.11	0.0053	0.085
Ethylbenzene	0.0046	0.00023	0.0037
Xylenes	0.038	0.0019	0.030
n-Hexane	0.17	0.0084	0.13
Greenhouse Gases			
CO_2	1.32	1.32	21.07
CH_4	6.24	0.31	4.99
CO_2e	132	7.87	125.92

a Assumes maximum development scenario

30. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 4 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	46.77
Hazardous Air Pollutants			
Benzene	0.13	0.56	2.24
Toluene	0.090	0.39	1.58
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.28
n-Hexane	0.078	0.34	1.36
Greenhouse Gases			
CH_4	3.28	14.35	57.40
CO_2e	68.81	301.38	1205.50

a Assumes maximum development scenario

31. Compressor Station Fugitives

Number of Compressor Stations 4 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**12.10**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.025
Toluene Emissions	0.0001	0.016	0.028
Ethylbenzene Emissions	----	0.00070	0.0010
Xylene Emissions	0.00001	0.0058	0.0085
n-Hexane Emissions	0.0035	0.026	0.23

31. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**36.37**	**0.318**	**764.1**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

32. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Facilities	4	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	11.13

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.11
Toluene	0.045	0.18
Ethylbenzene	0.0020	0.0078
Xylenes	0.016	0.064
n-Hexane	0.071	0.29
Greenhouse Gases		
CO2	0.56	2.25
CH4	2.66	10.65
CO2e	56.50	226.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

33. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	10,260	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.15	0.27	6.05E-03	0.00	0.00	0.15	0.27
CO	1.02E-02	0.03	0.05	4.48E-02	0.00	0.00	0.03	0.05
VOC [c]	1.55E-03	0.00	0.01	1.61E-03	0.00	0.00	0.00	0.01
SO_2	3.07E-05	0.000	0.000	1.84E-05	0.0000	0.0000	0.000	0.000
PM_{10}	2.57E-03	0.01	0.01	1.31E-04	0.000	0.000	0.01	0.01
$PM_{2.5}$	2.50E-03	0.01	0.01	1.21E-04	0.000	0.000	0.01	0.01
Greenhouse Gases								
CO_2	4.520	12.7	23.2	1.050	0.0	0.0	12.7	23.2
CH_4	2.59E-05	0.0001	0.000	9.38E-05	0.000	0.000	0.000	0.000
N_2O	4.01E-06	0.0000	0.0000	2.68E-05	0.0000	0.0000	0.0000	0.0000
CO_2e [c]	---	12.7	23.2	---	0.0	0.0	12.7	23.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

34. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	4	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.80	1.28	5.13
$PM_{2.5}$	0.17	0.15	0.080	0.13	0.51

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0051	0.0094	0.037
$PM_{2.5}$	0.0081	0.0081	0.0013	0.0023	0.0092

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

35. Gas and Oil Separation Facility Generators

Assumptions:

Number of GOSPs	12	Facilities
Generator size	1,945	Horsepower
Number of Generators per GOSP	1	engines/Facility

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (tons/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	225.37
CO [a]	-	2.0	8.58	37.56	450.75
VOC [a]	-	0.7	3.00	13.15	157.76
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	17.86
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	17.86
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.54
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.73
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.26
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.011
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.090
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	9.43
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.28
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.21
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.41
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.012
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0070
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0058
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.30
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0081
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0059
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0063
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.010
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.019
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.045
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0055
Vinyl Chloride	7.18E-06	2.93E-05	0.00006	0.00028	0.0033
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.065
Greenhouse Gases					
CO_2 [e]	117	477.2	2046	8,962	107,542
CH_4 [e]	0.002	0.0090	0.0386	0.17	2.03
N_2O [e]	0.0002	0.00090	0.00386	0.02	0.20
CO_2e [f]	---	---	2048	2048.08	107647

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

36. GOSP Truck Loadout

Assumptions:

Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	12	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	46.31

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.15
Toluene	0.011	0.14
Ethylbenzene	0.00063	0.0075
Xylenes	0.0036	0.043
n-Hexane	0.19	2.32
Greenhouse Gases		
CO2	0.030	0.36
CH4	0.92	11.09
CO2e	19.44	233.24

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

37. GOSP Fugitives

Number of GOSP Facilities 12 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**139.32**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.35
Toluene Emissions	0.00011	0.0020	0.30
Ethylbenzene Emissions	----	0.00011	0.015
Xylene Emissions	0.000011	0.00065	0.091
n-Hexane Emissions	0.0035	0.035	5.55

Project: GMBU - Alternative A - Oil Wells
Date: 7/15/2013

37. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**213.61**	**1.87**	**4487.60**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

38. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	571,656	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.39	15.32	6.05E-03	0.00	0.00	8.39	15.32
CO	1.02E-02	1.60	2.92	4.48E-02	0.00	0.00	1.60	2.92
VOC [c]	1.55E-03	0.24	0.44	1.61E-03	0.00	0.00	0.24	0.44
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0000	0.0000	0.005	0.009
PM_{10}	2.57E-03	0.40	0.73	1.31E-04	0.000	0.000	0.40	0.73
$PM_{2.5}$	2.50E-03	0.39	0.71	1.21E-04	0.000	0.000	0.39	0.71
Greenhouse Gases								
CO_2	4.520	707.9	1,291.9	1.050	0.0	0.0	707.9	1,291.9
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.000	0.000	0.004	0.007
N_2O	4.01E-06	0.0006	0.0011	2.68E-05	0.0000	0.0000	0.0006	0.0011
CO_2e [c]	---	708.2	1,292.5	---	0.0	0.0	708.2	1292.5

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

39. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	12	facilities

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	16.85	26.95	323.44
$PM_{2.5}$	0.17	0.15	1.685	2.695	32.34

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	63
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	63

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.11	0.20	2.36
$PM_{2.5}$	0.0081	0.0081	0.026	0.048	0.58

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

40. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :		
Facility Production Rate	160	bbls oil per day per facility
Total Facilities	13	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.097	79.25
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.25
Toluene	0.0030	0.018	0.23
Ethylbenzene	0.00017	0.00099	0.013
Xylenes	0.0010	0.0057	0.074
n-Hexane	0.051	0.31	3.97
Greenhouse Gases			
CO_2	0.0079	0.047	0.62
CH_4	0.24	1.46	18.98
CO_2e	5.12	30.70	399.14

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

41. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	1241.60 scf/day-facility

* Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.151
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.275
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.0582
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.0221
Benzene	78.11	0.106	0.083	0.0022	1.32	0.0494
Toluene	92.14	0.083	0.076	0.0020	1.03	0.0457
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.00254
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.0146
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.779
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.102
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.121
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	13

Total Flashing Emissions for All Tanks (tons/yr)

VOC	202.24
Hazardous Air Pollutants	
Benzene	0.64
Toluene	0.59
Ethylbenzene	0.033
Xylenes	0.19
n-Hexane	10.12
HAPs	11.58
Greenhouse Gases	
CO2	1.57
CH4	48.43
CO2e	1018.5

42. Water Treatment Facility Fugitives

Number Water Treatment Facilities 13 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**11.97**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.033
Toluene Emissions	0.00011	0.0020	0.029
Ethylbenzene Emissions	----	0.00011	0.0016
Xylene Emissions	0.000011	0.00065	0.0091
n-Hexane Emissions	0.0035	0.0346	0.52

42. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**28.16**	**0.25**	**591.6**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

43. Water Treatment Plant Generator

Assumptions:

Number of facilities 13
Generator horsepower 1,945 hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	244.15
CO [a]	-	2.0	8.58	37.56	488.31
VOC [a]	-	0.7	3.00	13.15	170.91
PM_{10} [b,d]	1.94E-02	7.92E-02	0.340	1.49	19.35
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.340	1.49	19.35
SO_2 [b]	5.88E-04	2.40E-03	0.0103	0.045	0.586
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.79
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.28
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.012
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.097
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	10.22
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.39
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.31
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.52
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.013
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0076
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0063
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.33
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0088
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0064
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0068
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.011
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.021
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.048
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0059
Vinyl Chloride	7.18E-06	2.93E-05	0.000063	0.00028	0.0036
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.070
Greenhouse Gases					
CO_2 [e]	117	477.2	2,046	8,962	116,504
CH_4 [e]	0.002	9.00E-03	0.0386	0.17	2.20
N_2O [e]	0.0002	9.00E-04	0.00386	0.017	0.22
CO_2e [f]	---	---	2,048	8,971	116,618

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

44. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	12	GOSP Facilities
	4	Compressor Stations

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	39.41	172.62
CO [a]	84	2.72	11.90	84	0.124	0.54	33.11	145.00
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	2.17	9.49
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.24	1.04
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	8.28E-04	0.0036
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	1.34E-03	0.0059
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	7.09E-01	3.11
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	2.96E-02	0.13
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	4.73E-04	0.0021
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	2.40E-04	0.0011
POM 2[c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	2.33E-05	0.00010
POM 3[c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	6.31E-06	0.000028
POM 4[c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
POM 5[c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	9.46E-07	0.0000041
POM 6[c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	2.84E-06	0.000012
POM 7[c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	46988.9	205812
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.89	3.88
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.089	0.39
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	47035	206013

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

45. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 4
Number of GOSPs 12

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	14.30
CO [a]	0.37	1.11	4.86	77.79
Greenhouse Gases				
CO2 [b]	---	508	2,227	35,625
CH4 [b]	---	3.25	14.22	227.52
N2O [b]	---	0.0007	0.003	0.05
CO2e [b]	---	577	2,526	40,418

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

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

Identification

User Identification:	GMBU Water treatment tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 500 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		25.00
Diameter (ft):		12.00
Liquid Height (ft) :		24.00
Avg. Liquid Height (ft):		12.00
Volume (gallons):		20,304.71
Turnovers:		20.13
Net Throughput(gal/yr):		408,800.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	2,032.1687

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

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

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50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

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

Identification

User Identification:	GMBU PA Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		5.78
Net Throughput(gal/yr):		92,959.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	243.2049
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	92,959.0000
Annual Turnovers:	5.7830
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,124.5785

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

Emissions Report for: Annual

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	243.20	881.37	1,124.58

APPENDIX A-2

PROPOSED ACTION GAS WELL EMISSIONS

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative A - Gas Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	23.0	8.5	2.0	0.0006	19.2	4.8
	Drilling	577.7	562.5	31.3	1.2	725.4	80.7
	Completion	67.4	22.8	2.6	0.039	384.7	41.1
	Interim Reclamation	0.5	0.5	0.04	0.0004	10.5	1.1
	Wind Erosion	---	---	---	---	5.3	0.8
Wellsite Production Emissions	Production Heaters	483.1	405.8	26.6	2.9	36.7	36.7
	Wellsite Tanks	---	---	1,773.5	---	---	---
	Pneumatics	---	---	306.1	---	---	---
	Fugitives	---	---	1,452.7	---	---	---
	Wellsite Truck Loading	---	---	189.2	---	---	---
	Wellsite Dehydrators	---	---	47.3	---	---	---
	Wellsite Flares	20.1	109.3	---	---	---	---
	Operations Vehicle	7.9	8.0	0.4	0.007	246.2	25.1
Gas Processing Plant Emissions	Gas Plant Compressor Engines	11.6	23.2	8.1	0.03	0.9	0.9
	Gas Plant Flares	0.9	4.9	---	---	---	---
	Gas Plant Fugitives	---	---	0.8	---	---	---
	Gas Plant Dehydrator Heater	0.6	0.5	0.04	0.004	0.05	0.05
	Gas Plant Dehydrator	---	---	11.7	---	---	---
Compressor Station Emissions	Compressor Station Engines	1,545.0	3,089.9	1,081.5	3.3	55.8	55.8
	Compressor Station Tanks	---	---	26.1	---	---	---
	Compressor Station Dehydrator	---	---	233.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	1.4	0.3	55.7	0.0	31.1	3.2
	Compressor Station Dehydrator Heater	12.9	10.8	0.7	0.1	1.0	1.0
	Compressor Station Flare	17.9	97.2	---	---	---	---
	Compressor Station Fugitives	---	---	60.5	---	---	---
	Total Emissions	**2,769.9**	**4,344.2**	**5,310.6**	**7.5**	**1,516.9**	**251.2**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	23.0	577.7	67.4	0.5	---	668.6
CO	8.5	562.5	22.8	0.5	---	594.3
VOC	2.0	31.3	2.6	0.04	---	35.9
SO_2	0.0006	1.2	0.04	0.0004	---	1.2
PM_{10}	19.2	725.4	384.7	10.5	5.3	1145.1
$PM_{2.5}$	4.8	80.7	41.1	1.1	0.8	128.4
Hazardous Air Pollutants						
Benzene	---	0.51	0.010	---	---	0.52
Toluene	---	0.18	0.004	---	---	0.19
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.13	0.0026	---	---	0.13
n-Hexane	---	---	---	---	---	---
Formaldehyde	---	0.052	0.0011	---	---	0.053
Acetaldehyde	---	0.017	0.00034	---	---	0.017
Acrolein	---	0.0052	0.00011	---	---	0.0053
Naphthalene	---	0.085	0.0017	---	---	0.087
POM 2	---	0.050	0.0010	---	---	0.051
POM 5	---	0.00040	0.000008	---	---	0.00040
POM 6	---	0.0015	0.000032	---	---	0.0016
POM 7	---	0.0010	0.000021	---	---	0.0010
Greenhouses Gases						
CO_2	569.9	110,750	5,555	49	---	116,923
CH_4	0.0028	4.41	0.18	0.00159	---	4.60
N_2O	0.0010	0.89	0.04	0.00054	---	0.93
CO_2e	570.3	111,118	5,571	49	---	117,308

a Assumes maximum development scenario of 156 wells in one year

b Emissions in summary tables may vary slightly due to rounding differences.

c Total drilling emissions includes Tier IV drill rig engines

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Wellsite Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	483.1	---	---	---	---	20.1	---	7.9	511.1
CO	405.8	---	---	---	---	109.3	---	8.0	523.1
VOC	26.6	1773.5	1452.7	189.2	306.1	---	47.3	0.4	3,795.8
SO_2	2.9	---	---	---	---	---	---	0.007	2.9
PM_{10}	36.7	---	---	---	---	---	---	246.2	283.0
$PM_{2.5}$	36.7	---	---	---	---	---	---	25.1	61.8
Hazardous Air Pollutants									
Benzene	0.010	17.25	3.97	1.84	0.33	---	2.75	---	26.15
Toluene	0.016	28.75	5.20	3.07	0.17	---	11.64	---	48.84
Ethylbenzene	---	1.25	0.20	0.13	---	---	3.41	---	4.99
Xylene	---	10.25	1.69	1.09	0.017	---	24.25	---	37.30
n-Hexane	8.70	45.50	28.85	4.85	5.65	---	---	---	93.56
Formaldehyde	0.36	---	---	---	---	---	---	---	0.36
Dichlorobenzene	0.0058	---	---	---	---	---	---	---	0.0058
Naphthalene	0.0029	---	---	---	---	---	---	---	0.0029
POM 2	0.00029	---	---	---	---	---	---	---	0.00029
POM 3	0.000077	---	---	---	---	---	---	---	0.000077
POM 4	0.0000087	---	---	---	---	---	---	---	0.0000087
POM 5	0.000012	---	---	---	---	---	---	---	0.000012
POM 6	0.000035	---	---	---	---	---	---	---	0.000035
POM 7	0.0000087	---	---	---	---	---	---	---	0.000009
Greenhouse Gases									
CO_2	575,965	358.3	33.9	38.2	9.5	24,974.9	---	746.9	602,127
CH_4	10.86	1698.3	3871.0	181.19	1,079.17	238.0	73.98	0.0173	7,152
N_2O	1.09	---	---	---	---	0.0	---	0.0045	1.13
CO_2e	576,530	36,022	81,324	3,843	22,672	29,986	1,553	749	752,679

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Total Project Infrastructure Related Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	13.5	---	---	---	18.8	---	1556.6	1.4	1,590.2
CO	11.4	---	---	---	102.1	---	3113.1	0.3	3,226.8
VOC	0.7	26.1	61.4	55.6	---	245.5	1089.6	0.04	1,479.0
SO_2	0.08	---	---	---	---	---	3.3	0.0008	3.4
PM_{10}	1.0	---	---	---	---	---	56.7	31.1	88.8
$PM_{2.5}$	1.0	---	---	---	---	---	56.7	3.2	60.9
Hazardous Air Pollutants									
Benzene	0.00028	0.254	0.125	0.54	---	11.76	1.27	---	13.95
Toluene	0.00046	0.423	0.142	0.90	---	8.27	1.16	---	10.89
Ethylbenzene	---	0.0184	0.0049	0.0392	---	---	0.11	---	0.17
Xylene	---	0.151	0.043	0.322	---	1.48	0.52	---	2.51
n-Hexane	0.24	0.67	1.18	1.43	---	7.13	3.11	---	13.77
Formaldehyde	0.010	---	---	---	---	---	148.49	---	148.50
Acetaldehyde	---	---	---	---	---	---	23.50	---	23.50
Acrolein	---	---	---	---	---	---	14.47	---	14.47
Methanol	---	---	---	---	---	---	7.08	---	7.08
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	0.11	---	0.11
1,1,2-Trichloroethane	---	---	---	---	---	---	0.090	---	0.090
1,3-Dichloropropene	---	---	---	---	---	---	0.074	---	0.074
1,3-Butadiene	---	---	---	---	---	---	0.76	---	0.76
2,2,4-Trimethylpentane	---	---	---	---	---	---	0.70	---	0.70
Biphenyl	---	---	---	---	---	---	0.59	---	0.59
Carbon Tetrachloride	---	---	---	---	---	---	0.10	---	0.10
Chlorobenzene	---	---	---	---	---	---	0.086	---	0.086
Chloroform	---	---	---	---	---	---	0.080	---	0.080
Dichlorobenzene	0.00016	---	---	---	---	---	---	---	0.00016
Ethylene Dibromide	---	---	---	---	---	---	0.12	---	0.12
Methylene Chloride	---	---	---	---	---	---	0.057	---	0.057
Naphthalene	0.000083	---	---	---	---	---	0.21	---	0.21
Phenol	---	---	---	---	---	---	0.067	---	0.067
Styrene	---	---	---	---	---	---	0.066	---	0.066
Tetrachloroethane	---	---	---	---	---	---	0.0070	---	0.0070
Vinyl Chloride	---	---	---	---	---	---	0.042	---	0.042
PAH -POM 1	---	---	---	---	---	---	0.079	---	0.079
POM 2	0.0000080	---	---	---	---	---	0.17	---	0.17
POM 3	0.0000022	---	---	---	---	---	---	---	0.0000022
POM 4	0.00000024	---	---	---	---	---	---	---	0.00000024
POM 5	0.00000032	---	---	---	---	---	---	---	0.00000032
POM 6	0.00000097	---	---	---	---	---	0.00047	---	0.00047
POM 7	0.00000024	---	---	---	---	---	0.0019	---	0.0019
Greenhouse Gases									
CO_2	16,127	105.3	1.61	11.24	36,935	---	660,849	116	714,145
CH_4	0.304	25.0	183.9	53.27	352.0	301.38	12.46	0.00066	928.3
N_2O	0.030	---	---	---	0.062	---	1.25	0.00010	1.3
CO_2e	16,143	630	3,864	1,130	44,345	6,329	661,498	116	734,054

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	668.6	511.1	1,590.2	2,769.9
CO	594.3	523.1	3,226.8	4,344.2
VOC	35.9	3,795.8	1,479.0	5,310.6
SO_2	1.2	2.9	3.4	7.5
PM_{10}	1,145.1	283.0	88.8	1,516.9
$PM_{2.5}$	128.4	61.8	60.9	251.2
Hazardous Air Pollutants				
Benzene	0.52	26.15	13.95	40.62
Toluene	0.19	48.84	10.89	59.92
Ethylbenzene	---	4.99	0.17	5.17
Xylene	0.13	37.30	2.51	39.94
n-Hexane	---	93.56	13.77	107.32
Formaldehyde	0.053	0.36	148.50	148.92
Acetaldehyde	0.017	---	23.50	23.52
Acrolein	0.0053	---	14.47	14.48
Methanol	---	---	7.08	7.08
1,1,2,2-Tetrachloroethane	---	---	0.11	0.11
1,1,2-Trichloroethane	---	---	0.090	0.090
1,3-Dichloropropene	---	---	0.074	0.074
1,3-Butadiene	---	---	0.76	0.76
2,2,4-Trimethylpentane	---	---	0.70	0.70
Biphenyl	---	---	0.59	0.59
Carbon Tetrachloride	---	---	0.10	0.10
Chlorobenzene	---	---	0.086	0.086
Chloroform	---	---	0.080	0.080
Dichlorobenzene	---	0.0058	0.00016	0.0060
Ethylene Dibromide	---	---	0.12	0.12
Methylene Chloride	---	---	0.057	0.057
Naphthalene	0.087	0.0029	0.21	0.30
Phenol	---	---	0.067	0.067
Styrene	---	---	0.066	0.066
Tetrachloroethane	---	---	0.0070	0.0070
Vinyl Chloride	---	---	0.042	0.042
(PAH) POM 1	---	---	0.079	0.079
POM 2	0.051	0.00029	0.17	0.22
POM 3	---	0.000077	0.0000022	0.000079
POM 4	---	0.0000087	0.0000002	0.000009
POM 5	0.00040	0.000012	0.0000003	0.00042
POM 6	0.0016	0.000035	0.00047	0.0021
POM 7	0.0010	0.000009	0.0019	0.0030
Total HAPs	1.05	211.21	238.28	450.54
Greenhouse Gases				
CO_2	116,923	602,127	714,145	1,433,195
CH_4	4.60	7,152	928	8,085
N_2O	0.931	1.13	1.34	3.40
CO_2e	117,308	752,679	734,054	1,604,040

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	156	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	5.53	1.97	0.035	5.53	11.07
PM_{15}	0.50	0.009	1.41	0.50	0.009	1.41	2.82
PM_{10}	0.38	0.007	1.06	0.38	0.007	1.06	2.11
$PM_{2.5}$	0.21	0.00372	0.58	0.21	0.004	0.58	1.16

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	156	well pads/year
Oil well pads	0	well pads/year
Distance graded - Deep gas well	1.96	miles
Distance graded - Oil well	0.00	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Deep gas wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	5.27	0.15	0.0026	0.41
PM_{15}	2.52	0.07	0.0013	0.20
PM_{10}	1.51	0.042	0.00076	0.12
$PM_{2.5}$	0.16	0.005	0.000082	0.013

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	156	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.009	1.38	1.97	0.009	1.38	2.75
PM_{15}	0.50	0.002	0.35	0.50	0.002	0.35	0.70
PM_{10}	0.38	0.002	0.26	0.38	0.002	0.26	0.53
$PM_{2.5}$	0.21	0.0009	0.14	0.21	0.001	0.14	0.29

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.08
PM_{15}	0.48	0.05	0.00024	0.037
PM_{10}	0.29	0.032	0.00014	0.022
$PM_{2.5}$	0.03	0.003	0.000016	0.0024

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	156	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	3.44	1.97	0.022	3.44	6.88
PM_{15}	0.50	0.006	0.88	0.50	0.006	0.88	1.75
PM_{10}	0.38	0.0042	0.66	0.38	0.0042	0.66	1.31
$PM_{2.5}$	0.21	0.0023	0.36	0.21	0.0023	0.36	0.72

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.00	0.09	0.0010	0.16
PM_{15}	0.96	0.043	0.00048	0.07
PM_{10}	0.58	0.026	0.00029	0.04
$PM_{2.5}$	0.06	0.0028	0.000031	0.005

a Assumes maximum development scenario

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	156	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	13.81
$PM_{2.5}$	0.12	0.11	0.56	0.009	1.38

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.06
$PM_{2.5}$	0.0036	0.0035	0.006	0.00010	0.015

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.45	1.27	7.90	4.57	712.87
$PM_{2.5}$	0.15	0.13	0.79	0.46	71.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.023	0.022	0.041	0.0261	4.06
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	1.00

Project: GMBU - Alternative A -Gas Wells

7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$		Annual
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		Annual
$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$		Daily
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$		Daily
Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road		

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$		Daily
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$		Daily
Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year
W = average weight in tons of vehicles traveling the road		

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	156	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	10.37
$PM_{2.5}$	0.14	0.12	0.42	0.007	1.04

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.05
$PM_{2.5}$	0.0047	0.0046	0.005	0.00009	0.013

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	4
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	35,750	---
Total Round Trips	---	8

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.55	1.36	9.64	2.43	379.85
$PM_{2.5}$	0.16	0.14	0.96	0.24	37.98

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.026	0.025	0.05	0.02	2.36
$PM_{2.5}$	0.006	0.006	0.01	0.004	0.58

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	1116.90	6.54	1123.44
$PM_{2.5}$	111.69	1.60	113.29

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	468	acres total disturbance for well pads per year
	1,893,926	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2-period	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2-period
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	10.68	0.00
PM_{10}	5.34	0.00
$PM_{2.5}$	0.80	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	156	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.52
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.96
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.060
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00060
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.027
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.026
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	57.88
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0028
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0010
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	58.25

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	156	new pads per year
Backhoe miles per pad	0.77	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	3.1	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	3.1	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr) * Horse Power * Hours * Load Factor}}{\text{453.6 (g/lb) * 2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	22.49
CO	1.43	7.51
VOC	0.36	1.92
PM_{10}	0.22	1.16
$PM_{2.5}$	0.22	1.16
Greenhouse Gases		
CO_2	97.50	512.02
CO_2e [e]	97.50	512.02

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of deep gas wells drilled	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells[c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.0101	0.40	41.25
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.0993	0.25	26.04
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	2.44
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.0000	0.00030	0.030
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.0003	0.022	2.29
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.0002	0.022	2.22
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.201	38.19	3932.16
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.0003	0.00077	0.079
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.0001	0.00023	0.024
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	3941.14

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Number of deep gas wells	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.004	0.48	21.46
CO	1.98E-02	0.12	0.04	7.26E-02	0.15	0.04	0.27	12.29
VOC [c]	3.16E-03	0.020	0.006	3.54E-03	0.007	0.0021	0.03	1.21
SO_2	4.57E-05	0.0003	0.00008	2.83E-05	0.00006	0.000017	0.0003	0.015
PM_{10}	4.22E-03	0.03	0.008	1.94E-04	0.0004	0.00012	0.03	1.20
$PM_{2.5}$	4.09E-03	0.03	0.007	1.79E-04	0.0004	0.00011	0.03	1.16
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	2029.05
CH_4	6.56E-05	0.0004	0.00012	2.08E-04	0.0004	0.00012	0.0008	0.04
N_2O	1.20E-05	0.00007	0.00002	8.05E-05	0.00017	0.00005	0.00024	0.011
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	2033

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	156	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.48
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.54
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.014	0.039
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00043
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.026
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.025
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	48.52
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0016
N_2O	1.20E-05	0.00002	0.0000004	8.05E-05	0.00017	0.0000030	0.00019	0.00054
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	48.72

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	1320	hours/deep gas well
Development Rate	156	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 , 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Gas Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	3.44	536.44
CO [a]	5.73E-03	5.21	3.44	536.44
VOC [a]	3.09E-04	0.28	0.19	28.89
PM_{10} [a]	6.61E-05	0.06	0.04	6.19
$PM_{2.5}$ [a]	6.61E-05	0.06	0.04	6.19
SO_2 [b]	1.21E-05	0.011	0.0073	1.14
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.0033	0.51
Toluene [c]	1.97E-06	0.0018	0.0012	0.18
Xylenes [c]	1.35E-06	0.0012	0.00081	0.13
Formaldehyde [c]	5.52E-07	0.00050	0.00033	0.052
Acetaldehyde [c]	1.76E-07	0.00016	0.00011	0.017
Acrolein [c]	5.52E-08	0.00005	0.000033	0.0052
Naphthalene [d]	9.10E-07	0.00083	0.00055	0.085
POM 2 [d,e,f]	5.39E-07	0.00049	0.00032	0.050
POM 5 [d,e,g]	4.22E-09	0.0000038	0.0000025	0.00040
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000099	0.0015
POM 7 [d,e,i]	1.07E-08	0.000010	0.0000064	0.0010
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	684.73	106,818
CH_4 [j,k]	4.63E-05	0.042	0.028	4.33
N_2O [j,k]	9.26E-06	0.0084	0.0056	0.87
CO_2e [m]	---	1040.96	687.03	107,177

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

15. Well Fracturing Engine

Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	156	wells/year (deep gas wells)

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Horsepower (hp)* Hours (hour/year) * Load Factor}}{\text{2000 lb/ton}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Gas Well Emissions (lb/hr)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.82	0.29	45.96
CO [a]	0.85	5.50E-03	2.25	0.07	10.53
VOC [a]	0.09	7.05E-04	0.29	0.009	1.35
PM_{10} [a]	0.10	0.0007	0.29	0.009	1.34
$PM_{2.5}$ [a]	0.10	0.0007	0.29	0.009	1.34
SO_2 [a]	1.52E-03	1.21E-05	0.0050	0.00015	0.023
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0022	0.000067	0.010
Toluene [b]	2.81E-04	1.97E-06	0.00080	0.000024	0.0038
Xylenes [b]	1.93E-04	1.35E-06	0.00055	0.000017	0.0026
Formaldehyde [b]	7.89E-05	5.52E-07	0.00023	0.0000068	0.0011
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000072	0.0000022	0.00034
Acrolein [b]	7.88E-06	5.52E-08	0.000023	0.00000068	0.00011
Naphthalene [c]	1.30E-04	9.10E-07	0.00037	0.000011	0.0017
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00022	0.0000066	0.0010
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000017	0.000000052	0.000008
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000068	0.00000020	0.000032
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000044	0.00000013	0.000021
Greenhouse Gases					
CO_2 [i]	163.05	1.14	753.3	22.60	3525.4
CH_4 [j]	6.61E-03	4.63E-05	0.031	0.00092	0.14
N_2O [j]	1.32E-03	9.26E-06	0.0061	0.00018	0.029
CO_2e [l]	---	---	755.8	22.7	3,537.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

17. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	261,747	miles/year-all wells
Operation Pickup Truck Mileage:	295,888	miles/year-all wells
Hours of Operation:	10	hours per day
Hours of Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	3.84	7.01	6.05E-03	0.49	0.90	4.33	7.91
CO	1.02E-02	0.73	1.33	4.48E-02	3.63	6.63	4.36	7.96
VOC [c]	1.55E-03	0.11	0.20	1.61E-03	0.13	0.24	0.24	0.44
SO_2	3.07E-05	0.002	0.004	1.84E-05	0.0015	0.0027	0.004	0.007
PM_{10}	2.57E-03	0.18	0.34	1.31E-04	0.011	0.019	0.19	0.36
$PM_{2.5}$	2.50E-03	0.18	0.33	1.21E-04	0.010	0.018	0.19	0.35
Greenhouse Gases								
CO_2	4.520	324.1	591.5	1.050	85.1	155.3	409.3	746.9
CH_4	2.59E-05	0.0019	0.003	9.38E-05	0.008	0.014	0.009	0.017
N_2O	4.01E-06	0.0003	0.0005	2.68E-05	0.0022	0.0040	0.0025	0.004
CO_2e [c]	---	324.3	591.8	---	86.0	156.9	410.2	748.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

18. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of producing wells	2500	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	29
Light Trucks	8,000	33
Mean Vehicle Weight	25,416	---
Total Round Trips	---	62

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.33	1.17	0.061	0.098	244.60
$PM_{2.5}$	0.13	0.12	0.0061	0.0098	24.46

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.00028	0.00052	1.29
$PM_{2.5}$	0.0045	0.0045	0.000069	0.000126	0.32

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

19. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	2500	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total Wellsite Emissions [a] (tons/yr)
VOC	0.71	0.00	1773.50
Hazardous Air Pollutants			
Benzene	0.0069	0.00	17.25
Toluene	0.012	0.00	28.75
Ethylbenzene	0.00050	0.00	1.25
Xylenes	0.0041	0.00	10.25
n-Hexane	0.018	0.00	45.50
Greenhouse Gases			
CO_2	0.14	0.00	358.3
CH_4	0.68	0.00	1698.3
CO_2e	14	0.00	36,022

a Total wellsite flashing emissions are based on 2500 uncontrolled tanks and 0 tanks controlled at 0%.

20. Condensate Truck Loadout

Assumptions:

Deep Gas Well Condensate Production Rate	2.0	bbl/day-well
Number of Deep Gas Wells	2500	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Condensate Loading [a]	0.6	5.2	66	520	4.94	2.0	0.076	189.22

	Condensate Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00074	1.84
Toluene	0.0012	3.07
Ethylbenzene	0.000053	0.13
Xylenes	0.00044	1.09
n-Hexane	0.0019	4.85
Greenhouse Gases		
CO2	0.015	38.22
CH4	0.072	181.19
CO2e	1.54	3843.3

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Assumes maximum development scenario

c Emissions estimated based on ratio of HAP/VOC in tank emissions

21. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.0546	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.0008	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.00520	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.00230	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
2,500	306.08	1,079.17	9.45	22,672

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

22. Production Heater Emissions

Assumptions

Deep Gas Well Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Gas wells with dehydrators	2500	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Deep Gas Well Dehydrator Heater			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	100	0.044	0.19	110.29	483.09
CO [a]	84	0.037	0.16	92.65	405.79
VOC [b]	5.5	0.0024	0.011	6.07	26.57
SO_2 [b]	0.6	0.00026	0.0012	0.66	2.90
PM_{10} [b]	7.6	0.0034	0.015	8.38	36.71
$PM_{2.5}$ [b]	7.6	0.0034	0.015	8.38	36.71
Hazardous Air Pollutants					
Benzene [c]	2.10E-03	9.26E-07	4.06E-06	0.0023	0.010
Toluene [c]	3.40E-03	1.50E-06	6.57E-06	0.0038	0.016
Hexane [c]	1.80E+00	7.94E-04	3.48E-03	1.99	8.70
Formaldehyde [c]	7.50E-02	3.31E-05	1.45E-04	0.083	0.36
Dichlorobenzene [c]	1.20E-03	5.29E-07	2.32E-06	0.0013	0.0058
Naphthalene [c]	6.10E-04	2.69E-07	1.18E-06	0.00067	0.0029
POM 2 [c,d,e]	5.90E-05	2.60E-08	1.14E-07	0.000065	0.00029
POM 3 [c,f]	1.60E-05	7.06E-09	3.09E-08	0.000018	0.00008
POM 4 [c,g]	1.80E-06	7.94E-10	3.48E-09	0.000002	0.00001
POM 5 [c,h]	2.40E-06	1.06E-09	4.64E-09	0.000003	0.00001
POM 6 [c,i]	7.20E-06	3.18E-09	1.39E-08	0.000008	0.00003
POM 7 [c,j]	1.8E-06	7.94E-10	3.48E-09	0.000002	0.00001
Greenhouse Gases					
CO_2 [l]	119,226	52.60	230.39	131,499	575,965
CH_4 [l]	2.25	0.0010	0.0043	2.48	10.86
N_2O [l]	0.22	0.00010	0.00043	0.25	1.09
CO_2e [m]	---	52.65	230.61	131,628	576,530

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

23. Deep Gas Well Fugitive Emissions

Number of Producting Wells 2500 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1452.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b Weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	3.97
Toluene Emissions	0.0001	0.0162	5.20
Ethylbenzene Emissions	----	0.0007	0.20
Xylene Emissions	0.00001	0.0058	1.69
n-Hexane Emissions	0.0035	0.0257	28.85

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**3870.96**	**33.87**	**81324**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

24. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.4 MMscf/day/well
Wells Requiring Dehydrators: 2,500 wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0043	0.019	47.28
Hazardous Air Pollutants			
Benzene	0.00025	0.0011	2.75
Toluene	0.0011	0.0047	11.64
Ethylbenzene	0.00031	0.0014	3.41
Xylenes	0.0022	0.010	24.25
Greenhouse Gases			
CH_4	0.0068	0.030	73.98
CO_2e	0.14	0.62	1553.48

25. Wellsite Flare Emissions

Assumptions:

Number of gas well dehydrators with controls	2500	well pads
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.002	0.01	4.59	20.09
CO [a]	0.37	0.01	0.04	24.96	109.31
Greenhouse Gases					
CO2 [b]	---	2.28	9.99	5,702	24,975
CH4 [b]	---	0.02	0.10	54.3	238.0
N2O [b]	---	0.00000	0.00002	0.0	0.042
CO2e [b]	---	2.74	11.99	6,846	29,986

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

26. Compressor Station Engines

Assumptions:

Number of new compressor stations	20	facilities
Number of expanded compressor stations	0	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission factor conversion:

g/hp-hr = AP-42 emission factor (lb/MMbtu) * 8000 Average BTU/hp-hr / 1,000,000 * 453.59 g/lb

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp) * 8760 (hr/yr)}}{\text{453.6 g/lb * 2000 (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions per Facility (lb/hr-facility)	Emissions per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	1544.97
CO [a]	-	2.0	35.27	154.50	3089.95
VOC [a]	-	0.7	12.35	54.07	1081.48
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	55.77
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	55.77
SO_2 [b]	5.88E-04	0.002	0.04	0.16	3.30
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	1.23
Toluene	4.08E-04	1.48E-03	0.013	0.057	1.14
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.11
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.52
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	3.11
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	148.01
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	23.43
Acrolein	5.14E-03	1.87E-02	0.16	0.72	14.41
Methanol	2.50E-03	9.07E-03	0.080	0.35	7.01
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.11
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.089
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.074
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.75
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.70
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.59
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.10
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.085
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.080
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.12
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.056
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.21
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.067
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.066
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0070
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.042
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.075
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.17
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.000005	0.000023	0.00047
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.0019
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	655,320
CH_4 [g]	0.002	0.0080	0.14	0.62	12.36
N_2O [g]	0.0002	0.00080	0.014	0.062	1.24
CO_2e [h]	---	---	7,488	32,798	655,963

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

27. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :		
Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	20	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	26.07
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.254
Toluene	0.11	0.0053	0.423
Ethylbenzene	0.0046	0.00023	0.0184
Xylenes	0.038	0.0019	0.151
n-Hexane	0.17	0.0084	0.67
Greenhouse Gases			
CO_2	1.32	1.32	105.33
CH_4	6.24	0.31	24.96
CO_2e	132	7.87	629.6

a Assumes maximum development scenario

28. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 20 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	233.83
Hazardous Air Pollutants			
Benzene	0.13	0.56	11.20
Toluene	0.090	0.39	7.88
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	1.41
n-Hexane	0.078	0.34	6.79
Greenhouse Gases			
CH_4	3.28	14.35	287.02
CO_2e	68.81	301.38	6027.50

a Assumes maximum development scenario

29. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Facilities	20	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	55.63

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.54
Toluene	0.045	0.90
Ethylbenzene	0.0020	0.039
Xylenes	0.016	0.32
n-Hexane	0.071	1.43
Greenhouse Gases		
CO2	0.56	11.24
CH4	2.664	53.27
CO2e	56.50	1129.92

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

30. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	51,302	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.75	1.37	6.05E-03	0.00	0.00	0.75	1.37
CO	1.02E-02	0.14	0.26	4.48E-02	0.00	0.00	0.14	0.26
VOC [c]	1.55E-03	0.022	0.040	1.61E-03	0.00	0.00	0.022	0.040
SO_2	3.07E-05	0.0004	0.001	1.84E-05	0.00	0.00	0.0004	0.0008
PM_{10}	2.57E-03	0.036	0.066	1.31E-04	0.00	0.00	0.036	0.066
$PM_{2.5}$	2.50E-03	0.035	0.064	1.21E-04	0.00	0.00	0.035	0.064
Greenhouse Gases								
CO_2	4.520	63.5	115.9	1.050	0.0	0.0	63.5	115.9
CH_4	2.59E-05	0.0004	0.001	9.38E-05	0.00	0.00	0.0004	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	63.6	116.0	---	0.0	0.0	63.6	116.0

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

31. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	20	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	6
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	6

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.96	1.54	30.80
$PM_{2.5}$	0.17	0.15	0.096	0.15	3.08

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0062	0.0112	0.22
$PM_{2.5}$	0.0081	0.0081	0.0015	0.0028	0.055

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

32. Compressor Station Fugitive Emissions

Number of Compressor Stations 20 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.020
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**60.55**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.124
Toluene Emissions	0.0001	0.016	0.141
Ethylbenzene Emissions	----	0.00070	0.005
Xylene Emissions	0.00001	0.0058	0.043
n-Hexane Emissions	0.0035	0.026	1.17

32. Compressor Station Fugitive Emissions

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**181.85**	**1.591**	**3820.5**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

33. Gas Processing Plant Compression

Assumptions:

Number of compressors	4	engines
Compressor horsepower	300	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	0.66	2.90	11.59
CO [a]	-	2.0	1.32	5.79	23.17
VOC [a]	-	0.7	0.46	2.03	8.11
PM_{10} [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
SO_2 [b]	5.88E-04	2.40E-03	0.0016	0.007	0.028
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.0021	0.0093	0.037
Toluene	5.58E-04	2.28E-03	0.00075	0.0033	0.013
Ethylbenzene	2.48E-05	1.01E-04	0.000033	0.00015	0.00059
Xylenes	1.95E-04	7.96E-04	0.00026	0.0012	0.0046
Formaldehyde	2.05E-02	8.37E-02	0.028	0.12	0.48
Acetaldehyde	2.79E-03	1.14E-02	0.0038	0.016	0.066
Acrolein	2.63E-03	1.07E-02	0.0036	0.016	0.062
Methanol	3.06E-03	1.25E-02	0.0041	0.018	0.072
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.000034	0.00015	0.00060
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.000021	0.000090	0.00036
1,3-Dichloropropene	1.27E-05	5.18E-05	0.000017	0.000075	0.00030
1,3-Butadiene	6.63E-04	2.71E-03	0.00090	0.0039	0.016
Carbon Tetrachloride	1.77E-05	7.23E-05	0.000024	0.00010	0.00042
Chlorobenzene	1.29E-05	5.27E-05	0.000017	0.000076	0.00031
Chloroform	1.37E-05	5.59E-05	0.000018	0.000081	0.00032
Ethylene Dibromide	2.13E-05	8.70E-05	0.000029	0.00013	0.00050
Methylene Chloride	4.12E-05	1.68E-04	0.000056	0.00024	0.0010
Naphthalene	9.71E-05	3.96E-04	0.00013	0.00057	0.0023
Styrene	1.19E-05	4.86E-05	0.000016	0.000070	0.00028
Vinyl Chloride	7.18E-06	2.93E-05	0.000010	0.000042	0.00017
PAH -POM 1	1.41E-04	5.76E-04	0.00019	0.00083	0.0033
Greenhouse Gases					
CO_2 [e]	117	477.2	315.59	1382	5529.1
CH_4 [e]	0.002	9.00E-03	0.0060	0.026	0.10
N_2O [e]	0.0002	9.00E-04	0.00060	0.003	0.010
CO_2e [f]	---	---	315.9	1384	5535

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

34. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

35. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

36. Central Facility Heater Emissions

Assumptions

Gas Processing Dehydrator Reboiler Size	1,500	Mbtu/hr
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
	1	Gas Processing Plant
	20	Compressor Station

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Compressor Station Reboiler			Gas Processing Plant Reboiler			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.15	0.64	100	0.15	0.64	3.09	13.53
CO [a]	84	0.12	0.54	84	0.12	0.54	2.59	11.36
VOC [b]	5.5	0.008	0.035	5.5	0.008	0.035	0.17	0.74
SO_2 [b]	0.6	0.001	0.0039	0.6	0.001	0.0039	0.019	0.081
PM_{10} [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
$PM_{2.5}$ [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	3.09E-06	1.35E-05	2.10E-03	3.09E-06	1.35E-05	0.000065	0.00028
Toluene [c]	3.40E-03	5.00E-06	2.19E-05	3.40E-03	5.00E-06	2.19E-05	0.00011	0.00046
Hexane [c]	1.80E+00	2.65E-03	1.16E-02	1.80E+00	2.65E-03	1.16E-02	0.056	0.24
Formaldehyde [c]	7.50E-02	1.10E-04	4.83E-04	7.50E-02	1.10E-04	4.83E-04	0.0023	0.010
Dichlorobenzene [c]	1.2E-03	1.76E-06	7.73E-06	1.2E-03	1.76E-06	7.73E-06	0.000037	0.00016
Naphthalene [c]	6.1E-04	8.97E-07	3.93E-06	6.1E-04	8.97E-07	3.93E-06	0.000019	0.000083
POM 2[c,d,e]	5.9E-05	8.68E-08	3.80E-07	5.9E-05	8.68E-08	3.80E-07	0.000002	0.000008
POM 3[c,f]	1.6E-05	2.35E-08	1.03E-07	1.6E-05	2.35E-08	1.03E-07	0.0000005	0.000002
POM 4[c,g]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
POM 5[c,h]	2.4E-06	3.53E-09	1.55E-08	2.4E-06	3.53E-09	1.55E-08	0.0000001	0.0000003
POM 6[c,i]	7.2E-06	1.06E-08	4.64E-08	7.2E-06	1.06E-08	4.64E-08	0.0000002	0.000001
POM 7[c,j]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
Greenhouse Gases								
CO_2 [l]	119,226	175.3	768.0	119,226	175.3	768.0	3,682	16,127
CH_4 [l]	2.25	0.0033	0.014	2.25	0.0033	0.014	0.07	0.30
N_2O [l]	0.22	0.0003	0.001	0.22	0.0003	0.001	0.01	0.03
CO_2e [m]	---	175.5	768.7	---	175.5	768.7	3,686	16,143

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)
c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98
d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.
f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.
g POM 4 includes: 3-Methylchloranthrene.
h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
j POM 7 includes: Chrysene.
k Assumes maximum development scenario
l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

37. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 20
Number of Gas Processing Plants 1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	18.76
CO [a]	0.37	1.11	4.86	102.10
Greenhouse Gases				
CO2 [b]	---	402	1,759	36,935
CH4 [b]	---	3.83	16.76	352.0
N2O [b]	---	0.0007	0.003	0.062
CO2e [b]	---	482	2,112	44,345

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

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50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B

PROPOSED ACTION ANNUAL DEVELOPMENT EMISSIONS

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APPENDIX B-1

MONUMENT BUTTE PROJECT AREA EMISSIONS AS OF DECEMBER 31, 2011

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		December 31, 2011 Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	---	---	---
	Drilling Tailpipe	---	---	---
	Drilling - Rigs	---	---	---
	Completion Tailpipe	---	---	---
	Completion Rigs	---	---	---
	Completion Venting	---	---	---
	Interim Reclamation Tailpipe	---	---	---
Production Emissions	Pump Unit Engines	1,035.2	301.7	1,336.9
	Production Heaters	305.8	161.3	467.2
	Wellsite Tanks - W&B	0.0	1,323.6	1,323.6
	Wellsite Tanks - Flashing	0.0	1,345.0	1,345.0
	Wellsite Truck Loading	0.0	213.5	213.5
	Wellsite Flares	0.0	0.0	0.0
	Wellsite Fugitives	0.0	437.5	437.5
	Wellsite Pneumatics	0.0	145.3	145.3
	Operations Vehicle	19.9	0.7	20.5
	Infrastructure	202.0	57.0	259.0
	Total Emissions	**1,563**	**3,986**	**5,549**

a Emissions in summary tables may vary slightly due to rounding differences.

Operations Tailpipe Emissions

Assumptions:

Total Annual New Pumper Mileage:	725,912	miles/year
Total Annual Pickup Mileage:	136,109	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.23	0.41	5.36E-02	10.66	19.45	19.87
VOC	1.61E-03	0.06	0.11	1.55E-03	0.31	0.56	0.67

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

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Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.79
VOC Wt. Fraction: 0.19
Non-HC Wt. Fraction: 0.02
Total: 1.00

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.41	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.97	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.53	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.00	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.74	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.20	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.35	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.58	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.27	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0051	6,996	0.06	0.00	0.00
Decanes	0.000	142.29	0.000	0.0007	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.0002	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.35	4,756	3.89	0.00	0.00
Nitrogen	0.647	28.01	0.181	0.91	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.59	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.005	34.08	0.002	0.01	637	0.03	588	0.03
Total	**100.0**	**-**	**20.0**	**100.0**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2011 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,833	bbls oil per day-all wells
Number of Well Pads with Tanks:	1187	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Average Throughput:	89,325	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.00	1323.59

a Total wellsite working and breathing emissions are based on 2374 uncontrolled tanks and 0 tanks controlled at 0%.

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	13833	bbl/day-all wells
Number of Well Pads with Tanks:	1187	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 107.34 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	41.75	322.05
Ethane	30.07	16.516	4.97	0.132	17.73	256.37
Propane	44.10	16.909	7.46	0.198	18.15	384.94
i-Butane	58.12	3.694	2.15	0.057	3.97	110.83
n-Butane	58.12	9.044	5.26	0.140	9.71	271.35
i-Pentane	72.15	3.269	2.36	0.063	3.51	121.76
n-Pentane	72.15	4.297	3.10	0.082	4.61	160.04
Cyclopentane	70.10	0.361	0.25	0.007	0.39	13.06
Hexanes	86.18	2.285	1.97	0.052	2.45	101.66
Heptanes	100.20	1.423	1.43	0.038	1.53	73.61
Octanes	114.23	0.403	0.46	0.012	0.43	23.76
Nonanes	128.26	0.076	0.10	0.003	0.08	5.03
Decanes +	142.29	0.026	0.04	0.001	0.03	1.91
Benzene	78.11	0.106	0.08	0.002	0.11	4.27
Toluene	92.14	0.083	0.08	0.002	0.09	3.95
Ethylbenzene	106.17	0.004	0.00	0.000	0.00	0.22
Xylenes	106.17	0.023	0.02	0.001	0.02	1.26
n-Hexane	86.18	1.513	1.30	0.035	1.62	67.31
Nitrogen	28.01	0.612	0.17	0.005	0.66	8.85
Carbon Dioxide	44.01	0.460	0.20	0.005	0.49	10.45
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**46.71**	**1344.96**
HAP SUBTOTAL		**1.73**	**1.49**	**0.04**	**1.86**	**77.01**
TOTAL		**100.00**	**37.63**	**1.00**	**107.34**	**1942.68**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1344.96	0.00	1344.96

a Total wellsite flashing emissions are based on 2374 uncontrolled tanks and 0 tanks controlled at 0%.

Project: Greater Monument Butte Unit 12/31/2011 Emissions

Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 13,832.9 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	13832.9	213.55

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60 ^{o} F.

b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	369	engines
Number of Ajax Engines	818	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	868.9
VOC	1.3	0.31	256.7

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	166.3
VOC [c]	0.51	0.12	45.0

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

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Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.177	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.204	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.231	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.258	0.0008	0.0010	0.005	0.000011	0.0000038	0.00002
Decanes +	142.285	0.0001	0.0001	0.001	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.001	0.000003	0.0000008	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.013	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

	Number of Wells	VOC emissions (tons/year)
Proposed Action	1,187	145.33

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producing Wells 1187 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**437.55**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Number of wells with heater treater	1187	wells
Number of wellpads with tanks	1187	wells
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	305.83
VOC [b]	5.5	0.002	0.007	5.5	0.002	0.007	5.5	0.000	0.000	161.32

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

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

Identification

User Identification:	GMB Unit 12/31/11 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	5.56
Net Throughput(gal/yr):	89,325.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB Unit 12/31/11 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB Unit 12/31/11 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	233.6974
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	89,325.0000
Annual Turnovers:	5.5569
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,115.0711

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

Emissions Report for: Annual

GMB Unit 12/31/11 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	233.70	881.37	1,115.07

APPENDIX B-2

PROPOSED ACTION DEVELOPMENT FOR 2012

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		December 31, 2012 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.3	0.6	8.0
	Drilling Tailpipe	3.0	0.2	3.2
	Drilling - Rigs	57.7	12.0	69.7
	Completion Tailpipe	11.7	0.9	12.6
	Completion Rigs	23.2	0.7	23.9
	Completion Venting	0.0	4.7	4.7
	Interim Reclamation Tailpipe	0.6	0.0	0.6
Production Emissions	Pump Unit Engines	898.5	259.1	1,157.6
	Production Heaters	283.5	140.6	424.2
	Wellsite Tanks - W&B	0.0	1,215.4	1,215.4
	Wellsite Tanks - Flashing	0.0	1,504.0	1,504.0
	Wellsite Truck Loading	0.0	238.8	238.8
	Wellsite Flares	0.0	0.0	0.0
	Wellsite Fugitives	0.0	432.8	432.8
	Wellsite Pneumatics	0.0	143.7	143.7
	Operations Vehicle	22.0	0.7	22.7
	Infrastructure	202.0	57.0	259.0
	Total Emissions	**1,510**	**4,011**	**5,521**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	187	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.62
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.071

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	187	
Average Round Trip Distance	24.9	miles
Hours of Operation	64	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.015	7.39E-03	0.038	0.0012	3.00
VOC	3.16E-03	0.020	0.00063	3.54E-03	0.018	0.00059	0.23

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	187	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	11.74
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.87

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	187	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.57
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.047

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	2	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	57.71
VOC	2.20E-03	2.00	12.02

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	187	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	23.21
VOC [b]	0.090	0.28	0.0035	0.65

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	187	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	16.57
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	2.94
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.34
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.49
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	0.92
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.30
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.33
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.14
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.067
Octanes	114	0.009	0.010	0.0005	0.0004	0.0001	0.012
Nonanes	128	0.001	0.001	0.0001	0.00004	0.00001	0.0013
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00018
Benzene	78.1	0.005	0.004	0.0002	0.0003	0.00003	0.0050
Toluene	92.1	0.002	0.002	0.0001	0.0001	0.00001	0.0026
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00026
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.087
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.22
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.15
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0021
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**4.70**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.095**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**24.59**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	807,577	miles/year
Total Annual Pickup Mileage:	117,961	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.20	0.36	5.36E-02	11.86	21.64	22.00
VOC	1.61E-03	0.052	0.09	1.55E-03	0.34	0.63	0.72

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	15,468	bbls oil per day-all wells
Number of Well Pads with Tanks:	1027	well pads
Tanks per wellsite:	2	tanks
Number of Well Pads with Controls:	0	well pads
Control Efficiency of tanks:	0	%
Average Throughput:	115,448	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.59	0.000	1215.37

a Total wellsite working and breathing emissions are based on 2054 uncontrolled tanks and 0 tanks controlled at 0%.

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	15468	bbl/day-all wells
Number of Well Pads with Tanks:	1027	well pads
Tanks per wellsite:	2	tanks
Number of Well Pads with Controls:	0	well pads
Control Efficiency of tanks:	0	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 120.03 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	46.69	360.13
Ethane	30.07	16.516	4.97	0.132	19.82	286.69
Propane	44.10	16.909	7.46	0.198	20.30	430.45
i-Butane	58.12	3.694	2.15	0.057	4.43	123.93
n-Butane	58.12	9.044	5.26	0.140	10.86	303.43
i-Pentane	72.15	3.269	2.36	0.063	3.92	136.15
n-Pentane	72.15	4.297	3.10	0.082	5.16	178.97
Cyclopentane	70.10	0.361	0.25	0.007	0.43	14.61
Hexanes	86.18	2.285	1.97	0.052	2.74	113.67
Heptanes	100.20	1.423	1.43	0.038	1.71	82.31
Octanes	114.23	0.403	0.46	0.012	0.48	26.57
Nonanes	128.26	0.076	0.10	0.003	0.09	5.63
Decanes +	142.29	0.026	0.04	0.001	0.03	2.14
Benzene	78.11	0.106	0.08	0.002	0.13	4.78
Toluene	92.14	0.083	0.08	0.002	0.10	4.41
Ethylbenzene	106.17	0.004	0.00	0.000	0.00	0.25
Xylenes	106.17	0.023	0.02	0.001	0.03	1.41
n-Hexane	86.18	1.513	1.30	0.035	1.82	75.27
Nitrogen	28.01	0.612	0.17	0.005	0.73	9.90
Carbon Dioxide	44.01	0.460	0.20	0.005	0.55	11.69
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**52.23**	**1503.98**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**2.08**	**86.12**
TOTAL		**100.00**	**37.63**	**1.00**	**120.03**	**2172.38**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1503.98	0.00	1503.98

a Total wellsite flashing emissions are based on 2054 uncontrolled tanks and 0 tanks controlled at 0%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 15,468.4 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	15468.4	238.80

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	570	engines
Number of Ajax Engines	604	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	641.6
VOC	1.3	0.31	189.5

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	256.9
VOC [c]	0.51	0.12	69.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1174	143.73

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1174 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**432.75**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	heater treaters
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Number of wells with heater treaters	1174	wells
Number of wellpads with tanks	1027	well pads
Tanks per wellsite	2	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	283.54
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	140.62

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	0	well pads
Number of wellpads with tanks	1027	well pads
Tank vent gas to flares	0.00	scf/hr
Heating Value of Combusted Gas	2100	Btu/scf
Heat Rating	0.00	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.00	0.00

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2012 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	7.18
Net Throughput(gal/yr):	115,448.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2012 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2012 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	302.0420
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	115,448.0000
Annual Turnovers:	7.1820
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,183.4156

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

Emissions Report for: Annual

GMB 12/31/2012 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	302.04	881.37	1,183.42

APPENDIX B-3

PROPOSED ACTION DEVELOPMENT FOR 2013

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		December 31, 2013 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.3	0.6	7.9
	Drilling Tailpipe	3.8	0.3	4.0
	Drilling - Rigs	72.1	15.0	87.2
	Completion Tailpipe	11.0	0.8	11.9
	Completion Rigs	21.8	0.6	22.5
	Completion Venting	0.0	4.4	4.4
	Interim Reclamation Tailpipe	0.5	0.0	0.6
Production Emissions	Pump Unit Engines	765.4	217.8	983.2
	Production Heaters	255.2	124.9	380.1
	Wellsite Tanks - W&B	0.0	917.9	917.9
	Wellsite Tanks - Flashing	0.0	1,202.8	1,202.8
	Wellsite Truck Loading	0.0	228.9	228.9
	Wellsite Flares	0.9	0.0	0.9
	Wellsite Fugitives	0.0	423.9	423.9
	Wellsite Pneumatics	0.0	140.8	140.8
	Operations Vehicle	21.2	0.7	21.9
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,391**	**3,383**	**4,774**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.59
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.067

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{\text{453.6 (g/lb)} * \text{2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	85	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.020	7.39E-03	0.038	0.0016	3.76
VOC	3.16E-03	0.020	0.00084	3.54E-03	0.018	0.00078	0.28

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	11.05
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.81

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.54
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.044

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	2.5	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	72.14
VOC	2.20E-03	2.00	15.03

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	176	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	21.84
VOC [b]	0.090	0.28	0.0035	0.61

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	176	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	15.60
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	2.77
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.20
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.46
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	0.87
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.28
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.31
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.13
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.063
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.011
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0012
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00016
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0047
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0025
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00025
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.082
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.21
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.14
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0020
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**4.42**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.089**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**23.14**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	780,355	miles/year
Total Annual Pickup Mileage:	108,887	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.18	0.33	5.36E-02	11.46	20.91	21.24
VOC	1.61E-03	0.048	0.09	1.55E-03	0.33	0.60	0.69

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	14,830	bbls oil per day-all wells
Number of Well Pads with Tanks:	911	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	159	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	124,779	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.60	0.030	917.89

a Total wellsite working and breathing emissions are based on 1504 uncontrolled tanks and 318 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	14830	bbl/day-all wells
Number of Well Pads with Tanks:	911	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	159	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 115.08 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	44.76	345.27
Ethane	30.07	16.516	4.97	0.132	19.01	274.86
Propane	44.10	16.909	7.46	0.198	19.46	412.69
i-Butane	58.12	3.694	2.15	0.057	4.25	118.82
n-Butane	58.12	9.044	5.26	0.140	10.41	290.91
i-Pentane	72.15	3.269	2.36	0.063	3.76	130.53
n-Pentane	72.15	4.297	3.10	0.082	4.95	171.58
Cyclopentane	70.10	0.361	0.25	0.007	0.42	14.01
Hexanes	86.18	2.285	1.97	0.052	2.63	108.98
Heptanes	100.20	1.423	1.43	0.038	1.64	78.91
Octanes	114.23	0.403	0.46	0.012	0.46	25.48
Nonanes	128.26	0.076	0.10	0.003	0.09	5.39
Decanes +	142.29	0.026	0.04	0.001	0.03	2.05
Benzene	78.11	0.106	0.08	0.002	0.12	4.58
Toluene	92.14	0.083	0.08	0.002	0.10	4.23
Ethylbenzene	106.17	0.004	0.00	0.000	0.00	0.24
Xylenes	106.17	0.023	0.02	0.001	0.03	1.35
n-Hexane	86.18	1.513	1.30	0.035	1.74	72.16
Nitrogen	28.01	0.612	0.17	0.005	0.70	9.49
Carbon Dioxide	44.01	0.460	0.20	0.005	0.53	11.20
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**50.08**	**1441.93**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**1.99**	**82.56**
TOTAL		**100.00**	**37.63**	**1.00**	**115.08**	**2082.75**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1190.26	12.58	1202.84

a Total wellsite flashing emissions are based on 1504 uncontrolled tanks and 318 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 14,830.2 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	14830.2	228.94

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	746	engines
Number of Ajax Engines	404	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	429.1
VOC	1.3	0.31	126.8

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	336.3
VOC [c]	0.51	0.12	91.0

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1150	140.80

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1150 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**423.91**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Number of wells with heater treaters	1070	wells
Number of wellpads with tanks	911	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	255.20
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	124.94

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	159	well pads
Vent gas from each well pad	9.28	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0013	0.0058	0.21	0.92

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2013 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	8.01
Net Throughput(gal/yr):	124,779.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2013 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2013 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	326.4543
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	124,779.0000
Annual Turnovers:	8.0147
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,207.8279

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

Emissions Report for: Annual

GMB 12/31/2013 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	326.45	881.37	1,207.83

APPENDIX B-4

PROPOSED ACTION DEVELOPMENT FOR 2014

116133.3/LIT13R0350

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		December 31, 2014 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.3	0.6	8.0
	Drilling Tailpipe	3.8	0.3	4.0
	Drilling - Rigs	72.1	15.0	87.2
	Completion Tailpipe	12.3	0.9	13.2
	Completion Rigs	24.3	0.7	25.0
	Completion Venting	0.0	4.9	4.9
	Interim Reclamation Tailpipe	0.6	0.0	0.6
Production Emissions	Pump Unit Engines	641.3	179.0	820.3
	Production Heaters	233.6	112.3	345.9
	Wellsite Tanks - W&B	0.0	827.0	827.0
	Wellsite Tanks - Flashing	0.0	1,245.2	1,245.2
	Wellsite Truck Loading	0.0	249.7	249.7
	Wellsite Flares	1.2	0.0	1.2
	Wellsite Fugitives	0.0	422.4	422.4
	Wellsite Pneumatics	0.0	140.3	140.3
	Operations Vehicle	22.9	0.7	23.7
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,252**	**3,302**	**4,554**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.65
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.075

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	77	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.018	7.39E-03	0.038	0.0015	3.76
VOC	3.16E-03	0.020	0.00075	3.54E-03	0.018	0.00070	0.28

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	12.30
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.91

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.60
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.049

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	2.5	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	72.14
VOC	2.20E-03	2.00	15.03

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2014 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	196	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	24.32
VOC [b]	0.090	0.28	0.0035	0.68

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	196	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	17.37
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.08
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.46
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.52
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	0.96
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.31
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.35
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.15
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.071
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.013
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0013
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00018
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0052
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0027
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00027
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.091
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.23
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.15
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0022
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**4.93**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.099**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**25.77**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	843,873	miles/year
Total Annual Pickup Mileage:	99,813	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.17	0.30	5.36E-02	12.39	22.62	22.92
VOC	1.61E-03	0.044	0.08	1.55E-03	0.36	0.65	0.73

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	16173.3	bbls oil per day-all wells
Number of Well Pads with Tanks:	817	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	179	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	151,736	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.64	0.032	827.03

a Total wellsite working and breathing emissions are based on 1276 uncontrolled tanks and 358 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	16173	bbl/day-all wells
Number of Well Pads with Tanks:	817	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	179	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 125.50 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	48.81	376.54
Ethane	30.07	16.516	4.97	0.132	20.73	299.75
Propane	44.10	16.909	7.46	0.198	21.22	450.07
i-Butane	58.12	3.694	2.15	0.057	4.64	129.58
n-Butane	58.12	9.044	5.26	0.140	11.35	317.26
i-Pentane	72.15	3.269	2.36	0.063	4.10	142.36
n-Pentane	72.15	4.297	3.10	0.082	5.39	187.12
Cyclopentane	70.10	0.361	0.25	0.007	0.45	15.27
Hexanes	86.18	2.285	1.97	0.052	2.87	118.85
Heptanes	100.20	1.423	1.43	0.038	1.79	86.06
Octanes	114.23	0.403	0.46	0.012	0.51	27.78
Nonanes	128.26	0.076	0.10	0.003	0.10	5.88
Decanes +	142.29	0.026	0.04	0.001	0.03	2.23
Benzene	78.11	0.106	0.08	0.002	0.13	5.00
Toluene	92.14	0.083	0.08	0.002	0.10	4.62
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.26
Xylenes	106.17	0.023	0.02	0.001	0.03	1.47
n-Hexane	86.18	1.513	1.30	0.035	1.90	78.70
Nitrogen	28.01	0.612	0.17	0.005	0.77	10.35
Carbon Dioxide	44.01	0.460	0.20	0.005	0.58	12.22
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**54.61**	**1572.51**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**2.17**	**90.04**
TOTAL		**100.00**	**37.63**	**1.00**	**125.50**	**2271.37**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1227.98	17.23	1245.21

a Total wellsite flashing emissions are based on 1276 uncontrolled tanks and 358 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 16,173 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	16173.3	249.68

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	942	engines
Number of Ajax Engines	204	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	216.7
VOC	1.3	0.31	64.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	424.6
VOC [c]	0.51	0.12	115.0

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1146	140.31

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1146 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**422.43**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	996	wells
Number of wellpads with tanks	817	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	233.56
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	112.31

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	179	well pads
Vent gas from each well pad	10.65	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0015	0.0067	0.27	1.19

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2014 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	9.44
Net Throughput(gal/yr):	151,736.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2014 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2014 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	396.9808
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	151,736.0000
Annual Turnovers:	9.4395
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,278.3545

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

Emissions Report for: Annual

GMB 12/31/2014 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	396.98	881.37	1,278.35

APPENDIX B-5

PROPOSED ACTION DEVELOPMENT FOR 2015

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		December 31, 2015 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.1
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	86.6	18.0	104.6
	Completion Tailpipe	14.7	1.1	15.8
	Completion Rigs	29.2	0.8	30.0
	Completion Venting	0.0	5.9	5.9
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	534.8	144.9	679.7
	Production Heaters	236.5	111.0	347.5
	Wellsite Tanks - W&B	0.0	811.6	811.6
	Wellsite Tanks - Flashing	0.0	1,412.3	1,412.3
	Wellsite Truck Loading	0.0	305.8	305.8
	Wellsite Flares	1.8	0.0	1.8
	Wellsite Fugitives	0.0	380.0	380.0
	Wellsite Pneumatics	0.0	144.6	144.6
	Operations Vehicle	28.0	0.9	28.9
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,176**	**3,441**	**4,617**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.78
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.090

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	77	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.018	7.39E-03	0.038	0.0015	4.51
VOC	3.16E-03	0.020	0.00075	3.54E-03	0.018	0.00070	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	14.75
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.72
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.059

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	86.57
VOC	2.20E-03	2.00	18.04

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	235	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	29.16
VOC [b]	0.090	0.28	0.0035	0.82

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	235	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	20.83
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.70
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.94
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.62
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.16
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.37
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.42
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.18
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.085
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.015
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00022
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0063
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0033
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00033
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.109
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.28
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.18
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0026
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**5.91**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.119**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**30.90**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,034,425	miles/year
Total Annual Pickup Mileage:	99,813	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.17	0.30	5.36E-02	15.19	27.72	28.02
VOC	1.61E-03	0.044	0.08	1.55E-03	0.44	0.80	0.88

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	19808.9	bbls oil per day-all wells
Number of Well Pads with Tanks:	805	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	226	well pads
Control Efficiency of tanks:	95	%
Throughput:	188,615	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.69	0.034	811.57

a Total wellsite working and breathing emissions are based on 1158 uncontrolled tanks and 452 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	19808.91	bbl/day-all wells
Number of Well Pads with Tanks:	805	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	226	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 153.72 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	59.79	461.18
Ethane	30.07	16.516	4.97	0.132	25.39	367.13
Propane	44.10	16.909	7.46	0.198	25.99	551.24
i-Butane	58.12	3.694	2.15	0.057	5.68	158.71
n-Butane	58.12	9.044	5.26	0.140	13.90	388.57
i-Pentane	72.15	3.269	2.36	0.063	5.03	174.36
n-Pentane	72.15	4.297	3.10	0.082	6.61	229.19
Cyclopentane	70.10	0.361	0.25	0.007	0.55	18.71
Hexanes	86.18	2.285	1.97	0.052	3.51	145.57
Heptanes	100.20	1.423	1.43	0.038	2.19	105.40
Octanes	114.23	0.403	0.46	0.012	0.62	34.03
Nonanes	128.26	0.076	0.10	0.003	0.12	7.21
Decanes +	142.29	0.026	0.04	0.001	0.04	2.73
Benzene	78.11	0.106	0.08	0.002	0.16	6.12
Toluene	92.14	0.083	0.08	0.002	0.13	5.65
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.31
Xylenes	106.17	0.023	0.02	0.001	0.04	1.81
n-Hexane	86.18	1.513	1.30	0.035	2.33	96.39
Nitrogen	28.01	0.612	0.17	0.005	0.94	12.67
Carbon Dioxide	44.01	0.460	0.20	0.005	0.71	14.97
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**66.89**	**1926.00**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**2.66**	**110.28**
TOTAL		**100.00**	**37.63**	**1.00**	**153.71**	**2781.95**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1385.29	27.04	1412.32

a Total wellsite flashing emissions are based on 1158 uncontrolled tanks and 452 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 19,808.9 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	19808.9	305.80

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1177	engines
Number of Ajax Engines	4	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	4.2
VOC	1.3	0.31	1.3

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	530.6
VOC [c]	0.51	0.12	143.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1181	144.59

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1181 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**380.04**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1031	wells
Number of wellpads with tanks	805	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	236.52
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	111.01

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	226	well pads
Vent gas from each well pad	12.53	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0078	0.40	1.77

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2015 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	11.73
Net Throughput(gal/yr):	188,615.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2015 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2015 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	493.4659
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	188,615.0000
Annual Turnovers:	11.7338
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,374.8395

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

Emissions Report for: Annual

GMB 12/31/2015 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	493.47	881.37	1,374.84

APPENDIX B-6

PROPOSED ACTION DEVELOPMENT FOR 2016

116133.3/LIT13R0350

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		December 31, 2016 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	86.6	18.0	104.6
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.3	0.9	31.1
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	574.7	155.6	730.3
	Production Heaters	254.4	117.5	371.9
	Wellsite Tanks - W&B	0.0	855.4	855.4
	Wellsite Tanks - Flashing	0.0	1,631.5	1,631.5
	Wellsite Truck Loading	0.0	374.0	374.0
	Wellsite Flares	2.4	0.0	2.4
	Wellsite Fugitives	0.0	470.0	470.0
	Wellsite Pneumatics	0.0	156.1	156.1
	Operations Vehicle	34.3	1.1	35.4
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,243**	**3,891**	**5,134**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00072	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.31
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	86.57
VOC	2.20E-03	2.00	18.04

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

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Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	244	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.28
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	244	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.63
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.84
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.06
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.20
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.39
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.13**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.124**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**32.08**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,270,346	miles/year
Total Annual Pickup Mileage:	99,813	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.17	0.30	5.36E-02	18.65	34.05	34.35
VOC	1.61E-03	0.044	0.08	1.55E-03	0.54	0.98	1.06

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	24226.3	bbls oil per day-all wells
Number of Well Pads with Tanks:	850	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	275	well pads
Control Efficiency of tanks:	95	%
Throughput:	218,464	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.73	0.036	855.41

a Total wellsite working and breathing emissions are based on 1150 uncontrolled tanks and 550 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	24226.28	bbl/day-all wells
Number of Well Pads with Tanks:	850	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	275	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 188.00 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	73.12	564.02
Ethane	30.07	16.516	4.97	0.132	31.05	449.00
Propane	44.10	16.909	7.46	0.198	31.79	674.17
i-Butane	58.12	3.694	2.15	0.057	6.94	194.10
n-Butane	58.12	9.044	5.26	0.140	17.00	475.22
i-Pentane	72.15	3.269	2.36	0.063	6.15	213.24
n-Pentane	72.15	4.297	3.10	0.082	8.08	280.29
Cyclopentane	70.10	0.361	0.25	0.007	0.68	22.88
Hexanes	86.18	2.285	1.97	0.052	4.30	178.03
Heptanes	100.20	1.423	1.43	0.038	2.68	128.91
Octanes	114.23	0.403	0.46	0.012	0.76	41.62
Nonanes	128.26	0.076	0.10	0.003	0.14	8.81
Decanes +	142.29	0.026	0.04	0.001	0.05	3.34
Benzene	78.11	0.106	0.08	0.002	0.20	7.49
Toluene	92.14	0.083	0.08	0.002	0.16	6.91
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.38
Xylenes	106.17	0.023	0.02	0.001	0.04	2.21
n-Hexane	86.18	1.513	1.30	0.035	2.84	117.88
Nitrogen	28.01	0.612	0.17	0.005	1.15	15.50
Carbon Dioxide	44.01	0.460	0.20	0.005	0.86	18.30
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**81.81**	**2355.50**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**3.25**	**134.88**
TOTAL		**100.00**	**37.63**	**1.00**	**187.99**	**3402.33**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1593.43	38.10	1631.53

a Total wellsite flashing emissions are based on 1150 uncontrolled tanks and 550 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 24,226.3 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	24226.3	374.00

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1275	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	574.7
VOC [c]	0.51	0.12	155.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1275	156.10

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1275 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**469.98**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1125	wells
Number of wellpads with tanks	850	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	254.43
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	117.47

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	275	well pads
Vent gas from each well pad	14.05	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0020	0.0088	0.55	2.42

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2016 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	218,464.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2016 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2016 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	571.5586
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	218,464.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,452.9323

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

Emissions Report for: Annual

GMB 12/31/2016 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	571.56	881.37	1,452.93

APPENDIX B-7

PROPOSED ACTION DEVELOPMENT FOR 2017

116133.3/LIT13R0350

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		December 31, 2017 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	86.6	18.0	104.6
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	684.3	185.2	869.5
	Production Heaters	310.7	144.2	454.9
	Wellsite Tanks - W&B	0.0	1,047.4	1,047.4
	Wellsite Tanks - Flashing	0.0	1,932.4	1,932.4
	Wellsite Truck Loading	0.0	435.1	435.1
	Wellsite Flares	2.7	0.0	2.7
	Wellsite Fugitives	0.0	504.3	504.3
	Wellsite Pneumatics	0.0	185.9	185.9
	Operations Vehicle	39.8	1.2	41.0
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,414**	**4,566**	**5,980**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	86.57
VOC	2.20E-03	2.00	18.04

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2017 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,469,972	miles/year
Total Annual Pickup Mileage:	127,035	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.21	0.38	5.36E-02	21.59	39.40	39.78
VOC	1.61E-03	0.056	0.10	1.55E-03	0.62	1.14	1.24

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2017 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	28184.3	bbls oil per day-all wells
Number of Well Pads with Tanks:	1044	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	324	well pads
Control Efficiency of tanks:	95	%
Throughput:	206,928	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.71	0.036	1047.43

a Total wellsite working and breathing emissions are based on 1440 uncontrolled tanks and 648 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	28184.34	bbl/day-all wells
Number of Well Pads with Tanks:	1044	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	324	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 218.71 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	85.07	656.17
Ethane	30.07	16.516	4.97	0.132	36.12	522.36
Propane	44.10	16.909	7.46	0.198	36.98	784.31
i-Butane	58.12	3.694	2.15	0.057	8.08	225.82
n-Butane	58.12	9.044	5.26	0.140	19.78	552.86
i-Pentane	72.15	3.269	2.36	0.063	7.15	248.08
n-Pentane	72.15	4.297	3.10	0.082	9.40	326.09
Cyclopentane	70.10	0.361	0.25	0.007	0.79	26.62
Hexanes	86.18	2.285	1.97	0.052	5.00	207.12
Heptanes	100.20	1.423	1.43	0.038	3.11	149.97
Octanes	114.23	0.403	0.46	0.012	0.88	48.42
Nonanes	128.26	0.076	0.10	0.003	0.17	10.25
Decanes +	142.29	0.026	0.04	0.001	0.06	3.89
Benzene	78.11	0.106	0.08	0.002	0.23	8.71
Toluene	92.14	0.083	0.08	0.002	0.18	8.04
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.45
Xylenes	106.17	0.023	0.02	0.001	0.05	2.57
n-Hexane	86.18	1.513	1.30	0.035	3.31	137.14
Nitrogen	28.01	0.612	0.17	0.005	1.34	18.03
Carbon Dioxide	44.01	0.460	0.20	0.005	1.01	21.29
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**95.17**	**2740.34**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**3.78**	**156.91**
TOTAL		**100.00**	**37.63**	**1.00**	**218.71**	**3958.19**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1889.89	42.52	1932.41

a Total wellsite flashing emissions are based on 1440 uncontrolled tanks and 648 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 28,184.3 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	28184.3	435.10

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1518	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	684.3
VOC [c]	0.51	0.12	185.2

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1518	185.85

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1518 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**504.26**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1368	wells
Number of wellpads with tanks	1044	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	310.72
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	144.18

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	324	well pads
Vent gas from each well pad	13.46	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0084	0.62	2.73

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2017 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	206,928.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2017 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2017 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	541.3774
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	206,928.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,422.7511

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

Emissions Report for: Annual

GMB 12/31/2017 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	541.38	881.37	1,422.75

APPENDIX B-8

PROPOSED ACTION DEVELOPMENT FOR 2018

116133.3/LIT13R0350

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		December 31, 2018 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	793.8	214.9	1,008.7
	Production Heaters	367.0	170.9	537.9
	Wellsite Tanks - W&B	0.0	1,283.9	1,283.9
	Wellsite Tanks - Flashing	0.0	2,223.5	2,223.5
	Wellsite Truck Loading	0.0	494.6	494.6
	Wellsite Flares	3.1	0.0	3.1
	Wellsite Fugitives	0.0	649.1	649.1
	Wellsite Pneumatics	0.0	215.6	215.6
	Operations Vehicle	45.4	1.4	46.8
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,547**	**5,369**	**6,915**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2018 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,678,672	miles/year
Total Annual Pickup Mileage:	145,182	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.24	0.44	5.36E-02	24.65	44.99	45.43
VOC	1.61E-03	0.064	0.12	1.55E-03	0.71	1.30	1.42

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2018 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	32038.8	bbls oil per day all wells
Number of Well Pads with Tanks:	1238	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	373	well pads
Control Efficiency of tanks:	95	%
Throughput:	198,366	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.73	0.036	1283.88

a Total wellsite working and breathing emissions are based on 1730 uncontrolled tanks and 746 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	32038.81	bbl/day-all wells
Number of Well Pads with Tanks:	1238	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	373	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 248.62 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	96.70	745.91
Ethane	30.07	16.516	4.97	0.132	41.06	593.80
Propane	44.10	16.909	7.46	0.198	42.04	891.57
i-Butane	58.12	3.694	2.15	0.057	9.18	256.70
n-Butane	58.12	9.044	5.26	0.140	22.49	628.47
i-Pentane	72.15	3.269	2.36	0.063	8.13	282.00
n-Pentane	72.15	4.297	3.10	0.082	10.68	370.68
Cyclopentane	70.10	0.361	0.25	0.007	0.90	30.26
Hexanes	86.18	2.285	1.97	0.052	5.68	235.45
Heptanes	100.20	1.423	1.43	0.038	3.54	170.48
Octanes	114.23	0.403	0.46	0.012	1.00	55.04
Nonanes	128.26	0.076	0.10	0.003	0.19	11.65
Decanes +	142.29	0.026	0.04	0.001	0.06	4.42
Benzene	78.11	0.106	0.08	0.002	0.26	9.90
Toluene	92.14	0.083	0.08	0.002	0.21	9.14
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.51
Xylenes	106.17	0.023	0.02	0.001	0.06	2.92
n-Hexane	86.18	1.513	1.30	0.035	3.76	155.90
Nitrogen	28.01	0.612	0.17	0.005	1.52	20.50
Carbon Dioxide	44.01	0.460	0.20	0.005	1.14	24.21
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**108.19**	**3115.10**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**4.30**	**178.37**
TOTAL		**100.00**	**37.63**	**1.00**	**248.62**	**4499.52**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	2176.55	46.93	2223.47

a Total wellsite flashing emissions are based on 1730 uncontrolled tanks and 746 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 32,038.8 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	32038.8	494.60

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1761	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	793.8
VOC [c]	0.51	0.12	214.9

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1761	215.60

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1761 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**649.13**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1611	wells
Number of wellpads with tanks	1238	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	367.02
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	170.90

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	373	well pads
Vent gas from each well pad	13.20	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0083	0.70	3.08

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2018 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	218,464.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2018 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2018 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	571.5586
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	218,463.9985
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,452.9323

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

Emissions Report for: Annual

GMB 12/31/2018 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	571.56	881.37	1,452.93

APPENDIX B-9

PROPOSED ACTION DEVELOPMENT FOR 2019

116133.3/LIT13R0350

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		December 31, 2019 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	903.4	244.6	1,147.9
	Production Heaters	423.3	197.6	620.9
	Wellsite Tanks - W&B	0.0	1,446.4	1,446.4
	Wellsite Tanks - Flashing	0.0	2,606.4	2,606.4
	Wellsite Truck Loading	0.0	574.7	574.7
	Wellsite Flares	3.5	0.0	3.5
	Wellsite Fugitives	0.0	738.7	738.7
	Wellsite Pneumatics	0.0	245.4	245.4
	Operations Vehicle	52.8	1.7	54.5
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,720**	**6,170**	**7,890**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2019 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.009	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,950,889	miles/year
Total Annual Pickup Mileage:	172,404	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.29	0.52	5.36E-02	28.65	52.28	52.81
VOC	1.61E-03	0.076	0.14	1.55E-03	0.83	1.51	1.65

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2019 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	37229.7	bbls oil per day all wells
Number of Well Pads with Tanks:	1432	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	422	well pads
Control Efficiency of tanks:	95	%
Throughput:	199,278	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	1446.37

a Total wellsite working and breathing emissions are based on 2020 uncontrolled tanks and 844 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	37229.74	bbl/day-all wells
Number of Well Pads with Tanks:	1432	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	422	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 288.90 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	112.37	866.76
Ethane	30.07	16.516	4.97	0.132	47.72	690.01
Propane	44.10	16.909	7.46	0.198	48.85	1036.03
i-Butane	58.12	3.694	2.15	0.057	10.67	298.29
n-Butane	58.12	9.044	5.26	0.140	26.13	730.30
i-Pentane	72.15	3.269	2.36	0.063	9.44	327.69
n-Pentane	72.15	4.297	3.10	0.082	12.41	430.74
Cyclopentane	70.10	0.361	0.25	0.007	1.04	35.16
Hexanes	86.18	2.285	1.97	0.052	6.60	273.59
Heptanes	100.20	1.423	1.43	0.038	4.11	198.10
Octanes	114.23	0.403	0.46	0.012	1.16	63.96
Nonanes	128.26	0.076	0.10	0.003	0.22	13.54
Decanes +	142.29	0.026	0.04	0.001	0.08	5.14
Benzene	78.11	0.106	0.08	0.002	0.31	11.50
Toluene	92.14	0.083	0.08	0.002	0.24	10.63
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.59
Xylenes	106.17	0.023	0.02	0.001	0.07	3.39
n-Hexane	86.18	1.513	1.30	0.035	4.37	181.16
Nitrogen	28.01	0.612	0.17	0.005	1.77	23.82
Carbon Dioxide	44.01	0.460	0.20	0.005	1.33	28.13
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**125.72**	**3619.81**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**5.00**	**207.27**
TOTAL		**100.00**	**37.63**	**1.00**	**288.90**	**5228.53**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	2553.08	53.34	2606.42

a Total wellsite flashing emissions are based on 2020 uncontrolled tanks and 844 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 37,229.7 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	37229.7	574.74

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2004	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	903.4
VOC [c]	0.51	0.12	244.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2004	245.35

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2004 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**738.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1854	wells
Number of wellpads with tanks	1432	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	423.31
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	197.61

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	422	well pads
Vent gas from each well pad	13.07	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0082	0.79	3.45

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2019 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	199,278.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2019 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2019 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	521.3631
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	199,278.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,402.7367

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

Emissions Report for: Annual

GMB 12/31/2019 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	521.36	881.37	1,402.74

		December 31, 2019 Deep Gas Well Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	2.3	0.1	2.4
	Wellsite Tanks	0.0	8.5	8.5
	Wellsite Truck Loading	0.0	0.9	0.9
	Wellsite Dehydrators	0.0	0.2	0.2
	Wellsite Flares	0.1	0.0	0.1
	Wellsite Fugitives	0.0	6.9	6.9
	Wellsite Pneumatics	0.0	1.5	1.5
	Operations Vehicle	0.072	0.009	0.081
	Infrastructure	7.4	9.8	17.2
	Total Emissions	**37.1**	**29.3**	**66.4**

a) Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{\text{453.6 (g/lb)} * \text{2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.0087	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	1,675	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.027	5.36E-02	0.025	0.045	0.072
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.00071	0.0013	0.0086

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.188
Non-HC Wt. Fraction: 0.015
Total: 0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2019 Date: 4/26/2013

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	12	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	8.51

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 24.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	24.0	0.91

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.
b Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
12	1.47

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 12 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**6.87**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	12	producing wells
Number of wellpads with tanks	12	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	2.32
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.13

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	12	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.022	0.10

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	12	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.23

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	12	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	7.42
VOC	0.7	0.10	0.43	5.19

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	1.12

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	0.42

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B-10

PROPOSED ACTION DEVELOPMENT FOR 2020

116133.3/LIT13R0350

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		December 31, 2020 Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	1,012.9	274.2	1,287.1
	Production Heaters	479.6	224.3	703.9
	Wellsite Tanks - W&B	0.0	1,655.3	1,655.3
	Wellsite Tanks - Flashing	0.0	2,989.5	2,989.5
	Wellsite Truck Loading	0.0	654.9	654.9
	Wellsite Flares	3.9	0.0	3.9
	Wellsite Fugitives	0.0	828.3	828.3
	Wellsite Pneumatics	0.0	275.1	275.1
	Operations Vehicle	60.2	1.9	62.0
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,894**	**7,018**	**8,912**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	2,223,106	miles/year
Total Annual Pickup Mileage:	190,552	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.32	0.58	5.36E-02	32.65	59.58	60.16
VOC	1.61E-03	0.084	0.15	1.55E-03	0.94	1.72	1.88

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	42420.7	bbls oil per day all wells
Number of Well Pads with Tanks:	1626	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	471	well pads
Control Efficiency of tanks:	95	%
Throughput:	199,972	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	1655.33

a Total wellsite working and breathing emissions are based on 2310 uncontrolled tanks and 942 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	42420.68	bbl/day-all wells
Number of Well Pads with Tanks:	1626	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	471	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 329.18 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	128.03	987.62
Ethane	30.07	16.516	4.97	0.132	54.37	786.21
Propane	44.10	16.909	7.46	0.198	55.66	1180.48
i-Butane	58.12	3.694	2.15	0.057	12.16	339.88
n-Butane	58.12	9.044	5.26	0.140	29.77	832.12
i-Pentane	72.15	3.269	2.36	0.063	10.76	373.38
n-Pentane	72.15	4.297	3.10	0.082	14.15	490.80
Cyclopentane	70.10	0.361	0.25	0.007	1.19	40.06
Hexanes	86.18	2.285	1.97	0.052	7.52	311.74
Heptanes	100.20	1.423	1.43	0.038	4.68	225.72
Octanes	114.23	0.403	0.46	0.012	1.33	72.88
Nonanes	128.26	0.076	0.10	0.003	0.25	15.43
Decanes +	142.29	0.026	0.04	0.001	0.09	5.86
Benzene	78.11	0.106	0.08	0.002	0.35	13.11
Toluene	92.14	0.083	0.08	0.002	0.27	12.11
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.67
Xylenes	106.17	0.023	0.02	0.001	0.08	3.87
n-Hexane	86.18	1.513	1.30	0.035	4.98	206.42
Nitrogen	28.01	0.612	0.17	0.005	2.01	27.14
Carbon Dioxide	44.01	0.460	0.20	0.005	1.51	32.05
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**143.25**	**4124.52**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**5.69**	**236.17**
TOTAL		**100.00**	**37.63**	**1.00**	**329.18**	**5957.54**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	2929.78	59.74	2989.52

a Total wellsite flashing emissions are based on 2310 uncontrolled tanks and 942 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 42,420.7 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	42420.7	654.88

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2247	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	1,012.9
VOC [c]	0.51	0.12	274.2

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2247	275.10

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2247 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**828.28**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	2097	wells
Number of wellpads with tanks	1626	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	479.61
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	224.32

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	471	well pads
Vent gas from each well pad	13.11	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0082	0.88	3.86

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2020 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	199,972.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2020 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2020 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	523.1787
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	199,972.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,404.5524

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

Emissions Report for: Annual

GMB 12/31/2020 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	523.18	881.37	1,404.55

		December 31, 2020 Deep Gas Well Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	4.6	0.3	4.9
	Wellsite Tanks	0.0	17.0	17.0
	Wellsite Truck Loading	0.0	1.8	1.8
	Wellsite Dehydrators	0.0	0.5	0.5
	Wellsite Flares	0.2	0.0	0.2
	Wellsite Fugitives	0.0	13.7	13.7
	Wellsite Pneumatics	0.0	2.9	2.9
	Operations Vehicle	0.117	0.010	0.127
	Infrastructure	14.8	16.5	31.3
	Total Emissions	**47.0**	**54.2**	**101.2**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.0087	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	3,350	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.0274	5.36E-02	0.05	0.09	0.12
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.0014	0.003	0.010

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.188
Non-HC Wt. Fraction: 0.015
Total: 0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	24	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	17.03

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 48.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	48.0	1.82

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60°F.
b Assumes maximum development scenario

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
24	2.94

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Operations Wellsite Fugitives

Number of Producting Wells 24 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**13.74**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b VOC weight fractions from wellsite gas analysis and estimates

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	24	producing wells
Number of wellpads with tanks	24	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	4.64
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.26

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	24	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.044	0.19

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	24	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.45

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	24	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	14.83
VOC	0.7	0.10	0.43	10.38

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	2.24

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	0.84

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B-11

PROPOSED ACTION DEVELOPMENT FOR 2021

116133.3/LIT13R0350

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		December 31, 2021 Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	1,122.4	303.9	1,426.3
	Production Heaters	535.9	251.0	786.9
	Wellsite Tanks - W&B	0.0	1,864.3	1,864.3
	Wellsite Tanks - Flashing	0.0	3,372.7	3,372.7
	Wellsite Truck Loading	0.0	735.0	735.0
	Wellsite Flares	4.3	0.0	4.3
	Wellsite Fugitives	0.0	917.8	917.8
	Wellsite Pneumatics	0.0	304.9	304.9
	Operations Vehicle	67.5	2.1	69.6
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**2,067**	**7,866**	**9,934**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	2,495,323	miles/year
Total Annual Pickup Mileage:	217,774	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.36	0.66	5.36E-02	36.64	66.87	67.53
VOC	1.61E-03	0.096	0.18	1.55E-03	1.06	1.93	2.11

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	47611.6	bbls oil per day all wells
Number of Well Pads with Tanks:	1820	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	520	well pads
Control Efficiency of tanks:	95	%
Throughput:	200,518	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	1864.33

a Total wellsite working and breathing emissions are based on 2600 uncontrolled tanks and 1040 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	47611.61	bbl/day-all wells
Number of Well Pads with Tanks:	1820	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	520	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 369.47 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	143.70	1108.47
Ethane	30.07	16.516	4.97	0.132	61.02	882.42
Propane	44.10	16.909	7.46	0.198	62.47	1324.93
i-Butane	58.12	3.694	2.15	0.057	13.65	381.47
n-Butane	58.12	9.044	5.26	0.140	33.41	933.95
i-Pentane	72.15	3.269	2.36	0.063	12.08	419.07
n-Pentane	72.15	4.297	3.10	0.082	15.88	550.86
Cyclopentane	70.10	0.361	0.25	0.007	1.33	44.96
Hexanes	86.18	2.285	1.97	0.052	8.44	349.89
Heptanes	100.20	1.423	1.43	0.038	5.26	253.34
Octanes	114.23	0.403	0.46	0.012	1.49	81.79
Nonanes	128.26	0.076	0.10	0.003	0.28	17.32
Decanes +	142.29	0.026	0.04	0.001	0.10	6.57
Benzene	78.11	0.106	0.08	0.002	0.39	14.71
Toluene	92.14	0.083	0.08	0.002	0.31	13.59
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.75
Xylenes	106.17	0.023	0.02	0.001	0.08	4.34
n-Hexane	86.18	1.513	1.30	0.035	5.59	231.68
Nitrogen	28.01	0.612	0.17	0.005	2.26	30.46
Carbon Dioxide	44.01	0.460	0.20	0.005	1.70	35.97
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**160.78**	**4629.23**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**6.39**	**265.07**
TOTAL		**100.00**	**37.63**	**1.00**	**369.46**	**6686.55**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	3306.59	66.13	3372.73

a Total wellsite flashing emissions are based on 2600 uncontrolled tanks and 1040 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 47,611.6 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	47611.6	735.01

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2490	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	1,122.4
VOC [c]	0.51	0.12	303.9

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2490	304.85

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2490 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**917.85**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	2340	wells
Number of wellpads with tanks	1820	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	535.91
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	251.04

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	520	well pads
Vent gas from each well pad	13.13	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0082	0.98	4.27

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2021 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	200,518.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2021 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2021 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	524.6072
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	200,518.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,405.9809

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

Emissions Report for: Annual

GMB 12/31/2021 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	524.61	881.37	1,405.98

		December 31, 2021 Deep Gas Well Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	7.0	0.4	7.3
	Wellsite Tanks	0.0	25.5	25.5
	Wellsite Truck Loading	0.0	2.7	2.7
	Wellsite Dehydrators	0.0	0.7	0.7
	Wellsite Flares	0.3	0.0	0.3
	Wellsite Fugitives	0.0	20.6	20.6
	Wellsite Pneumatics	0.0	4.4	4.4
	Operations Vehicle	0.162	0.011	0.173
	Infrastructure	22.2	23.2	45.5
	Total Emissions	**56.9**	**79.0**	**135.9**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

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Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/hp-hr)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.009	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	5,026	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.0274	5.36E-02	0.07	0.13	0.16
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.0021	0.004	0.011

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: GMBU Deep Gas Wells December 31, 2021
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Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.188
Non-HC Wt. Fraction: 0.015
Total: 0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	36	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	25.54

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 72.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	72.0	2.72

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60°F.
b Assumes maximum development scenario

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
36	4.41

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Operations Wellsite Fugitives

Number of Producting Wells 36 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**20.61**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b VOC weight fractions from wellsite gas analysis and estimates

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	36	producing wells
Number of wellpads with tanks	36	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	6.96
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.38

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	36	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.066	0.29

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	36	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.68

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	36	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	22.25
VOC	0.7	0.10	0.43	15.57

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	3.37

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	1.26

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B-12

PROPOSED ACTION DEVELOPMENT FOR 2022

116133.3/LIT13R0350

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		December 31, 2022 Emissions (tpy) [a]		
	Source ID	NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	1,232.0	333.5	1,565.5
	Production Heaters	592.2	277.8	870.0
	Wellsite Tanks - W&B	0.0	2,073.3	2,073.3
	Wellsite Tanks - Flashing	0.0	3,756.0	3,756.0
	Wellsite Truck Loading	0.0	815.1	815.1
	Wellsite Flares	4.7	0.0	4.7
	Wellsite Fugitives	0.0	1,007.4	1,007.4
	Wellsite Pneumatics	0.0	334.6	334.6
	Operations Vehicle	74.9	2.3	77.2
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**2,241**	**8,715**	**10,956**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{\text{453.6 (g/lb)} * \text{2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	2,767,540	miles/year
Total Annual Pickup Mileage:	235,921	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.39	0.71	5.36E-02	40.64	74.17	74.88
VOC	1.61E-03	0.104	0.19	1.55E-03	1.18	2.14	2.33

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	52802.5	bbls oil per day all wells
Number of Well Pads with Tanks:	2014	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	569	well pads
Control Efficiency of tanks:	95	%
Throughput:	200,959	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	2073.34

a Total wellsite working and breathing emissions are based on 2890 uncontrolled tanks and 1138 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	52802.54	bbl/day-all wells
Number of Well Pads with Tanks:	2014	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	569	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 409.75 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	159.37	1229.32
Ethane	30.07	16.516	4.97	0.132	67.67	978.63
Propane	44.10	16.909	7.46	0.198	69.28	1469.38
i-Butane	58.12	3.694	2.15	0.057	15.14	423.06
n-Butane	58.12	9.044	5.26	0.140	37.06	1035.77
i-Pentane	72.15	3.269	2.36	0.063	13.39	464.76
n-Pentane	72.15	4.297	3.10	0.082	17.61	610.91
Cyclopentane	70.10	0.361	0.25	0.007	1.48	49.87
Hexanes	86.18	2.285	1.97	0.052	9.36	388.04
Heptanes	100.20	1.423	1.43	0.038	5.83	280.96
Octanes	114.23	0.403	0.46	0.012	1.65	90.71
Nonanes	128.26	0.076	0.10	0.003	0.31	19.21
Decanes +	142.29	0.026	0.04	0.001	0.11	7.29
Benzene	78.11	0.106	0.08	0.002	0.43	16.32
Toluene	92.14	0.083	0.08	0.002	0.34	15.07
Ethylbenzene	106.17	0.004	0.00	0.000	0.02	0.84
Xylenes	106.17	0.023	0.02	0.001	0.09	4.81
n-Hexane	86.18	1.513	1.30	0.035	6.20	256.94
Nitrogen	28.01	0.612	0.17	0.005	2.51	33.78
Carbon Dioxide	44.01	0.460	0.20	0.005	1.88	39.89
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**178.31**	**5133.94**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**7.08**	**293.97**
TOTAL		**100.00**	**37.63**	**1.00**	**409.74**	**7415.56**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	3683.49	72.52	3756.01

a Total wellsite flashing emissions are based on 2890 uncontrolled tanks and 1138 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 52,802.5 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	52802.5	815.15

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2733	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	1,232.0
VOC [c]	0.51	0.12	333.5

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2733	334.60

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2733 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**1007.42**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	2583	wells
Number of wellpads with tanks	2014	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	592.20
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	277.75

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	569	well pads
Vent gas from each well pad	13.16	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0082	1.07	4.68

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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

Identification

User Identification:	GMB 12/31/2022 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	200,959.00
Is Tank Heated (y/n):	N

Paint Characteristics

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

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

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

GMB 12/31/2022 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMB 12/31/2022 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	525.7610
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	200,959.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,407.1346

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

Emissions Report for: Annual

GMB 12/31/2022 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	525.76	881.37	1,407.13

		December 31, 2022 Deep Gas Well Emissions (tpy) [a]		
	Source ID	**NO_X**	**VOC**	**NOx+VOC**
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	9.3	0.5	9.8
	Wellsite Tanks	0.0	34.1	34.1
	Wellsite Truck Loading	0.0	3.6	3.6
	Wellsite Dehydrators	0.0	0.9	0.9
	Wellsite Flares	0.4	0.0	0.4
	Wellsite Fugitives	0.0	27.5	27.5
	Wellsite Pneumatics	0.0	5.9	5.9
	Operations Vehicle	0.207	0.012	0.220
	Infrastructure	29.7	30.0	59.6
	Total Emissions	**66.7**	**103.9**	**170.6**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.009	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	6,701	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.0274	5.36E-02	0.10	0.18	0.21
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.0028	0.005	0.012

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.188
Non-HC Wt. Fraction: 0.015
Total: 0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	48	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	34.05

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 96.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	96.0	3.63

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60°F.
b Assumes maximum development scenario

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
48	5.88

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 48 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**27.48**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	48	producing wells
Number of wellpads with tanks	48	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	9.28
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.51

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	48	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.088	0.39

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	48	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.91

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	48	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	29.66
VOC	0.7	0.10	0.43	20.76

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	4.49

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	1.69

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX C

ALTERNATIVE B -- NO ACTION EMISSIONS

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Project: GMBU - Alternative B

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative B [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	18.2	6.5	1.6	0.0003	9.3	3.2
	Drilling	821.3	451.5	166.1	0.9	216.3	45.6
	Completion	90.6	39.5	10.3	0.05	347.0	38.1
	Interim Reclamation	1.1	1.2	0.09	0.001	24.1	2.5
	Wind Erosion	---	---	---	---	2.0	0.3
Wellsite Production Emissions	Pump Unit Engines	505.3	428.7	147.3	0.3	28.7	28.7
	Production Heaters	150.9	126.8	8.3	0.9	11.5	11.5
	Wellsite Tanks	---	---	967.2	---	---	---
	Pneumatics	---	---	96.5	---	---	---
	Fugitives	---	---	334.9	---	---	---
	Wellsite Dehydrators	---	---	79.0	---	---	---
	Wellsite Truck Loading	---	---	73.8	---	---	---
	Operations Vehicle	5.2	2.6	0.2	0.004	129.4	13.3
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	21.7	---	---	---
	Water Treatment Fugitives	---	---	0.9	---	---	---
	Water Treatment Generator	18.8	37.6	13.1	0.05	1.5	1.5
Gas Processing Plant	Gas Plant Compressor Engines	11.6	23.2	8.1	0.03	0.9	0.9
	Gas Plant Heaters	0.6	0.5	0.04	0.004	0.05	0.05
	Gas Plant Flares	0.9	4.9	---	---	---	---
	Gas Plant Fugitives	---	---	0.8	---	---	---
	Gas Plant Dehydrator	---	---	11.7	---	---	---
Gas and Oil Separation Plant	GOSP Heaters	14.2	11.9	0.8	0.1	1.1	1.1
	GOSP Fugitives	---	---	11.6	---	---	---
	GOSP Generators	18.8	37.6	13.1	0.05	1.5	1.5
	GOSP Flare	0.9	4.9	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	1.2	0.2	3.9	0.001	25.9	2.7
Compressor Station Emissions	Compressor Station Engines	154.5	309.0	108.1	0.3	5.6	5.6
	Compressor Station Tanks	---	---	2.6	---	---	---
	Compressor Station Dehydrator	---	---	23.4	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.1	0.03	5.6	0.0001	5.2	0.5
	Compressor Station Dehydrator Heater	1.3	1.1	0.1	0.01	0.1	0.1
	Compressor Station Flare	1.8	9.7	---	---	---	---
	Compressor Station Fugitives	---	---	6.1	---	---	---
	Total Emissions	**1,817.3**	**1,497.4**	**2,116.9**	**2.8**	**810.1**	**157.0**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative B

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	18.2	821.3	90.6	1.1	---	931.2
CO	6.5	451.5	39.5	1.2	---	498.7
VOC	1.6	166.1	10.3	0.09	---	178.1
SO_2	0.0003	0.9	0.05	0.001	---	1.0
PM_{10}	9.3	216.3	347.0	24.1	2.0	598.7
$PM_{2.5}$	3.2	45.6	38.1	2.5	0.3	89.6
Hazardous Air Pollutants						
Benzene	---	0.40	0.022	---	---	0.43
Toluene	---	0.15	0.0091	---	---	0.16
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.10	0.0040	---	---	0.10
n-Hexane	---	---	0.12	---	---	0.12
Formaldehyde	---	0.041	0.0015	---	---	0.043
Acetaldehyde	---	0.013	0.00048	---	---	0.014
Acrolein	---	0.0041	0.00015	---	---	0.0043
Naphthalene	---	0.068	0.0025	---	---	0.070
POM 2	---	0.040	0.0015	---	---	0.042
POM 5	---	0.00031	0.000011	---	---	0.00033
POM 6	---	0.0012	0.000045	---	---	0.0013
POM 7	---	0.00080	0.000029	---	---	0.00083
Greenhouses Gases						
CO_2	440.6	88,196	5,998	112	---	94,746
CH_4	0.0016	3.52	23.68	0.0037	---	27.21
N_2O	0.00057	0.71	0.047	0.0012	---	0.76
CO_2e	440.8	88,490	6,510	112	---	95,553

a Assumes maximum development scenario of 360 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier II drill rig engines

Project: GMBU - Alternative B

Date: 7/15/2013

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Pump Engines	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	505.3	150.9	---	---	---	---	---	5.2	661.4
CO	428.7	126.8	---	---	---	---	---	2.6	558.1
VOC	147.3	8.3	967.2	334.9	73.8	96.5	79.0	0.2	1,707.2
SO_2	0.3	0.9	---	---	---	---	---	0.004	1.3
PM_{10}	28.7	11.5	---	---	---	---	---	129.4	169.6
$PM_{2.5}$	28.7	11.5	---	---	---	---	---	13.3	53.4
Hazardous Air Pollutants									
Benzene	1.15	0.0032	4.04	0.92	0.34	0.10	4.60	---	11.16
Toluene	0.57	0.0051	4.81	0.96	0.43	0.054	19.46	---	26.29
Ethylbenzene	0.064	---	0.24	0.04	0.021	---	5.71	---	6.07
Xylene	0.16	---	1.62	0.31	0.15	0.0054	40.55	---	42.79
n-Hexane	0.26	2.72	44.79	11.77	3.31	1.78	---	---	64.63
Formaldehyde	32.77	0.11	---	---	---	---	---	---	32.89
Acetaldehyde	4.61	---	---	---	---	---	---	---	4.61
Acrolein	4.62	---	---	---	---	---	---	---	4.62
Methanol	1.47	---	---	---	---	---	---	---	1.47
1,1,2,2-Tetrachloroethane	0.039	---	---	---	---	---	---	---	0.04
1,1,2-Trichloroethane	0.031	---	---	---	---	---	---	---	0.03
1,3-Dichloropropene	0.026	---	---	---	---	---	---	---	0.03
1,3-Butadiene	0.49	---	---	---	---	---	---	---	0.49
2,2,4-Trimethylpentane	0.50	---	---	---	---	---	---	---	0.50
Biphenyl	0.0023	---	---	---	---	---	---	---	0.002
Carbon Tetrachloride	0.036	---	---	---	---	---	---	---	0.04
Chlorobenzene	0.026	---	---	---	---	---	---	---	0.03
Chloroform	0.028	---	---	---	---	---	---	---	0.03
Dichlorobenzene	---	0.0018	---	---	---	---	---	---	0.0018
Ethylene Dibromide	0.044	---	---	---	---	---	---	---	0.04
Methylene Chloride	0.087	---	---	---	---	---	---	---	0.09
Naphthalene	0.057	0.00092	---	---	---	---	---	---	0.06
Phenol	0.025	---	---	---	---	---	---	---	0.02
Styrene	0.033	---	---	---	---	---	---	---	0.03
Vinyl Chloride	0.015	---	---	---	---	---	---	---	0.015
PAH -POM 1	0.080	---	---	---	---	---	---	---	0.08
POM 2	0.020	0.000089	---	---	---	---	---	---	0.02
POM 3	---	0.000024	---	---	---	---	---	---	0.000024
POM 4	---	0.0000027	---	---	---	---	---	---	0.0000027
POM 5	0.000003	0.0000036	---	---	---	---	---	---	0.000007
POM 6	0.0002	0.000011	---	---	---	---	---	---	0.0002
POM 7	0.0004	0.0000027	---	---	---	---	---	---	0.0004
Greenhouse Gases									
CO_2	69,401	179,931	36.3	5.8	3.65	2.98	---	460	249,841
CH_4	1.31	3.39	338.1	667.3	29.04	340	124	0.0059	1,503
N_2O	0.13	0.34	---	---	---	---	---	0.0014	0.47
CO_2e	69,470	180,108	7,136	14,019	614	7,146	2,597	460	281,549

a Assumes maximum development scenario of 788 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative B

Date: 7/15/2013

Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]									
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Generators	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC										
NO_X	16.1	---	---	---	37.6	3.6	---	166.1	1.4	224.7
CO	13.5	---	---	---	75.1	19.4	---	332.2	0.3	440.5
VOC	0.9	24.3	19.4	9.4	26.3	---	35.1	116.3	0.0	231.6
SO_2	0.1	---	---	---	0.1	---	---	0.4	0.0008	0.5
PM_{10}	1.2	---	---	---	3.0	---	---	6.5	31.1	41.8
$PM_{2.5}$	1.2	---	---	---	3.0	---	---	6.5	3.2	13.9
Hazardous Air Pollutants										
Benzene	0.00034	0.094	0.045	0.066	0.12	---	1.68	0.16	---	2.17
Toluene	0.00055	0.11	0.042	0.10	0.043	---	1.18	0.13	---	1.60
Ethylbenzene	---	0.0054	0.0019	0.0046	0.0019	---	---	0.012	---	0.025
Xylene	---	0.035	0.013	0.036	0.015	---	0.21	0.056	---	0.37
n-Hexane	0.29	1.15	0.63	0.34	---	---	1.02	0.31	---	3.74
Formaldehyde	0.012	---	---	---	1.57	---	---	15.29	---	16.87
Acetaldehyde	---	---	---	---	0.21	---	---	2.41	---	2.62
Acrolein	---	---	---	---	0.20	---	---	1.50	---	1.70
Methanol	---	---	---	---	0.23	---	---	0.77	---	1.01
1,1,2,2-Tetrachloroethane	---	---	---	---	0.0019	---	---	0.012	---	0.014
1,1,2-Trichloroethane	---	---	---	---	0.0012	---	---	0.0093	---	0.010
1,3-Dichloropropene	---	---	---	---	0.0010	---	---	0.0077	---	0.0087
1,3-Butadiene	---	---	---	---	0.051	---	---	0.091	---	0.14
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	0.070	---	0.070
Biphenyl	---	---	---	---	---	---	---	0.059	---	0.059
Carbon Tetrachloride	---	---	---	---	0.0014	---	---	0.011	---	0.012
Chlorobenzene	---	---	---	---	0.0010	---	---	0.0088	---	0.010
Chloroform	---	---	---	---	0.0011	---	---	0.0083	---	0.0094
Dichlorobenzene	0.00019	---	---	---	---	---	---	---	---	0.00019
Ethylene Dibromide	---	---	---	---	0.0016	---	---	0.013	---	0.015
Methylene Chloride	---	---	---	---	0.0032	---	---	0.0066	---	0.010
Naphthalene	0.00010	---	---	---	0.0074	---	---	0.023	---	0.031
Phenol	---	---	---	---	---	---	---	0.0067	---	0.0067
Styrene	---	---	---	---	0.00091	---	---	0.0069	---	0.0078
Tetrachloroethane	---	---	---	---	---	---	---	0.00070	---	0.00070
Vinyl Chloride	---	---	---	---	0.00055	---	---	0.0043	---	0.0049
PAH -POM 1	---	---	---	---	0.011	---	---	0.011	---	0.022
POM 2	0.000010	---	---	---	---	---	---	0.017	---	0.017
POM 3	0.0000026	---	---	---	---	---	---	---	---	0.0000026
POM 4	0.00000029	---	---	---	---	---	---	---	---	0.00000029
POM 5	0.00000039	---	---	---	---	---	---	---	---	0.00000039
POM 6	0.0000012	---	---	---	---	---	---	0.000047	---	0.000048
POM 7	0.00000029	---	---	---	---	---	---	0.00019	---	0.00019
Greenhouse Gases										
CO_2	19,199	10.7	0.4	1.2	17,924	8,906	---	71,061	115	117,217
CH_4	0.36	7.68	40.2	6.3	0.3	57	43.1	1.3	0.001	156.1
N_2O	0.036	---	---	---	0.03	0.01	---	0.1	0.0001	0.2
CO_2e	19,218	172	845	132	17,941	10,104	904	71,131	115	120,563

a Assumes maximum development scenario of 788 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative B

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	931.2	661.4	224.7	1,817.3
CO	498.7	558.1	440.5	1,497.4
VOC	178.1	1,707.2	231.6	2,116.9
SO_2	1.0	1.3	0.5	2.8
PM_{10}	598.7	169.6	41.8	810.1
$PM_{2.5}$	89.6	53.4	13.9	157.0
Hazardous Air Pollutants				
Benzene	0.43	11.16	2.17	13.75
Toluene	0.16	26.29	1.60	28.04
Ethylbenzene	---	6.07	0.025	6.10
Xylene	0.10	42.79	0.37	43.26
n-Hexane	0.12	64.63	3.74	68.50
Formaldehyde	0.043	32.89	16.87	49.80
Acetaldehyde	0.014	4.61	2.62	7.24
Acrolein	0.0043	4.62	1.70	6.33
Methanol	---	1.47	1.01	2.48
1,1,2,2-Tetrachloroethane	---	0.039	0.014	0.053
1,1,2-Trichloroethane	---	0.031	0.010	0.042
1,3-Dichloropropene	---	0.026	0.0087	0.035
1,3-Butadiene	---	0.49	0.14	0.63
2,2,4-Trimethylpentane	---	0.50	0.070	0.57
Biphenyl	---	0.0023	0.059	0.062
Carbon Tetrachloride	---	0.036	0.012	0.048
Chlorobenzene	---	0.026	0.010	0.036
Chloroform	---	0.028	0.0094	0.037
Dichlorobenzene	---	0.0018	0.00019	0.0020
Ethylene Dibromide	---	0.044	0.015	0.058
Methylene Chloride	---	0.087	0.010	0.10
Naphthalene	0.070	0.058	0.031	0.16
Phenol	---	0.025	0.0067	0.032
Styrene	---	0.033	0.0078	0.040
Vinyl Chloride	---	0.015	0.0049	0.020
(PAH) POM 1	---	0.080	0.022	0.10
POM 2	0.042	0.020	0.017	0.078
POM 3	---	0.000024	0.0000026	0.000027
POM 4	---	0.0000027	0.00000029	0.0000030
POM 5	0.00033	0.0000070	0.00000039	0.00033
POM 6	0.0013	0.00022	0.000048	0.0015
POM 7	0.00083	0.00040	0.00019	0.0014
Total HAPs	0.98	196.07	30.55	227.61
Greenhouse Gases				
CO_2	94,746	249,841	117,217	461,805
CH_4	27.21	1,503	156	1,686
N_2O	0.76	0.47	0.22	1.45
CO_2e	95553	281,549	120,563	497,665

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative B

Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per new well pad
	12	hours per day
	36	hours per new well pad
	0.3	days per expanded well pad
	3.6	hours per expanded well pad
Annual amount of new well pads	58	pads/year
Annual amount of expanded well pads	302	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)

PM_{10} Multiplier 0.75 * PM_{15} (AP-42 Table 11.9-1, 7/98)

$PM_{2.5}$ Multiplier 0.105 * TSP (AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]				Backhoe Emissions [a]				Total
	lbs/hr	tons/new well pad	tons/expanded pad	tons/yr [b]	lbs/hr	tons/new well pad	tons/expanded pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	0.0035	3.13	1.97	0.035	0.0035	3.13	6.26
PM_{15}	0.50	0.009	0.00090	0.80	0.50	0.009	0.00090	0.80	1.59
PM_{10}	0.38	0.007	0.00068	0.60	0.38	0.007	0.00068	0.60	1.20
$PM_{2.5}$	0.21	0.004	0.00037	0.33	0.21	0.004	0.00037	0.33	0.66

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
	0.3	days per expanded well pad
	3.6	hours per expanded well pad
Annual amount of new well pads	58	well pads/year
Annual amount of expanded well pads	302	well pads/year
Distance graded - New pads	1.19	miles
Distance graded - Expanded pads	0.13	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)

PM_{10} Multiplier 0.6 * PM_{15} (AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier 0.031 * TSP (AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - New Pads			**Grader Construction Emissions - Expanded Pads**			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**lbs/well**	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	3.21	0.089	0.0016	0.36	0.10	0.000049	0.11
PM_{15}	1.53	0.043	0.00077	0.17	0.047	0.000024	0.052
PM_{10}	0.92	0.026	0.00046	0.10	0.028	0.000014	0.031
$PM_{2.5}$	0.10	0.0028	0.000050	0.011	0.0031	0.0000015	0.0033

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.53	miles of road per well pad
	26	hours per well pad road
Annual amount of well pads with roads	58	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.025	1.46	1.97	0.025	1.46	2.92
PM_{15}	0.50	0.006	0.37	0.50	0.006	0.37	0.74
PM_{10}	0.38	0.0048	0.28	0.38	0.0048	0.28	0.56
$PM_{2.5}$	0.21	0.0026	0.15	0.21	0.003	0.15	0.31

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	26	hours per well pad roads
Road construction grading distance	0.53	miles road per well pad
Annual well pads	58	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.43	0.06	0.0007	0.04
PM_{15}	0.68	0.027	0.0003	0.020
PM_{10}	0.41	0.016	0.00021	0.012
$PM_{2.5}$	0.04	0.0017	0.000022	0.0013

a Assumes maximum development scenario

Project: GMBU - Alternative B

Date: 7/15/2013

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.53	miles of pipeline per well pad
	64	hours per well pad pipeline
Annual amount of well pads withpipeline	58	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.063	3.65	1.97	0.063	3.65	7.31
PM_{15}	0.50	0.016	0.93	0.50	0.016	0.93	1.86
PM_{10}	0.38	0.012	0.70	0.38	0.012	0.70	1.40
$PM_{2.5}$	0.21	0.007	0.38	0.21	0.007	0.38	0.77

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	64	hours per well pad pipeline
Pipeline construction grading distance	1.07	miles pipeline per well pad
Annual well pads	58	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.86	0.045	0.0014	0.08
PM_{15}	1.37	0.021	0.0007	0.040
PM_{10}	0.82	0.013	0.00041	0.024
$PM_{2.5}$	0.09	0.0014	0.000044	0.0026

a Assumes maximum development scenario

Project: GMBU - Alternative B

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per new pad	3	day/well pad
Number of new pads per year	58	well pads/year
Days per expanded pad	0.3	day/well pad
Number of expanded pads per year	302	well pads/year

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}-new	1.20	1.05	5.61	0.09	5.14
$PM_{2.5}$-new	0.12	0.11	0.56	0.009	0.51
PM_{10}-expand	1.20	1.05	5.61	0.009	2.67
$PM_{2.5}$-expand	0.12	0.11	0.56	0.0009	0.27

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.023
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.0057
PM_{10}-expand	0.015	0.014	0.023	0.000040	0.012
$PM_{2.5}$-expand	0.0036	0.0035	0.0056	0.000010	0.0030

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	265	wells /year

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.32	1.16	11.29	0.71	188.83
$PM_{2.5}$	0.13	0.12	1.13	0.07	18.88

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.052	0.0036	0.95
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.23

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	95	wells /year

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.45	1.27	7.90	4.57	434.12
$PM_{2.5}$	0.15	0.13	0.79	0.46	43.41

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.023	0.022	0.041	0.0261	2.48
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	0.61

Project: GMBU - Alternative B

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	360	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	23.94
$PM_{2.5}$	0.14	0.12	0.42	0.007	2.39

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.13
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.031

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	265	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	341.58
$PM_{2.5}$	0.14	0.12	1.75	0.13	34.16

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.87
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.46

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	95	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	3
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	34,429	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.52	1.34	8.30	2.09	199.00
$PM_{2.5}$	0.15	0.13	0.83	0.21	19.90

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.025	0.024	0.046	0.013	1.21
$PM_{2.5}$	0.006	0.006	0.011	0.0031	0.30

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	1195.28	6.67	1201.95
$PM_{2.5}$	119.53	1.64	121.16

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	190	acres total disturbance for roads and pipelines per year
	768,737	square meters total initial disturbance for roads and pipelines
	177	acres total disturbance for well pads per year
	717,340	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	4.04	0.00
PM_{10}	2.02	0.00
$PM_{2.5}$	0.30	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction - new well pad	3	days per well pad
New well pads per year	58	well pads/year
Days for construction - expanded well pad	0.3	days per well pad
Expanded well pads per year	302	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks-new pads			Heavy Duty Pickups-new pads			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.19
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.36
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.022
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00022
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.010
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.010
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	21.52
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0010
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0004
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	21.66

Construction Vehicles	Heavy Haul Trucks-expanded pads			Heavy Duty Pickups-expanded pads			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.00028	7.39E-03	0.031	0.000055	0.18	0.10
CO	1.98E-02	0.041	0.000074	7.26E-02	0.30	0.00054	0.34	0.19
VOC	3.16E-03	0.0065	0.000012	3.54E-03	0.015	0.000026	0.021	0.012
SO_2	4.57E-05	0.000095	0.00000017	2.83E-05	0.00012	0.00000021	0.00021	0.00012
PM_{10}	4.22E-03	0.0087	0.000016	1.94E-04	0.00080	0.0000014	0.010	0.0052
$PM_{2.5}$	4.09E-03	0.0085	0.000015	1.79E-04	0.00074	0.0000013	0.0092	0.0050
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.025	1.61E+00	6.67	0.012	20.61	11.21
CH_4	6.56E-05	0.00014	0.00000024	2.08E-04	0.00086	0.0000016	0.0010	0.00054
N_2O	1.20E-05	0.000025	0.00000004	8.05E-05	0.00033	0.0000006	0.00036	0.00019
CO_2e [d]	---	13.95	0.025	---	6.79	0.012	20.75	11.28

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	58	new pads per year
	302	expanded pads per year
Backhoe Hours-new pad	125.5	hours per pad
Backhoe Hours-expanded pad	3.6	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer hours-new pad	125.5	hours per pad
Dozer Hours-expanded pad	3.6	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Motor Grader Hours-new pad	125.5	hours per pad
Motor Grader Hours-expanded pad	3.6	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe				Dozer			
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	New pad (tons/yr/pad)	Expanded (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	New pad (tons/yr/pad)	Expanded (tons/yr/pad)
Criteria Pollutants & VOC								
NOx	6.9	0.28	0.017	0.00050	8.38	1.48	0.09	0.0027
CO	3.49	0.14	0.009	0.00025	2.7	0.48	0.030	0.00086
VOC [b]	0.99	0.040	0.0025	0.000072	0.68	0.12	0.008	0.00022
PM_{10}	0.722	0.029	0.0018	0.000052	0.402	0.071	0.0045	0.00013
$PM_{2.5}$	0.722	0.029	0.0018	0.000052	0.402	0.071	0.0045	0.00013
Greenhouse Gases								
CO_2 [c]	188.2	7.59	0.48	0.014	188.2	33.31	2.09	0.060
CO_2e [e]	---	7.59	0.48	0.014	---	33.31	2.09	0.060

Heavy Const. Vehicles	Grader				Total	
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	New pad (tons/yr/pad)	Expanded (tons/yr/pad)	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC						
NOx	8.38	2.52	0.16	0.0045	4.28	17.91
CO	2.70	0.81	0.051	0.0015	1.43	5.99
VOC	0.68	0.20	0.013	0.00037	0.36	1.53
PM_{10}	0.402	0.12	0.008	0.00022	0.22	0.93
$PM_{2.5}$	0.402	0.12	0.008	0.00022	0.22	0.93
Greenhouse Gases						
CO_2	188.2	56.59	3.55	0.10	97.50	407.86
CO_2e [e]	---	56.59	3.55	0.10	97.50	407.86

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	24.9	miles
Number of oil wells drilled	265	wells
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)
Number of deep gas wells drilled	95	wells
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total-Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	9.55
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	9.52
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.72
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0082
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.52
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.50
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	957.16
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.028
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0094
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	960.66

Drilling Vehicles	Heavy Haul Trucks-Gas Wells			Heavy Duty Pickups-Gas Wells			Total-Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.010	0.40	25.12
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.099	0.25	15.86
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	1.49
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.000039	0.00030	0.019
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.00027	0.022	1.40
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.00024	0.022	1.35
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.20	38.19	2394.59
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.00028	0.00077	0.048
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.00011	0.00023	0.014
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	2400.05

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	24.9	miles
Number of oil wells	265	wells
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)
Number of deep gas wells	95	wells
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	16.63
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	15.83
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	1.23
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.014
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.91
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.88
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1656.46
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.047
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.015
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1662.25

Completion Vehicles	Heavy Haul Trucks-Gas Wells			Heavy Duty Pickups-Gas Wells			Total Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.0044	0.48	13.07
CO	1.98E-02	0.12	0.035	7.26E-02	0.15	0.043	0.27	7.48
VOC [c]	3.16E-03	0.020	0.0057	3.54E-03	0.0073	0.0021	0.027	0.74
SO_2	4.57E-05	0.00028	0.000082	2.83E-05	0.000059	0.000017	0.00034	0.0094
PM_{10}	4.22E-03	0.026	0.0076	1.94E-04	0.00040	0.00012	0.027	0.73
$PM_{2.5}$	4.09E-03	0.025	0.0073	1.79E-04	0.00037	0.00011	0.026	0.71
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	1235.64
CH_4	6.56E-05	0.00041	0.00012	2.08E-04	0.00043	0.00012	0.00084	0.023
N_2O	1.20E-05	0.000075	0.000021	8.05E-05	0.00017	0.000048	0.00024	0.0066
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	1238.17

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	360	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	1.10
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	1.24
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.090
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00099
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.059
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.057
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	111.96
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0037
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00124
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	112.42

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation-Oil well	144	hours/oil well
Development Rate-Oil well	265	oil wells/year
Drilling Hours of Operation-Gas well	1320	hours/deep gas well
Development Rate-Gas well	95	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr) * horsepower (hp) * Hours (hour/year) * Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 2)					
	Drill Rig	Drill Rig	Oil Well Drill	Gas Well Drill	Total
Species	E. Factor	Emissions	Rig Emissions	Rig Emissions	Emissions [l]
	(lb/hp-hr)	(lb/hr)	(tons/yr-well)	(tons/yr-well)	(tons/yr)
Criteria Pollutants & VOC					
NOx [a]	1.06E-02	9.62	0.69	6.35	786.62
CO [a]	5.73E-03	5.21	0.38	3.44	426.09
VOC [a]	2.20E-03	2.00	0.14	1.32	163.88
PM_{10} [a]	3.31E-04	0.30	0.022	0.198	24.58
$PM_{2.5}$ [a]	3.31E-04	0.30	0.022	0.198	24.58
SO_2 [b]	1.21E-05	0.011	0.00079	0.0073	0.90
Hazardous Air Pollutants					
Benzene [c]	5.43E-06	0.0049	0.00036	0.0033	0.40
Toluene [c]	1.97E-06	0.0018	0.00013	0.0012	0.15
Xylenes [c]	1.35E-06	0.0012	0.000088	0.00081	0.10
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.00033	0.041
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.00011	0.013
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.000033	0.0041
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.00055	0.068
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.00032	0.040
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.0000025	0.00031
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.000010	0.0012
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.0000064	0.00080
Greenhouse Gases					
CO_2 [j]	1.14	1037.47	74.70	684.73	84,844.05
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.028	3.44
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.0056	0.69
CO_2e [m]	---	1040.96	74.95	687.03	85,130

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	265	wells/year (oil wells)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	95	wells/year (deep gas wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

	Frac Engine Emissions					
Species	**E. Factor (lb/MMBtu)**	**E. Factor (lb/hp-hr)**	**Engine Emissions (lb/hr)**	**Oil Well Emissions (tons/yr-well)**	**Gas Well Emissions (tons/yr-well)**	**Emissions [k] (tons/yr)**
Criteria Pollutants & VOC						
NOx [a]	3.2	0.024	9.84	0.12	0.30	60.94
CO [a]	0.85	5.50E-03	2.62	0.033	0.078	16.19
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.0083	1.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.0092	1.90
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.0092	1.90
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.00014	0.029
Hazardous Air Pollutants						
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.000072	0.015
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.000026	0.0054
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.000018	0.0037
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.0000073	0.0015
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.0000023	0.00048
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.0000007	0.00015
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.000012	0.0025
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.0000071	0.0015
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.00000006	0.000011
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.00000022	0.000045
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.00000014	0.000029
Greenhouse Gases						
CO_2 [i]	163.05	1.14	501.6	6.32	15.05	3105.27
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.00061	0.13
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.00012	0.03
CO_2e [l]	---	---	503.3	6.3	15.1	3,115.7

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	265	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	23.49
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	4.17
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	3.32
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.70
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.30
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.42
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.47
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.20
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.096
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.017
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0018
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00025
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0071
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0037
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00037
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.123
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.32
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.21
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0030
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**6.66**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.13**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**34.84**

a Assumes maximum development scenario

Project: GMBU - Alternative B

Date: 7/15/2013

17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Operations Tailpipe Emissions -Oil and Gas Wells

Assumptions:

Total Tanker Truck Mileage:	185,838	miles/year-all wells
Operation Pickup Truck Mileage:	75,511	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	2.73	4.98	6.05E-03	0.13	0.23	2.85	5.21
CO	1.02E-02	0.52	0.95	4.48E-02	0.93	1.69	1.45	2.64
VOC [c]	1.55E-03	0.08	0.14	1.61E-03	0.03	0.06	0.11	0.20
SO_2	3.07E-05	0.002	0.003	1.84E-05	0.0004	0.0007	0.0019	0.0035
PM_{10}	2.57E-03	0.13	0.24	1.31E-04	0.003	0.005	0.13	0.24
$PM_{2.5}$	2.50E-03	0.13	0.23	1.21E-04	0.003	0.005	0.13	0.24
Greenhouse Gases								
CO_2	4.520	230.1	420.0	1.050	21.7	39.6	251.9	459.6
CH_4	2.59E-05	0.0013	0.002	9.38E-05	0.002	0.004	0.003	0.006
N_2O	4.01E-06	0.0002	0.0004	2.68E-05	0.0006	0.0010	0.0008	0.0014
CO_2e [c]	---	230.2	420.2	---	21.9	40.0	252.2	460.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

19. Operations Traffic Fugitive Dust Emissions - Oil and Gas Wells

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	429	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	20
Light Trucks	8,000	8
Mean Vehicle Weight	34,128	---
Total Round Trips	---	28

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.52	1.33	0.19	0.30	128.39
$PM_{2.5}$	0.15	0.13	0.019	0.030	12.84

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.025	0.025	0.0010	0.0019	0.80
$PM_{2.5}$	0.0061	0.0061	0.00025	0.00046	0.20

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	3,758	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	429	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Average Throughput:	67,151	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.53	0.00	453.48
Hazardous Air Pollutants [b]			
Benzene	0.0017	0.00	1.44
Toluene	0.0016	0.00	1.33
Ethylbenzene	0.000086	0.00	0.07
Xylenes	0.00050	0.00	0.43
n-Hexane	0.026	0.00	22.70
Greenhouse Gases [b]			
CO_2	0.0041	0.00	3.52
CH_4	0.13	0.00	108.59
CO_2e	2.66	0.00	2283.82

a Total wellsite working and breathing emissions are based on 858 uncontrolled tanks and 0 tanks controlled at 0%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	3,758	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	429	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 29.16 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	11.34	87.50
Ethane	30.07	16.516	4.97	13.20	4.82	69.66
Propane	44.10	16.909	7.46	19.81	4.93	104.59
i-Butane	58.12	3.694	2.15	5.71	1.08	30.11
n-Butane	58.12	9.044	5.26	13.97	2.64	73.72
i-Pentane	72.15	3.269	2.36	6.27	0.95	33.08
n-Pentane	72.15	4.297	3.10	8.24	1.25	43.48
Cyclopentane	70.10	0.361	0.25	0.67	0.11	3.55
Hexanes	86.18	2.285	1.97	5.23	0.67	27.62
Heptanes	100.20	1.423	1.43	3.79	0.42	20.00
Octanes	114.23	0.403	0.46	1.22	0.12	6.46
Nonanes	128.26	0.076	0.10	0.26	0.022	1.37
Decanes +	142.29	0.026	0.037	0.098	0.008	0.52
Benzene	78.11	0.106	0.083	0.22	0.031	1.16
Toluene	92.14	0.083	0.076	0.20	0.024	1.07
Ethylbenzene	106.17	0.004	0.004	0.011	0.0012	0.060
Xylenes	106.17	0.023	0.024	0.065	0.0067	0.34
n-Hexane	86.18	1.513	1.30	3.46	0.44	18.29
Nitrogen	28.01	0.612	0.17	0.46	0.18	2.40
Carbon Dioxide	44.01	0.460	0.20	0.54	0.13	2.84
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**12.69**	**365.42**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**0.50**	**20.92**
TOTAL		**100.0**	**37.63**	**100.0**	**29.16**	**527.82**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	365.42	0.00	365.42
Hazardous Air Pollutants [b]			
Benzene	1.16	0.00	1.16
Toluene	1.07	0.00	1.07
Ethylbenzene	0.06	0.00	0.060
Xylenes	0.34	0.00	0.34
n-Hexane	18.29	0.00	18.29
Greenhouse Gases [b]			
CO_2	2.84	0.00	2.84
CH_4	87.50	0.00	87.50
CO_2e	1840.34	0.00	1840.3

a Total wellsite flashing emissions are based on 858 uncontrolled tanks and 0 tanks controlled at 0%.

22. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	209	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total Wellsite Emissions [a] (tons/yr)
VOC	0.71	0.00	148.26
Hazardous Air Pollutants			
Benzene	0.0069	0.00	1.44
Toluene	0.012	0.00	2.40
Ethylbenzene	0.00050	0.00	0.10
Xylenes	0.0041	0.00	0.86
n-Hexane	0.018	0.00	3.80
Greenhouse Gases			
CO_2	0.14	0.00	29.9
CH_4	0.68	0.00	142.0
CO_2e	14	0.00	3,011

a Total wellsite flashing emissions are based on 209 uncontrolled tanks and 0 tanks controlled at 0%.

23. Truck Loadout

Assumptions:

Oil Well Production Rate	8.8	bbl/day-well
Number of Oil Wells not going to a GOSP	429	wells
Gas Well Production Rate	2	bbl/day-well
Number of Gas Wells	209	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [c]
Oil Loading [a]	0.6	2.8	50	520	2.01	8.8	0.14	58.02
Condensate Loading [b]	0.6	5.2	66	520	4.94	2.0	0.076	15.82

	Oil Loading		Condensate Loading		Totals
	tpy-well [d]	tpy[c,d]	tpy-well [e]	tpy[c,e]	tpy[c]
Hazardous Air Pollutants					
Benzene	0.00043	0.18	0.00074	0.15	0.34
Toluene	0.00040	0.17	0.00123	0.26	0.43
Ethylbenzene	0.000022	0.009	0.00005	0.01	0.02
Xylenes	0.00013	0.05	0.00044	0.09	0.15
n-Hexane	0.0068	2.90	0.00194	0.41	3.31
Greenhouse Gases					
CO2	0.00105	0.45	0.01529	3.20	3.65
CH4	0.032	13.89	0.07248	15.15	29.04
CO2e	0.68	292.2	1.53731	321.30	613.50

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60° F.

b Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

c Assumes maximum development scenario

d Emissions estimated based on flashing analysis weight fractions

e Emissions estimated based on ratio of HAP/VOC in tank emissions

24. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.32

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	788	96.48	340.15	2.98	7,146

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

25. Wellsite Pumping Unit Engines

Assumptions:

Older Pumpjack Engine power:	25	hp
New Pumpjack Engine power:	65	hp
Older Pumpjack Engine load factor:	1.0	
New Pumpjack Engine load factor:	0.38	
Percent of new pumpjack engines:	31	%
Number of Wells Requiring Pumping Unit Engines:	579	wells

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp) * 8760 (hr/yr) * load factor}}{\text{453.6 (g/lb) * 2000 (lb/ton)}}$$

Pollutant	AP-42 Emission Factor (lb/MMBtu)	Older Engine Emission Factor [c] (g/hp-hr)	New Engine Emission Factor [c] (g/hp-hr)	Older Engine Emissions (lb/hr/well)	Older Engine Emissions (ton/yr-well)	New Engine Emissions (lb/hr/well)	New Engine Emissions (ton/yr-well)	Total Emissions [h] (tons/yr)
Criteria Pollutants & VOC								
NOx [b]	-	4.4	1.89	0.24	1.06	0.10	0.45	505.27
CO [b]	-	3.3	2.58	0.18	0.80	0.14	0.62	428.72
VOC [b-old, a-new]	0.12	1.3	5.12E-01	0.072	0.31	0.028	0.12	147.28
PM_{10} [a,d]	4.83E-02	2.06E-01	2.06E-01	0.011	0.050	0.011	0.049	28.68
$PM_{2.5}$ [a,d]	4.83E-02	2.06E-01	2.06E-01	0.011	0.050	0.011	0.049	28.68
SO_2 [a]	5.88E-04	2.51E-03	2.51E-03	0.00014	0.00061	0.00014	0.00060	0.35
Hazardous Air Pollutants [a]								
Benzene	1.94E-03	8.27E-03	8.27E-03	0.00046	0.0020	0.00045	0.0020	1.15
Toluene	9.63E-04	4.11E-03	4.11E-03	0.00023	0.0010	0.00022	0.0010	0.57
Ethylbenzene	1.08E-04	4.60E-04	4.60E-04	0.000025	0.00011	0.000025	0.00011	0.064
Xylenes	2.68E-04	1.14E-03	1.14E-03	0.000063	0.00028	0.000062	0.00027	0.16
Formaldehyde	5.52E-02	2.35E-01	2.35E-01	0.013	0.057	0.013	0.056	32.77
Acetaldehyde	7.76E-03	3.31E-02	3.31E-02	0.0018	0.0080	0.0018	0.0079	4.61
Acrolein	7.78E-03	3.32E-02	3.32E-02	0.0018	0.0080	0.0018	0.0079	4.62
Benzo(a)pyrene/POM5	5.68E-09	2.42E-08	2.42E-08	#########	0.00000001	#########	0.00000001	0.0000034
Biphenyl	3.95E-06	1.68E-05	1.68E-05	0.0000009	0.0000041	0.0000009	0.0000040	0.0023
Methanol	2.48E-03	1.06E-02	1.06E-02	0.00058	0.0026	0.00058	0.0025	1.47
1,1,2,2-Tetrachloroethane	6.63E-05	2.83E-04	2.83E-04	0.000016	0.000068	0.000015	0.000067	0.039
1,1,2-Trichloroethane	5.27E-05	2.25E-04	2.25E-04	0.000012	0.000054	0.000012	0.000054	0.031
1,3-Dichloropropene	4.38E-05	1.87E-04	1.87E-04	0.000010	0.000045	0.000010	0.000045	0.026
1,3-Butadiene	8.20E-04	3.50E-03	3.50E-03	0.00019	0.00084	0.00019	0.00083	0.49
2,2,4-Trimethylpentane	8.46E-04	3.61E-03	3.61E-03	0.00020	0.00087	0.00020	0.00086	0.50
Carbon Tetrachloride	6.07E-05	2.59E-04	2.59E-04	0.000014	0.000062	0.000014	0.000062	0.036
Chlorobenzene	4.44E-05	1.89E-04	1.89E-04	0.000010	0.000046	0.000010	0.000045	0.026
Chloroform	4.71E-05	2.01E-04	2.01E-04	0.000011	0.000048	0.000011	0.000048	0.028
Chrysene/POM7	6.72E-07	2.87E-06	2.87E-06	0.0000002	0.0000007	0.0000002	0.0000007	0.00040
Ethylene Dibromide	7.34E-05	3.13E-04	3.13E-04	0.000017	0.000076	0.000017	0.000075	0.044
Methylene Chloride	1.47E-04	6.27E-04	6.27E-04	0.000035	0.00015	0.000034	0.00015	0.087
n-Hexane	4.45E-04	1.90E-03	1.90E-03	0.00010	0.00046	0.00010	0.00045	0.26
Naphthalene	9.63E-05	4.11E-04	4.11E-04	0.000023	0.000099	0.000022	0.000098	0.057
Phenol	4.21E-05	1.80E-04	1.80E-04	0.000010	0.000043	0.000010	0.000043	0.025
Styrene	5.48E-05	2.34E-04	2.34E-04	0.000013	0.000056	0.000013	0.000056	0.033
Vinyl Chloride	2.47E-05	1.05E-04	1.05E-04	0.000006	0.000025	0.0000057	0.000025	0.015
PAH	1.34E-04	5.71E-04	5.71E-04	0.000031	0.00014	0.000031	0.00014	0.080
POM -2 [e]	3.28E-05	1.40E-04	1.40E-04	0.0000077	0.000034	0.0000076	0.000033	0.020
POM-6 [f]	3.50E-07	1.49E-06	1.49E-06	0.0000001	0.0000004	0.0000001	0.0000004	0.00021
Greenhouse Gases								
CO_2 [g]	117	498	498	27.47	120.31	27.14	118.9	69,401
CH_4 [g]	0.002	0.01	0.01	0.001	0.0023	0.001	0.0022	1.31
N_2O [g]	0.0002	0.0009	0.0009	0.0001	0.00023	0.0001	0.00022	0.13
CO_2e [i]	----	----	----	27.50	120.4307	27.17	118.98	69,470

a AP-42 Table 3.2-1 Uncontrolled Emission Factors for 2-Stroke Lean-Burn Engines, 7/00

b Emission factors (g/hp-hr) from manufacturer specifications

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, benzo(a)fluoranthene, benzo(e)pyrene, fluorene, phenanthrene, perylene, and pyrene.

f POM 6 includes: Benz(a)anthracene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Estimated at full project production.

i Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

26. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Gas Wellsite Separator/Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters and tanks	429	wells
Gas wells with separators/dehydrators	209	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Emission Factor (lb/MMscf)	Oil Well Separator Heater		Oil Well Tank Heaters		Gas Well Dehydrator Heater		Total Heater	
		Well Emissions (lb/hr/well)	Well Emissions (tons/yr-well)	Well Emissions (lb/hr/well)	Well Emissions (tons/yr-well)	Well Emissions (lb/hr/well)	Well Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC									
NOx [a]	100	0.029	0.13	0.029	0.13	0.044	0.19	34.46	150.92
CO [a]	84	0.025	0.11	0.025	0.11	0.037	0.16	28.94	126.77
VOC [b]	5.5	0.0016	0.0071	0.0016	0.0071	0.0024	0.0106	1.90	8.30
SO_2 [b]	0.6	0.00018	0.00077	0.00018	0.00077	0.00026	0.00116	0.21	0.91
PM_{10} [b]	7.6	0.0022	0.0098	0.0022	0.0098	0.0034	0.0147	2.62	11.47
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	0.0022	0.0098	0.0034	0.0147	2.62	11.47
Hazardous Air Pollutants									
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	6.18E-07	2.71E-06	9.26E-07	4.06E-06	0.00072	0.0032
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	1.00E-06	4.38E-06	1.50E-06	6.57E-06	0.0012	0.0051
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	5.29E-04	2.32E-03	7.94E-04	3.48E-03	0.62	2.72
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	2.21E-05	9.66E-05	3.31E-05	1.45E-04	0.026	0.11
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	3.53E-07	1.55E-06	5.29E-07	2.32E-06	0.00041	0.0018
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	1.79E-07	7.86E-07	2.69E-07	1.18E-06	0.00021	0.00092
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	1.74E-08	7.60E-08	2.60E-08	1.14E-07	0.000020	0.000089
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	4.71E-09	2.06E-08	7.06E-09	3.09E-08	0.0000055	0.000024
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	5.29E-10	2.32E-09	7.94E-10	3.48E-09	0.0000006	0.0000027
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	7.06E-10	3.09E-09	1.06E-09	4.64E-09	0.0000008	0.0000036
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	2.12E-09	9.28E-09	3.18E-09	1.39E-08	0.0000025	0.000011
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	5.29E-10	2.32E-09	7.94E-10	3.48E-09	0.0000006	0.0000027
Greenhouse Gases									
CO_2 [l]	119,226	35.07	153.59	35.07	153.59	52.60	230.39	41080	179931
CH_4 [l]	2.25	0.00066	0.0029	0.00066	0.0029	0.0010	0.0043	0.77	3.39
N_2O [l]	0.22	0.000066	0.00029	0.000066	0.00029	0.00010	0.00043	0.077	0.34
CO_2e [m]	---	35.10	153.74	35.10	153.74	52.65	230.61	41,121	180,108

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

27. Oil Well Fugitives

Number of Producting Wells 579 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**213.43**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.59
Toluene Emissions	0.00011	0.0020	0.53
Ethylbenzene Emissions	----	0.00011	0.028
Xylene Emissions	0.000011	0.00065	0.16
n-Hexane Emissions	0.0035	0.035	9.36

Project: GMBU - Alternative B
Date: 7/15/2013

27. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**343.68**	**3.01**	**7,220**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

28. Deep Gas Well Fugitive Emissions

Number of Producting Wells 209 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**121.45**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b Weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.33
Toluene Emissions	0.0001	0.0162	0.43
Ethylbenzene Emissions	----	0.0007	0.02
Xylene Emissions	0.00001	0.0058	0.14
n-Hexane Emissions	0.0035	0.0257	2.41

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**323.61**	**2.83**	**6799**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

29. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	209	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
0 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0863	0.378	79.04
Hazardous Air Pollutants			
Benzene	0.00500	0.0220	4.60
Toluene	0.0213	0.0931	19.46
Ethylbenzene	0.00620	0.0273	5.71
Xylenes	0.0443	0.194	40.55
Greenhouse Gases			
CH_4	0.1351	0.592	123.69
CO_2e	2.84	12.43	2597.41

30. Compressor Station Engines

Assumptions:

Number of new compressor stations	2	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission Factor (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ g/lb} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions Per Facility (lb/hr-facility)	Emissions Per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	154.50
CO [a]	-	2.0	35.27	154.50	308.99
VOC [a]	-	0.7	12.35	54.07	108.15
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	5.58
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	5.58
SO_2 [b]	5.88E-04	0.002	0.038	0.16	0.33
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	0.12
Toluene	4.08E-04	1.48E-03	0.013	0.057	0.11
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.011
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.052
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	0.31
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	14.80
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	2.34
Acrolein	5.14E-03	1.87E-02	0.16	0.72	1.44
Methanol	2.50E-03	9.07E-03	0.080	0.35	0.70
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.011
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.0089
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.0074
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.075
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.070
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.059
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.010
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.0085
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.0080
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.012
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.0056
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.021
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.0067
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.0066
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.00070
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.0042
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.0075
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.017
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.0000053	0.000023	0.000047
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.00019
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	65,532
CH_4 [g]	0.002	0.0080	0.14	0.62	1.24
N_2O [g]	0.0002	0.00080	0.014	0.062	0.12
CO_2e [h]	---	---	7,488	32,798	65,596

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

31. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	2	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	2.61
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.025
Toluene	0.11	0.0053	0.042
Ethylbenzene	0.0046	0.00023	0.0018
Xylenes	0.038	0.0019	0.015
n-Hexane	0.17	0.0084	0.07
Greenhouse Gases			
CO_2	1.32	1.32	10.53
CH_4	6.24	0.31	2.50
CO_2e	132	7.87	62.96

a Assumes maximum development scenario

32. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 2 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	23.38
Hazardous Air Pollutants			
Benzene	0.13	0.56	1.12
Toluene	0.090	0.39	0.79
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.14
n-Hexane	0.078	0.34	0.68
Greenhouse Gases			
CH_4	3.28	14.35	28.70
CO_2e	68.81	301.38	602.75

a Assumes maximum development scenario

33. Compressor Station Fugitives

Number of Compressor Stations 2 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**6.05**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.012
Toluene Emissions	0.0001	0.016	0.014
Ethylbenzene Emissions	----	0.00070	0.00048
Xylene Emissions	0.00001	0.0058	0.0043
n-Hexane Emissions	0.0035	0.026	0.12

33. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**18.19**	**0.159**	**382.1**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

34. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Compressor Facilities	2	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	5.56

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.054
Toluene	0.045	0.090
Ethylbenzene	0.0020	0.0039
Xylenes	0.016	0.032
n-Hexane	0.071	0.14
Greenhouse Gases		
CO2	0.56	1.12
CH4	2.66	5.33
CO2e	56.50	113.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

35. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	5,130	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.075	0.14	6.05E-03	0.00	0.00	0.075	0.14
CO	1.02E-02	0.014	0.026	4.48E-02	0.00	0.00	0.014	0.026
VOC [c]	1.55E-03	0.0022	0.0040	1.61E-03	0.00	0.00	0.0022	0.0040
SO_2	3.07E-05	0.00004	0.00008	1.84E-05	0.00	0.00	0.000043	0.00008
PM_{10}	2.57E-03	0.0036	0.0066	1.31E-04	0.00	0.00	0.0036	0.0066
$PM_{2.5}$	2.50E-03	0.0035	0.0064	1.21E-04	0.00	0.00	0.0035	0.0064
Greenhouse Gases								
CO_2	4.520	6.4	11.6	1.050	0.00	0.00	6.4	11.6
CH_4	2.59E-05	0.00004	0.00007	9.38E-05	0.00	0.00	0.00004	0.00007
N_2O	4.01E-06	0.00001	0.00001	2.68E-05	0.00	0.00	0.00001	0.00001
CO_2e [c]	---	6.4	11.6	---	0.00	0.00	6.4	11.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

36. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	2	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	1.60	2.57	5.13
$PM_{2.5}$	0.17	0.15	0.16	0.26	0.51

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.010	0.019	0.037
$PM_{2.5}$	0.0081	0.0081	0.0025	0.0046	0.0092

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

37. Gas and Oil Separation Facility Generators

Assumptions:

Number of GOSPs	1	Facilities
Generator size	1,945	Horsepower
Number of Generators per GOSP	1	engines/Facility

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (tons/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	18.78
CO [a]	-	2.0	8.58	37.56	37.56
VOC [a]	-	0.7	3.00	13.15	13.15
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.045
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.061
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.021
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.0010
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.0075
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	0.79
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	0.11
Acrolein	2.63E-03	1.07E-02	0.023	0.10	0.10
Methanol	3.06E-03	1.25E-02	0.027	0.12	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.0010
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.00059
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.00049
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.025
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.00068
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.00049
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.00053
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.00082
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.0016
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.0037
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.00046
Vinyl Chloride	7.18E-06	2.93E-05	0.00006	0.00028	0.00028
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.0054
Greenhouse Gases					
CO_2 [e]	117	477.2	2046	8,962	8,962
CH_4 [e]	0.002	0.0090	0.0386	0.17	0.17
N_2O [e]	0.0002	0.00090	0.00386	0.017	0.017
CO_2e [f]	---	---	2048	2048.08	8971

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

38. GOSP Truck Loadout

Assumptions:		
Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	1	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	3.86

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.012
Toluene	0.011	0.011
Ethylbenzene	0.00063	0.00063
Xylenes	0.0036	0.0036
n-Hexane	0.19	0.19
Greenhouse Gases		
CO2	0.030	0.030
CH4	0.92	0.92
CO2e	19.44	19.44

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

39. GOSP Fugitives

Number of GOSP Facilities 1 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**11.61**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.03
Toluene Emissions	0.00011	0.0020	0.03
Ethylbenzene Emissions	----	0.00011	0.001
Xylene Emissions	0.000011	0.00065	0.008
n-Hexane Emissions	0.0035	0.035	0.46

39. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**17.80**	**0.16**	**373.97**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

40. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	45,862	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.67	1.23	6.05E-03	0.00	0.00	0.67	1.23
CO	1.02E-02	0.13	0.23	4.48E-02	0.00	0.00	0.13	0.23
VOC [c]	1.55E-03	0.02	0.04	1.61E-03	0.00	0.00	0.019	0.036
SO_2	3.07E-05	0.000	0.001	1.84E-05	0.00	0.00	0.00039	0.00070
PM_{10}	2.57E-03	0.03	0.06	1.31E-04	0.00	0.00	0.032	0.059
$PM_{2.5}$	2.50E-03	0.03	0.06	1.21E-04	0.00	0.00	0.031	0.057
Greenhouse Gases								
CO_2	4.520	56.8	103.6	1.050	0.00	0.00	56.8	103.6
CH_4	2.59E-05	0.0003	0.001	9.38E-05	0.00	0.00	0.0003	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	56.8	103.7	---	0.00	0.00	56.8	103.7

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

41. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	1	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	5
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	5

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	16.04	25.67	25.67
$PM_{2.5}$	0.17	0.15	1.604	2.567	2.57

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.10	0.19	0.19
$PM_{2.5}$	0.0081	0.0081	0.025	0.046	0.046

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

42. Gas Processing Plant Compression

Assumptions:

Number of compressors	4	engines
Compressor horsepower	300	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	0.66	2.90	11.59
CO [a]	-	2.0	1.32	5.79	23.17
VOC [a]	-	0.7	0.46	2.03	8.11
PM_{10} [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
SO_2 [b]	5.88E-04	2.40E-03	0.0016	0.0070	0.028
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.0021	0.0093	0.037
Toluene	5.58E-04	2.28E-03	0.00075	0.0033	0.013
Ethylbenzene	2.48E-05	1.01E-04	0.000033	0.00015	0.00059
Xylenes	1.95E-04	7.96E-04	0.00026	0.0012	0.0046
Formaldehyde	2.05E-02	8.37E-02	0.028	0.12	0.48
Acetaldehyde	2.79E-03	1.14E-02	0.0038	0.016	0.066
Acrolein	2.63E-03	1.07E-02	0.0036	0.016	0.062
Methanol	3.06E-03	1.25E-02	0.0041	0.018	0.072
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.000034	0.00015	0.00060
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.000021	0.000090	0.00036
1,3-Dichloropropene	1.27E-05	5.18E-05	0.000017	0.000075	0.00030
1,3-Butadiene	6.63E-04	2.71E-03	0.00090	0.0039	0.016
Carbon Tetrachloride	1.77E-05	7.23E-05	0.000024	0.00010	0.00042
Chlorobenzene	1.29E-05	5.27E-05	0.000017	0.000076	0.00031
Chloroform	1.37E-05	5.59E-05	0.000018	0.000081	0.00032
Ethylene Dibromide	2.13E-05	8.70E-05	0.000029	0.00013	0.00050
Methylene Chloride	4.12E-05	1.68E-04	0.000056	0.00024	0.0010
Naphthalene	9.71E-05	3.96E-04	0.00013	0.00057	0.0023
Styrene	1.19E-05	4.86E-05	0.000016	0.000070	0.00028
Vinyl Chloride	7.18E-06	2.93E-05	0.000010	0.000042	0.00017
PAH -POM 1	1.41E-04	5.76E-04	0.00019	0.00083	0.0033
Greenhouse Gases					
CO_2 [e]	117	477.2	315.59	1382	5529.1
CH_4 [e]	0.002	9.00E-03	0.0060	0.026	0.10
N_2O [e]	0.0002	9.00E-04	0.00060	0.003	0.010
CO_2e [f]	---	---	315.9	1384	5535

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

43. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

44. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

45. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :		
Facility Production Rate	160	bbls oil per day per facility
Total Facilities	1	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.10	6.10
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.019
Toluene	0.0030	0.018	0.018
Ethylbenzene	0.00017	0.00099	0.0010
Xylenes	0.0010	0.0057	0.0057
n-Hexane	0.051	0.31	0.31
Greenhouse Gases			
CO_2	0.0079	0.047	0.047
CH_4	0.24	1.46	1.46
CO_2e	5.12	30.70	30.70

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

Project: GMBU - Alternative B

Date: 7/15/2013

46. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	1241.60 scf/day-facility

Vent rate = Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.15
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.27
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.058
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.022
Benzene	78.11	0.106	0.083	0.0022	1.32	0.049
Toluene	92.14	0.083	0.076	0.0020	1.03	0.046
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.0025
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.015
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.78
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.10
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.12
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	1

Total Flashing Emissions for All Tanks (tons/yr)

VOC	15.56
Hazardous Air Pollutants	
Benzene	0.049
Toluene	0.046
Ethylbenzene	0.0025
Xylenes	0.015
n-Hexane	0.78
HAPs	0.89
Greenhouse Gases	
CO2	0.12
CH4	3.73
CO2e	78.3

47. Water Treatment Facility Fugitives

Number Water Treatment Facilities 1 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**0.92**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.003
Toluene Emissions	0.00011	0.0020	0.002
Ethylbenzene Emissions	----	0.00011	0.0001
Xylene Emissions	0.000011	0.00065	0.0007
n-Hexane Emissions	0.0035	0.0346	0.04

47. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**2.17**	**0.02**	**45.5**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

48. Water Treatment Plant Generator

Assumptions:

Number of facilities 1
Generator horsepower 1,945 hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	18.78
CO [a]	-	2.0	8.58	37.56	37.56
VOC [a]	-	0.7	3.00	13.15	13.15
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.045
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.061
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.021
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.0010
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.0075
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	0.79
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	0.11
Acrolein	2.63E-03	1.07E-02	0.023	0.10	0.10
Methanol	3.06E-03	1.25E-02	0.027	0.12	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.0010
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.00059
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.00049
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.025
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.00068
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.00049
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.00053
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.0008
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.0016
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.0037
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.00046
Vinyl Chloride	7.18E-06	2.93E-05	0.000063	0.00028	0.00028
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.0054
Greenhouse Gases					
CO_2 [e]	117	477.2	2,046	8,962	8,962
CH_4 [e]	0.002	9.00E-03	0.039	0.17	0.17
N_2O [e]	0.0002	9.00E-04	0.0039	0.017	0.017
CO_2e [f]	---	---	2,048	8,971	8,971

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

49. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Gas Processing Plant Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	1	GOSP Facilities
	2	Compressor Stations
	1	Gas Processing Plant

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	3.68	16.10
CO [a]	84	2.72	11.90	84	0.124	0.54	3.09	13.53
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	0.20	0.89
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.022	0.097
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	0.28	1.22
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	0.28	1.22
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	0.000077	0.00034
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	0.00013	0.00055
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	0.066	0.29
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	0.0028	0.012
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	0.000044	0.00019
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	0.000022	0.000098
POM 2[c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	0.0000022	0.000010
POM 3[c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	0.00000059	0.0000026
POM 4[c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	##########	0.00000029
POM 5[c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	##########	0.00000039
POM 6[c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	0.00000026	0.0000012
POM 7[c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	##########	0.00000029
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	4383	19199
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.083	0.36
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.0083	0.036
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	4388	19218

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

50. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations	2
Number of GOSPs	1
Number of Gas Plants	1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	3.57
CO [a]	0.37	1.11	4.86	19.45
Greenhouse Gases				
CO2 [b]	---	508	2,227	8,906
CH4 [b]	---	3.2	14.2	56.9
N2O [b]	---	0.0007	0.003	0.01
CO2e [b]	---	577	2,526	10,104

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

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

Identification

User Identification:	GMBU Alt B Oil Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		4.18
Net Throughput(gal/yr):		67,151.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		0.00

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

GMBU Alt B Oil Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU Alt B Oil Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	0.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	175.6845
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	67,151.0000
Annual Turnovers:	4.1775
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,057.0581

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

Emissions Report for: Annual

GMBU Alt B Oil Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	175.68	881.37	1,057.06

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

Identification

User Identification:	GMBU Water treatment tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 500 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		25.00
Diameter (ft):		12.00
Liquid Height (ft) :		24.00
Avg. Liquid Height (ft):		12.00
Volume (gallons):		20,304.71
Turnovers:		20.13
Net Throughput(gal/yr):		408,800.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	2,032.1687

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

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

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50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

APPENDIX D

ALTERNATIVE C – FIELD WIDE ELECTRIFICATION EMISSIONS

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APPENDIX D-1

FIELD WIDE ELECTRIFICATION ALTERNATIVE OIL WELL EMISSIONS

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Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative C - Oil Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	6.9	2.6	0.6	0.0002	5.8	1.4
	Drilling	83.9	83.9	4.7	0.2	147.4	16.0
	Completion	38.1	18.9	6.8	0.023	265.9	28.1
	Interim Reclamation	0.6	0.7	0.05	0.0006	3.2	0.3
	Wind Erosion	---	---	---	---	1.1	0.2
Wellsite Production Emissions	Production Heaters	327.0	274.6	18.0	2.0	24.8	24.8
	Wellsite Tanks	---	---	1,714.2	---	---	---
	Pneumatics	---	---	397.9	---	---	---
	Fugitives	---	---	1,198.0	---	---	---
	Wellsite Truck Loading	---	---	203.7	---	---	---
	Wellsite Flares	1.7	9.4	---	---	---	---
	Operations Vehicle	15.9	6.8	0.6	0.010	385.8	39.6
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	281.5	---	---	---
	Water Treatment Fugitives	---	---	12.0	---	---	---
Gas and Oil Separation Plants	GOSP Heaters	170.0	142.8	9.4	1.0	12.9	12.9
	GOSP Fugitives	---	---	139.3	---	---	---
	GOSP Flare	10.7	58.3	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	15.3	2.9	46.8	0.01	326.5	33.6
Compressor Station Emissions	Compressor Station Tanks	---	---	5.2	---	---	---
	Compressor Station Dehydrator	---	---	46.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.3	0.1	11.1	0.0	5.2	0.5
	Compressor Station Dehydrator Heater	2.6	2.2	0.1	0.0	0.2	0.2
	Compressor Station Flare	3.6	19.4	---	---	---	---
	Compressor Station Fugitives	---	---	12.1	---	---	---
	Electric Substation Gas Turbines	47.6	43.5	16.6	0.9	31.8	31.8
	Total Emissions	**724.3**	**666.1**	**4,125.3**	**4.1**	**1,210.6**	**189.6**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	6.9	83.9	38.1	0.6	---	129.6
CO	2.6	83.9	18.9	0.7	---	106.0
VOC	0.6	4.7	6.8	0.05	---	12.1
SO_2	0.0002	0.2	0.02	0.0006	---	0.2
PM_{10}	5.8	147.4	265.9	3.2	1.1	423.3
$PM_{2.5}$	1.4	16.0	28.1	0.3	0.2	46.0
Hazardous Air Pollutants						
Benzene	---	0.07	0.012	---	---	0.084
Toluene	---	0.03	0.005	---	---	0.031
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.02	0.0018	---	---	0.020
n-Hexane	---	---	0.095	---	---	0.095
Formaldehyde	---	0.007	0.0006	---	---	0.0080
Acetaldehyde	---	0.002	0.00020	---	---	0.0026
Acrolein	---	0.0007	0.00006	---	---	0.00080
Naphthalene	---	0.012	0.0010	---	---	0.013
POM 2	---	0.007	0.0006	---	---	0.0078
POM 5	---	0.00006	0.000005	---	---	0.000061
POM 6	---	0.0002	0.000019	---	---	0.00024
POM 7	---	0.0001	0.000012	---	---	0.00016
Greenhouses Gases						
CO_2	171.7	15,975	2,565	63	---	18,776
CH_4	0.001	0.64	18.17	0.002	---	18.81
N_2O	0.0003	0.13	0.02	0.0007	---	0.15
CO_2e	171.8	16,029	2,954	64	---	19,218

a Assumes maximum development scenario of 204 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]							
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC								
NO_X	327.0	---	---	---	---	1.7	15.9	344.6
CO	274.6	---	---	---	---	9.4	6.8	290.9
VOC	18.0	1714.2	1198.0	203.7	397.9	---	0.6	3,532.4
SO_2	2.0	---	---	---	---	---	0.010	2.0
PM_{10}	24.8	---	---	---	---	---	385.8	410.6
$PM_{2.5}$	24.8	---	---	---	---	---	39.6	64.4
Hazardous Air Pollutants								
Benzene	0.0069	5.45	3.31	0.65	0.42	---	---	9.84
Toluene	0.011	5.03	2.97	0.60	0.22	---	---	8.83
Ethylbenzene	---	0.28	0.16	0.03	---	---	---	0.47
Xylene	---	1.61	0.92	0.19	0.022	---	---	2.74
n-Hexane	5.89	85.79	52.55	10.19	7.35	---	---	161.77
Formaldehyde	0.25	---	---	---	---	---	---	0.25
Acetaldehyde	---	---	---	---	---	---	---	---
Acrolein	---	---	---	---	---	---	---	---
Methanol	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---
1,3-Dichloropropene	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---
Biphenyl	---	---	---	---	---	---	---	---
Carbon Tetrachloride	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---
Chloroform	---	---	---	---	---	---	---	---
Dichlorobenzene	0.0039	---	---	---	---	---	---	0.0039
Ethylene Dibromide	---	---	---	---	---	---	---	---
Methylene Chloride	---	---	---	---	---	---	---	---
Naphthalene	0.0020	---	---	---	---	---	---	0.0020
Phenol	---	---	---	---	---	---	---	---
Styrene	---	---	---	---	---	---	---	---
Vinyl Chloride	---	---	---	---	---	---	---	---
PAH -POM 1	---	---	---	---	---	---	---	---
POM 2	0.00019	---	---	---	---	---	---	0.00019
POM 3	0.000052	---	---	---	---	---	---	0.000052
POM 4	0.0000059	---	---	---	---	---	---	0.0000059
POM 5	0.0000078	---	---	---	---	---	---	0.0000078
POM 6	0.000024	---	---	---	---	---	---	0.000024
POM 7	0.0000059	---	---	---	---	---	---	0.0000059
Greenhouse Gases								
CO_2	389,813	22.8	16.9	1.58	12.29	3,257	1,391	394,514
CH_4	7.35	410.5	1929.1	48.78	1,403	10.0	0.0155	3,809
N_2O	0.74	---	---	---	---	0.0033	0.0035	0.74
CO_2e	390,195	8,643	40,529	1,026	29,474	3,468	1,392	474,727

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Gas Turbines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	172.6	---	---	---	14.3	---	47.61	15.6	250.1
CO	145.0	---	---	---	77.8	---	43.46	3.0	269.2
VOC	9.5	286.7	163.4	57.4	---	46.8	16.57	0.5	580.8
SO_2	1.0	---	---	---	---	---	0.93	0.01	2.0
PM_{10}	13.1	---	---	---	---	---	31.84	331.7	376.7
$PM_{2.5}$	13.1	---	---	---	---	---	31.84	34.2	79.1
Hazardous Air Pollutants									
Benzene	0.004	0.95	0.41	0.26	---	2.24	0.069	---	3.92
Toluene	0.006	0.91	0.36	0.32	---	1.58	0.75	---	3.91
Ethylbenzene	---	0.050	0.018	0.015	---	---	0.18	---	0.267
Xylene	---	0.29	0.11	0.11	---	0.28	0.37	---	1.16
n-Hexane	3.11	14.22	6.30	2.60	---	1.36	---	---	27.59
Formaldehyde	0.13	---	---	---	---	---	4.08	---	4.21
Acetaldehyde	---	---	---	---	---	---	0.23	---	0.23
Acrolein	---	---	---	---	---	---	0.037	---	0.037
Methanol	---	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---	---
1,3-Dichloropropene	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	0.0025	---	0.0025
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---
Biphenyl	---	---	---	---	---	---	---	---	---
Carbon Tetrachloride	---	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---	---
Chloroform	---	---	---	---	---	---	---	---	---
Dichlorobenzene	0.0021	---	---	---	---	---	---	---	0.0021
Ethylene Dibromide	---	---	---	---	---	---	---	---	---
Methylene Chloride	---	---	---	---	---	---	---	---	---
Naphthalene	0.0011	---	---	---	---	---	0.0075	---	0.0085
Phenol	---	---	---	---	---	---	---	---	---
Propylene Oxide	---	---	---	---	---	---	0.17	---	0.17
Styrene	---	---	---	---	---	---	---	---	---
Tetrachloroethane	---	---	---	---	---	---	---	---	---
Vinyl Chloride	---	---	---	---	---	---	---	---	---
PAH -POM 1	---	---	---	---	---	---	0.013	---	0.013
POM 2	0.00010	---	---	---	---	---	---	---	0.00010
POM 3	0.000028	---	---	---	---	---	---	---	0.00003
POM 4	0.0000031	---	---	---	---	---	---	---	0.000003
POM 5	0.0000041	---	---	---	---	---	---	---	0.000004
POM 6	0.000012	---	---	---	---	---	---	---	0.000012
POM 7	0.000003	---	---	---	---	---	---	---	0.000003
Greenhouse Gases									
CO_2	205,812	23.25	2.4	2.248	35,625	---	775,466	1,315	1,018,246
CH_4	3.88	72.40	278.1	10.65	228	57.40	14.6	0.008	664.6
N_2O	0.39	---	---	---	0.05	---	1.5	0.001	1.9
CO_2e	206,013	1,544	5,843	226	40,418	1,206	776,227	1,316	1,032,792

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	129.6	344.6	250.1	724.3
CO	106.0	290.9	269.2	666.1
VOC	12.1	3,532.4	580.8	4,125.3
SO_2	0.2	2.0	2.0	4.1
PM_{10}	423.3	410.6	376.7	1,210.6
$PM_{2.5}$	46.0	64.4	79.1	189.6
Hazardous Air Pollutants				
Benzene	0.084	9.84	3.92	13.84
Toluene	0.031	8.83	3.91	12.78
Ethylbenzene	---	0.47	0.27	0.74
Xylene	0.020	2.74	1.16	3.92
n-Hexane	0.095	161.77	27.59	189.46
Formaldehyde	0.0080	0.25	4.21	4.47
Acetaldehyde	0.0026	---	0.23	0.23
Acrolein	0.00080	---	0.037	0.038
Methanol	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---
1,3-Dichloropropene	---	---	---	---
1,3-Butadiene	---	---	0.0025	0.0025
2,2,4-Trimethylpentane	---	---	---	---
Biphenyl	---	---	---	---
Carbon Tetrachloride	---	---	---	---
Chlorobenzene	---	---	---	---
Chloroform	---	---	---	---
Dichlorobenzene	---	0.0039	0.0021	0.0060
Ethylene Dibromide	---	---	---	---
Methylene Chloride	---	---	---	---
Naphthalene	0.013	0.0020	0.0085	0.024
Phenol	---	---	---	---
Propylene Oxide	---	---	0.17	0.17
Styrene	---	---	---	---
Vinyl Chloride	---	---	---	---
(PAH) POM 1	---	---	0.013	0.013
POM 2	0.0078	0.00019	0.00010	0.0081
POM 3	---	0.000052	0.00003	0.00008
POM 4	---	0.0000059	0.000003	0.000009
POM 5	0.000061	0.0000078	0.000004	0.000073
POM 6	0.00024	0.000024	0.000012	0.00028
POM 7	0.00016	0.0000059	0.000003	0.00016
Total HAPs	0.26	183.91	41.53	225.69
Greenhouse Gases				
CO_2	18,776	394,514	1,018,246	1,431,536
CH_4	18.81	3,809	665	4,492
N_2O	0.15	0.74	1.90	2.80
CO_2e	19218	474,727	1,032,792	1,526,737

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	47	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	1.67	1.97	0.035	1.67	3.33
PM_{15}	0.50	0.009	0.42	0.50	0.009	0.42	0.85
PM_{10}	0.38	0.007	0.32	0.38	0.007	0.32	0.64
$PM_{2.5}$	0.21	0.004	0.18	0.21	0.004	0.18	0.35

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	0	well pads/year
Oil well pads	47	well pads/year
Distance graded - Oil well	1.19	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Oil wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	3.21	0.09	0.0016	0.075
PM_{15}	1.53	0.043	0.00077	0.036
PM_{10}	0.92	0.026	0.00046	0.022
$PM_{2.5}$	0.10	0.003	0.000050	0.0023

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	47	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.009	0.41	1.97	0.009	0.41	0.83
PM_{15}	0.50	0.002	0.11	0.50	0.002	0.11	0.21
PM_{10}	0.38	0.002	0.08	0.38	0.002	0.08	0.16
$PM_{2.5}$	0.21	0.0009	0.04	0.21	0.001	0.04	0.087

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.024
PM_{15}	0.48	0.05	0.00024	0.011
PM_{10}	0.29	0.032	0.00014	0.0068
$PM_{2.5}$	0.03	0.003	0.000016	0.00073

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	47	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	1.04	1.97	0.022	1.04	2.07
PM_{15}	0.50	0.006	0.26	0.50	0.006	0.26	0.53
PM_{10}	0.38	0.0042	0.20	0.38	0.0042	0.20	0.40
$PM_{2.5}$	0.21	0.0023	0.11	0.21	0.0023	0.11	0.22

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.00	0.09	0.0010	0.047
PM_{15}	0.96	0.043	0.00048	0.023
PM_{10}	0.58	0.026	0.00029	0.014
$PM_{2.5}$	0.06	0.0028	0.000031	0.0015

a Assumes maximum development scenario

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads

Round Trip Miles 19

Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads

Round Trip Miles 6

Precipitation Days (P) 45 days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	47	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	4.16
$PM_{2.5}$	0.12	0.11	0.56	0.009	0.42

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.02
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.005

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.32	1.16	11.29	0.71	145.36
$PM_{2.5}$	0.13	0.12	1.13	0.07	14.54

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.052	0.0036	0.74
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.18

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads

Round Trip Miles 19

Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads

Round Trip Miles 6

Precipitation Days (P) 45 days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	47	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	3.13
$PM_{2.5}$	0.14	0.12	0.42	0.007	0.31

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.02
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.004

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	262.95
$PM_{2.5}$	0.14	0.12	1.75	0.13	26.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.44
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.35

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	415.60	2.21	417.81
$PM_{2.5}$	41.56	0.54	42.10

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	94	acres total disturbance for well pads per year
	380,404	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	2.14	0.00
PM_{10}	1.07	0.00
$PM_{2.5}$	0.16	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	47	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.16
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.29
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.018
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00018
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.008
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.008
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	17.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0008
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0003
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	17.55

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	47	new pads per year
Backhoe miles per pad	0.58	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	2.3	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	2.3	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	6.77
CO	1.43	2.26
VOC	0.36	0.58
PM_{10}	0.22	0.35
$PM_{2.5}$	0.22	0.35
Greenhouse Gases		
CO_2	97.50	154.26
CO_2e [e]	97.50	154.26

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of oil wells drilled	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total-Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	7.35
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	7.33
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.56
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0063
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.40
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.39
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	736.83
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.022
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0072
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	739.53

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Number of oil wells	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total_Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	12.80
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	12.18
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	0.94
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.011
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.70
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.68
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1275.16
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.036
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.012
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1279.62

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	204	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.62
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.70
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.051
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00056
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.034
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.032
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	63.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0021
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00070
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	63.71

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	144	hours/oil well
Development Rate	204	oil wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr) * horsepower (hp) * Hours (hour/year) * Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 4)				
Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	0.38	76.53
CO [a]	5.73E-03	5.21	0.38	76.53
VOC [a]	3.09E-04	0.28	0.02	4.12
PM_{10} [a]	6.61E-05	0.06	0.004	0.88
$PM_{2.5}$ [a]	6.61E-05	0.06	0.004	0.88
SO_2 [b]	1.21E-05	0.011	0.00079	0.16
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.00036	0.073
Toluene [c]	1.97E-06	0.0018	0.00013	0.026
Xylenes [c]	1.35E-06	0.0012	0.000088	0.018
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.0074
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.0024
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.00074
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.012
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.0072
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.000056
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.00022
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.00014
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	74.70	15,238
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.62
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.12
CO_2e [m]	---	1040.96	74.95	15,290

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	204	wells/year (oil wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Engine Emissions (lb/hr)	Engine Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.84	0.12	25.32
CO [a]	0.85	5.50E-03	2.62	0.033	6.72
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.79
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.79
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.012
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.0061
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.0022
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.0015
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.00062
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.00020
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.000062
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.0010
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.00061
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.0000048
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.000019
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.000012
Greenhouse Gases					
CO_2 [i]	163.05	1.14	501.6	6.32	1289.9
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.052
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.010
CO_2e [l]	---	---	503.3	6.3	1,294.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	204	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	18.08
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	3.21
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	2.56
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.54
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.00
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.32
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.36
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.16
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.074
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.013
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0014
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00019
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0055
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0028
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00029
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.095
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.24
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.16
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0023
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**5.13**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.10**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**26.82**

a Assumes maximum development scenario

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	575,626	miles/year-all wells
Operation Pickup Truck Mileage:	171,615	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.45	15.43	6.05E-03	0.28	0.52	8.74	15.95
CO	1.02E-02	1.61	2.94	4.48E-02	2.11	3.84	3.71	6.78
VOC [c]	1.55E-03	0.24	0.45	1.61E-03	0.08	0.14	0.32	0.58
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0009	0.0016	0.006	0.010
PM_{10}	2.57E-03	0.41	0.74	1.31E-04	0.006	0.011	0.41	0.75
$PM_{2.5}$	2.50E-03	0.39	0.72	1.21E-04	0.006	0.010	0.40	0.73
Greenhouse Gases								
CO_2	4.520	712.8	1,300.9	1.050	49.4	90.1	762.2	1,391.0
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.004	0.008	0.008	0.016
N_2O	4.01E-06	0.0006	0.0012	2.68E-05	0.0013	0.0023	0.0019	0.0035
CO_2e [c]	---	713.1	1,301.4	---	49.9	91.0	763.0	1392.4

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

19. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	1450	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	63
Light Trucks	8,000	19
Mean Vehicle Weight	36,457	---
Total Round Trips	---	82

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.56	1.37	0.16	0.26	382.52
$PM_{2.5}$	0.16	0.14	0.016	0.026	38.25

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.027	0.027	0.00094	0.0017	2.47
$PM_{2.5}$	0.0066	0.0066	0.00023	0.00042	0.61

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	92,959	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.028	836.80
Hazardous Air Pollutants [b]			
Benzene	0.0018	0.000089	2.66
Toluene	0.0017	0.000083	2.46
Ethylbenzene	0.000092	0.0000046	0.14
Xylenes	0.00053	0.000026	0.78
n-Hexane	0.028	0.0014	41.88
Greenhouse Gases [b]			
CO_2	0.0044	0.0044	9.51
CH_4	0.13	0.0067	200.37
CO_2e	2.83	0.15	4217.32

a Total wellsite working and breathing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 102.39 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	39.82	307.20
Ethane	30.07	16.516	4.97	13.20	16.91	244.55
Propane	44.10	16.909	7.46	19.81	17.31	367.19
i-Butane	58.12	3.694	2.15	5.71	3.78	105.72
n-Butane	58.12	9.044	5.26	13.97	9.26	258.83
i-Pentane	72.15	3.269	2.36	6.27	3.35	116.14
n-Pentane	72.15	4.297	3.10	8.24	4.40	152.66
Cyclopentane	70.10	0.361	0.25	0.67	0.37	12.46
Hexanes	86.18	2.285	1.97	5.23	2.34	96.97
Heptanes	100.20	1.423	1.43	3.79	1.46	70.21
Octanes	114.23	0.403	0.46	1.22	0.41	22.67
Nonanes	128.26	0.076	0.10	0.26	0.078	4.80
Decanes +	142.29	0.026	0.037	0.098	0.027	1.82
Benzene	78.11	0.106	0.083	0.22	0.109	4.08
Toluene	92.14	0.083	0.076	0.20	0.085	3.77
Ethylbenzene	106.17	0.004	0.004	0.011	0.0041	0.21
Xylenes	106.17	0.023	0.024	0.065	0.0236	1.20
n-Hexane	86.18	1.513	1.30	3.46	1.55	64.21
Nitrogen	28.01	0.612	0.17	0.46	0.63	8.44
Carbon Dioxide	44.01	0.460	0.20	0.54	0.47	9.97
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**44.56**	**1282.94**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**1.77**	**73.46**
TOTAL		**100.0**	**37.63**	**100.0**	**102.39**	**1853.10**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	856.08	21.34	877.42
Hazardous Air Pollutants [b]			
Benzene	2.72	0.068	2.79
Toluene	2.51	0.063	2.58
Ethylbenzene	0.14	0.0035	0.14
Xylenes	0.80	0.020	0.82
n-Hexane	42.84	1.07	43.91
Greenhouse Gases [b]			
CO_2	6.65	6.65	13.30
CH_4	204.99	5.11	210.10
CO_2e	4311.40	113.97	4425.4

a Total wellsite flashing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.

22. Oil Truck Loadout

Assumptions:

Oil Well Production Rate	9.1	bbl/day-well
Number of Oil Wells not going to a GOSP	1450	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Oil Loading [a]	0.6	2.8	50	520	2.01	9.1	0.14	203.70

	Oil Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00045	0.65
Toluene	0.00041	0.60
Ethylbenzene	0.000023	0.033
Xylenes	0.00013	0.19
n-Hexane	0.0070	10.19
Greenhouse Gases		
CO2	0.00109	1.58
CH4	0.034	48.78
CO2e	0.71	1025.9

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60° F.

b Assumes maximum development scenario

c Emissions estimated based on flashing analysis weight fractions

23. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	3,250	397.90	1,402.92	12.29	29,474

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

24. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters	1450	wells
Oil well tanks	2,176	tanks
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Oil Well Separator Heater			Oil Well Tank Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.029	0.13	100	0.029	0.13	74.65	326.95
CO [a]	84	0.025	0.11	84	0.025	0.11	62.70	274.64
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	4.11	17.98
SO_2 [b]	0.6	0.00018	0.00077	0.6	0.00018	0.00077	0.45	1.96
PM_{10} [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	2.10E-03	6.18E-07	2.71E-06	0.0016	0.0069
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	3.40E-03	1.00E-06	4.38E-06	0.0025	0.011
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	1.80E+00	5.29E-04	2.32E-03	1.34	5.89
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	7.50E-02	2.21E-05	9.66E-05	0.056	0.25
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	1.20E-03	3.53E-07	1.55E-06	0.00090	0.0039
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	6.10E-04	1.79E-07	7.86E-07	0.00046	0.0020
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	5.90E-05	1.74E-08	7.60E-08	0.000044	0.00019
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	1.60E-05	4.71E-09	2.06E-08	0.000012	0.000052
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	1.80E-06	5.29E-10	2.32E-09	0.000001	0.000006
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	2.40E-06	7.06E-10	3.09E-09	0.000002	0.000008
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	7.20E-06	2.12E-09	9.28E-09	0.000005	0.000024
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	1.8E-06	5.29E-10	2.32E-09	0.000001	0.000006
Greenhouse Gases								
CO_2 [l]	119,226	35.07	153.59	119,226	35.07	153.59	88,998	389,813
CH_4 [l]	2.25	0.00066	0.0029	2.25	0.00066	0.0029	1.68	7.35
N_2O [l]	0.22	0.000066	0.00029	0.22	0.000066	0.00029	0.17	0.74
CO_2e [m]	---	35.10	153.74	---	35.10	153.74	89,086	390,195

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

25. Oil Well Fugitives

Number of Producting Wells 3250 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1198.00**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	3.31
Toluene Emissions	0.00011	0.0020	2.97
Ethylbenzene Emissions	----	0.00011	0.16
Xylene Emissions	0.000011	0.00065	0.92
n-Hexane Emissions	0.0035	0.035	52.55

Project: GMBU - Alternative C - Oil Wells
Date: 7/15/2013

25. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**1929.15**	**16.88**	**40,529**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

26. Wellsite Flare Emissions

Assumptions:

Number of oil well pads with controls	362	well pads
Vent gas from each well pad	7.66	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.0011	0.005	0.40	1.73
CO [a]	0.37	0.006	0.026	2.15	9.44
Greenhouse Gases					
CO2 [b]	---	2.05	9.00	744	3,257
CH4 [b]	---	0.0063	0.028	2.28	10.00
N2O [b]	---	0.000002	0.000009	0.0008	0.0033
CO2e [b]	---	2.19	9.58	792	3,468

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

27. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :		
Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	4	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	5.21
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.051
Toluene	0.11	0.0053	0.085
Ethylbenzene	0.0046	0.00023	0.0037
Xylenes	0.038	0.0019	0.030
n-Hexane	0.17	0.0084	0.13
Greenhouse Gases			
CO_2	1.32	1.32	21.07
CH_4	6.24	0.31	4.99
CO_2e	132	7.87	125.92

a Assumes maximum development scenario

28. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 4 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	46.77
Hazardous Air Pollutants			
Benzene	0.13	0.56	2.24
Toluene	0.090	0.39	1.58
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.28
n-Hexane	0.078	0.34	1.36
Greenhouse Gases			
CH_4	3.28	14.35	57.40
CO_2e	68.81	301.38	1205.50

a Assumes maximum development scenario

29. Compressor Station Fugitives

Number of Compressor Stations 4 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**12.10**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.025
Toluene Emissions	0.0001	0.016	0.028
Ethylbenzene Emissions	----	0.00070	0.0010
Xylene Emissions	0.00001	0.0058	0.0085
n-Hexane Emissions	0.0035	0.026	0.23

29. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**36.37**	**0.318**	**764.1**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

30. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Facilities	4	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	11.13

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.11
Toluene	0.045	0.18
Ethylbenzene	0.0020	0.0078
Xylenes	0.016	0.064
n-Hexane	0.071	0.29
Greenhouse Gases		
CO2	0.56	2.25
CH4	2.66	10.65
CO2e	56.50	226.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

31. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	10,260	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.15	0.27	6.05E-03	0.00	0.00	0.15	0.27
CO	1.02E-02	0.03	0.05	4.48E-02	0.00	0.00	0.03	0.05
VOC [c]	1.55E-03	0.00	0.01	1.61E-03	0.00	0.00	0.00	0.01
SO_2	3.07E-05	0.000	0.000	1.84E-05	0.0000	0.0000	0.000	0.000
PM_{10}	2.57E-03	0.01	0.01	1.31E-04	0.000	0.000	0.01	0.01
$PM_{2.5}$	2.50E-03	0.01	0.01	1.21E-04	0.000	0.000	0.01	0.01
Greenhouse Gases								
CO_2	4.520	12.7	23.2	1.050	0.0	0.0	12.7	23.2
CH_4	2.59E-05	0.0001	0.000	9.38E-05	0.000	0.000	0.000	0.000
N_2O	4.01E-06	0.0000	0.0000	2.68E-05	0.0000	0.0000	0.0000	0.0000
CO_2e [c]	---	12.7	23.2	---	0.0	0.0	12.7	23.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

32. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	4	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.80	1.28	5.13
$PM_{2.5}$	0.17	0.15	0.080	0.13	0.51

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0051	0.0094	0.037
$PM_{2.5}$	0.0081	0.0081	0.0013	0.0023	0.0092

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

33. GOSP Truck Loadout

Assumptions:		
Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	12	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	46.31

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.15
Toluene	0.011	0.14
Ethylbenzene	0.00063	0.0075
Xylenes	0.0036	0.043
n-Hexane	0.19	2.32
Greenhouse Gases		
CO2	0.030	0.36
CH4	0.92	11.09
CO2e	19.44	233.24

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

34. GOSP Fugitives

Number of GOSP Facilities 12 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**139.32**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.35
Toluene Emissions	0.00011	0.0020	0.30
Ethylbenzene Emissions	----	0.00011	0.015
Xylene Emissions	0.000011	0.00065	0.091
n-Hexane Emissions	0.0035	0.035	5.55

Project: GMBU - Alternative C - Oil Wells
Date: 7/15/2013

34. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**213.61**	**1.87**	**4487.60**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

35. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	571,656	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.39	15.32	6.05E-03	0.00	0.00	8.39	15.32
CO	1.02E-02	1.60	2.92	4.48E-02	0.00	0.00	1.60	2.92
VOC [c]	1.55E-03	0.24	0.44	1.61E-03	0.00	0.00	0.24	0.44
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0000	0.0000	0.005	0.009
PM_{10}	2.57E-03	0.40	0.73	1.31E-04	0.000	0.000	0.40	0.73
$PM_{2.5}$	2.50E-03	0.39	0.71	1.21E-04	0.000	0.000	0.39	0.71
Greenhouse Gases								
CO_2	4.520	707.9	1,291.9	1.050	0.0	0.0	707.9	1,291.9
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.000	0.000	0.004	0.007
N_2O	4.01E-06	0.0006	0.0011	2.68E-05	0.0000	0.0000	0.0006	0.0011
CO_2e [c]	---	708.2	1,292.5	---	0.0	0.0	708.2	1292.5

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

36. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	12	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	63
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	63

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	16.85	26.95	323.44
$PM_{2.5}$	0.17	0.15	1.685	2.695	32.34

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.11	0.20	2.36
$PM_{2.5}$	0.0081	0.0081	0.026	0.048	0.58

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

37. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :		
Facility Production Rate	160	bbls oil per day per facility
Total Facilities	13	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.097	79.25
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.25
Toluene	0.0030	0.018	0.23
Ethylbenzene	0.00017	0.00099	0.013
Xylenes	0.0010	0.0057	0.074
n-Hexane	0.051	0.31	3.97
Greenhouse Gases			
CO_2	0.0079	0.047	0.62
CH_4	0.24	1.46	18.98
CO_2e	5.12	30.70	399.14

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

38. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	1241.60 scf/day-facility

* Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.151
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.275
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.0582
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.0221
Benzene	78.11	0.106	0.083	0.0022	1.32	0.0494
Toluene	92.14	0.083	0.076	0.0020	1.03	0.0457
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.00254
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.0146
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.779
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.102
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.121
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	13

Total Flashing Emissions for All Tanks (tons/yr)

VOC	202.24
Hazardous Air Pollutants	
Benzene	0.64
Toluene	0.59
Ethylbenzene	0.033
Xylenes	0.19
n-Hexane	10.12
HAPs	11.58
Greenhouse Gases	
CO2	1.57
CH4	48.43
CO2e	1018.5

39. Water Treatment Facility Fugitives

Number Water Treatment Facilities 13 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**11.97**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.033
Toluene Emissions	0.00011	0.0020	0.029
Ethylbenzene Emissions	----	0.00011	0.0016
Xylene Emissions	0.000011	0.00065	0.0091
n-Hexane Emissions	0.0035	0.0346	0.52

39. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**28.16**	**0.25**	**591.6**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

40. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	12	GOSP Facilities
	4	Compressor Stations

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	39.41	172.62
CO [a]	84	2.72	11.90	84	0.124	0.54	33.11	145.00
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	2.17	9.49
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.24	1.04
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	8.28E-04	0.0036
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	1.34E-03	0.0059
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	7.09E-01	3.11
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	2.96E-02	0.13
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	4.73E-04	0.0021
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	2.40E-04	0.0011
POM 2[c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	2.33E-05	0.00010
POM 3[c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	6.31E-06	0.000028
POM 4[c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
POM 5[c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	9.46E-07	0.0000041
POM 6[c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	2.84E-06	0.000012
POM 7[c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	46988.9	205812
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.89	3.88
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.089	0.39
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	47035	206013

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

41. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 4
Number of GOSPs 12

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	14.30
CO [a]	0.37	1.11	4.86	77.79
Greenhouse Gases				
CO2 [b]	---	508	2,227	35,625
CH4 [b]	---	3.25	14.22	227.52
N2O [b]	---	0.0007	0.003	0.05
CO2e [b]	---	577	2,526	40,418

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

42. Electric Substation Turbines

Assumptions

Number of substations	5	Substations
Size of gas generators	20	MW
Size of steam generators	10	MW
Number of gas turbines per substation	2	turbines/substation
Number of steam turbines per substation	1	turbines/substation
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
20 MW turbine fuel input	189	MMBtu/hr
Turbine load factor	0.8	

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/MMBtu)} * \text{Fuel Input (MMBtu/hr)} * \text{turbines per facility} * \text{load factor} * \text{(hrs/year)}}{\text{2000 lbs/ton}}$$

	Emission Factor (lb/MMBtu)	Facility Emissions (lb/hr/facility)	Facility Emissions (tons/yr-facility)	Total Emissions [g] (lb/hr)	Total Emissions [g] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	0.0072	2.17	9.52	10.87	47.61
CO [a]	0.007	1.98	8.69	9.92	43.46
VOC [a]	0.0025	0.76	3.31	3.78	16.57
SO_2 [b]	0.00014	0.042	0.19	0.21	0.93
PM_{10} [c]	0.0048	1.45	6.37	7.27	31.84
$PM_{2.5}$ [c]	0.0048	1.45	6.37	7.27	31.84
Hazardous Air Pollutants [d]					
1,3-Butadiene	4.3E-07	0.00011	0.00049	0.00056	0.0025
Acetaldehyde	4.0E-05	0.011	0.046	0.053	0.23
Acrolein	6.4E-06	0.0017	0.0074	0.008	0.037
Benzene	1.2E-05	0.0032	0.014	0.016	0.069
Ethylbenzene	3.2E-05	0.0084	0.037	0.042	0.18
Formaldehyde	7.1E-04	0.19	0.817	0.93	4.08
Naphthalene	1.3E-06	0.00034	0.0015	0.0017	0.0075
PAH	2.2E-06	0.00058	0.0025	0.0029	0.013
Propylene Oxide	2.9E-05	0.0076	0.033	0.038	0.17
Toluene	1.3E-04	0.034	0.15	0.17	0.75
Xylene	6.4E-05	0.017	0.074	0.08	0.37
Greenhouse Gases					
CO2 [e]	117	35,409	155,093	177,047	775,466
CH_4 [e]	0.002	0.67	2.93	3.34	14.63
N_2O [e]	0.0002	0.067	0.29	0.33	1.46
CO_2e [f]	----	35,444	155,245	177,221	776,227

a Emission factors based on typical turbine specifications for turbines with catalysts to meet BACT levels - (2 ppmv NOx and VOC and 3 ppmv CO)

b Emission factor based on typical turbine manufacturer specifications

c Emission factor based on typical turbine manufacturer specifications and BACT levels

d Emission factors from AP-42, Table 3.1-3, HAPs from natural gas turbines, April 2000, with 13.3% control from the catalyst. Catalyst control efficiency from typical manufacturer data.

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH4 as 1.0E-03 kg/MMBtu and for N2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Assumes maximum development scenario. Emissions are from the 20 MW turbines as the 10 MW steam generators do not add any additional emissions

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

Identification

User Identification:	GMBU Water treatment tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 500 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		25.00
Diameter (ft):		12.00
Liquid Height (ft) :		24.00
Avg. Liquid Height (ft):		12.00
Volume (gallons):		20,304.71
Turnovers:		20.13
Net Throughput(gal/yr):		408,800.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	2,032.1687

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

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

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50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

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

Identification

User Identification:	GMBU PA Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		5.78
Net Throughput(gal/yr):		92,959.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	243.2049
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	92,959.0000
Annual Turnovers:	5.7830
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,124.5785

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

Emissions Report for: Annual

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	243.20	881.37	1,124.58

APPENDIX D-2

FIELD WIDE ELECTRIFICATION ALTERNATIVE GAS WELL EMISSIONS

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Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative C - Gas Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	23.0	8.5	2.0	0.0006	19.2	4.8
	Drilling	577.7	562.5	31.3	1.2	725.4	80.7
	Completion	67.4	22.8	2.6	0.039	384.7	41.1
	Interim Reclamation	0.5	0.5	0.04	0.0004	10.5	1.1
	Wind Erosion	---	---	---	---	5.3	0.8
Wellsite Production Emissions	Production Heaters	483.1	405.8	26.6	2.9	36.7	36.7
	Wellsite Tanks	---	---	1,773.5	---	---	---
	Pneumatics	---	---	306.1	---	---	---
	Fugitives	---	---	1,452.7	---	---	---
	Wellsite Truck Loading	---	---	189.2	---	---	---
	Wellsite Dehydrators	---	---	47.3	---	---	---
	Wellsite Flares	20.1	109.3	---	---	---	---
	Operations Vehicle	7.9	8.0	0.4	0.007	246.2	25.1
Gas Processing Plant Emissions	GP Flares	0.9	4.9	---	---	---	---
	GP Fugitives	---	---	0.8	---	---	---
	GP Dehydrator Heater	0.6	0.5	0.04	0.004	0.05	0.05
	GP Dehydrator	---	---	11.7	---	---	---
Compressor Station Emissions	Compressor Station Tanks	---	---	26.1	---	---	---
	Compressor Station Dehy	---	---	233.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	1.4	0.3	55.7	0.0	31.1	3.2
	Compressor Station Dehydrator Heater	12.9	10.8	0.7	0.1	1.0	1.0
	Compressor Station Flare	17.9	97.2	---	---	---	---
	Compressor Station Fugitives	---	---	60.5	---	---	---
	Electric Substation Gas Turbines	57.1	52.1	19.9	1.1	38.2	38.2
	Total Emissions	**1,270.5**	**1,283.2**	**4,240.9**	**5.3**	**1,498.4**	**232.7**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	23.0	577.7	67.4	0.5	---	668.6
CO	8.5	562.5	22.8	0.5	---	594.3
VOC	2.0	31.3	2.6	0.04	---	35.9
SO_2	0.0006	1.2	0.04	0.0004	---	1.2
PM_{10}	19.2	725.4	384.7	10.5	5.3	1145.1
$PM_{2.5}$	4.8	80.7	41.1	1.1	0.8	128.4
Hazardous Air Pollutants						
Benzene	---	0.51	0.010	---	---	0.52
Toluene	---	0.18	0.004	---	---	0.19
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.13	0.0026	---	---	0.13
n-Hexane	---	---	---	---	---	---
Formaldehyde	---	0.052	0.0011	---	---	0.053
Acetaldehyde	---	0.017	0.00034	---	---	0.017
Acrolein	---	0.0052	0.00011	---	---	0.0053
Naphthalene	---	0.085	0.0017	---	---	0.087
POM 2	---	0.050	0.0010	---	---	0.051
POM 5	---	0.00040	0.000008	---	---	0.00040
POM 6	---	0.0015	0.000032	---	---	0.0016
POM 7	---	0.0010	0.000021	---	---	0.0010
Greenhouses Gases						
CO_2	569.9	110,750	5,555	49	---	116,923
CH_4	0.0028	4.41	0.18	0.00159	---	4.60
N_2O	0.0010	0.89	0.04	0.00054	---	0.93
CO_2e	570.3	111,118	5,571	49	---	117,308

a Assumes maximum development scenario of 156 wells in one year

b Emissions in summary tables may vary slightly due to rounding differences.

c Total drilling emissions includes Tier IV drill rig engines

Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Wellsite Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	483.1	---	---	---	---	20.1	---	7.9	511.1
CO	405.8	---	---	---	---	109.3	---	8.0	523.1
VOC	26.6	1773.5	1452.7	189.2	306.1	---	47.3	0.4	3,795.8
SO_2	2.9	---	---	---	---	---	---	0.007	2.9
PM_{10}	36.7	---	---	---	---	---	---	246.2	283.0
$PM_{2.5}$	36.7	---	---	---	---	---	---	25.1	61.8
Hazardous Air Pollutants									
Benzene	0.010	17.25	3.97	1.84	0.33	---	2.75	---	26.15
Toluene	0.016	28.75	5.20	3.07	0.17	---	11.64	---	48.84
Ethylbenzene	---	1.25	0.20	0.13	---	---	3.41	---	4.99
Xylene	---	10.25	1.69	1.09	0.017	---	24.25	---	37.30
n-Hexane	8.70	45.50	28.85	4.85	5.65	---	---	---	93.56
Formaldehyde	0.36	---	---	---	---	---	---	---	0.36
Dichlorobenzene	0.0058	---	---	---	---	---	---	---	0.0058
Naphthalene	0.0029	---	---	---	---	---	---	---	0.0029
POM 2	0.00029	---	---	---	---	---	---	---	0.00029
POM 3	0.000077	---	---	---	---	---	---	---	0.000077
POM 4	0.0000087	---	---	---	---	---	---	---	0.0000087
POM 5	0.000012	---	---	---	---	---	---	---	0.000012
POM 6	0.000035	---	---	---	---	---	---	---	0.000035
POM 7	0.0000087	---	---	---	---	---	---	---	0.000009
Greenhouse Gases									
CO_2	575,965.1	358.3	33.9	38.2	9.5	24,974.9	---	746.9	602,127
CH_4	10.86	1698.3	3871.0	181.19	1,079.17	238.0	73.98	0.0173	7,152
N_2O	1.09	---	---	---	---	0.0	---	0.0045	1.13
CO_2e	576,530	36,022	81,324	3,843	22,672	29,986	1,553	749	752,679

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Total Project Infrastructure Related Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Substation Turbines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	13.5	---	---	---	18.8	---	57.1	1.4	90.8
CO	11.4	---	---	---	102.1	---	52.1	0.3	165.9
VOC	0.7	26.1	61.4	55.6	---	245.5	19.9	0.04	409.2
SO_2	0.08	---	---	---	---	---	1.1	0.001	1.2
PM_{10}	1.0	---	---	---	---	---	38.2	31.1	70.3
$PM_{2.5}$	1.0	---	---	---	---	---	38.2	3.2	42.4
Hazardous Air Pollutants									
Benzene	0.00028	0.254	0.125	0.54	---	11.76	0.083	---	12.76
Toluene	0.00046	0.423	0.142	0.90	---	8.27	0.90	---	10.63
Ethylbenzene	---	0.0184	0.0049	0.0392	---	---	0.22	---	0.28
Xylene	---	0.151	0.043	0.322	---	1.48	0.44	---	2.44
n-Hexane	0.24	0.67	1.18	1.43	---	7.13	---	---	10.65
Formaldehyde	0.010	---	---	---	---	---	4.90	---	4.91
Acetaldehyde	---	---	---	---	---	---	0.28	---	0.28
Acrolein	---	---	---	---	---	---	0.044	---	0.044
Methanol	---	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---	---
1,3-Dichloropropene	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	0.0030	---	0.0030
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---
Biphenyl	---	---	---	---	---	---	---	---	---
Carbon Tetrachloride	---	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---	---
Chloroform	---	---	---	---	---	---	---	---	---
Dichlorobenzene	0.00016	---	---	---	---	---	---	---	0.00016
Ethylene Dibromide	---	---	---	---	---	---	---	---	---
Methylene Chloride	---	---	---	---	---	---	---	---	---
Naphthalene	0.000083	---	---	---	---	---	0.0090	---	0.0091
Phenol	---	---	---	---	---	---	---	---	---
Propylene Oxide	---	---	---	---	---	---	0.20	---	0.20
Styrene	---	---	---	---	---	---	---	---	---
Tetrachloroethane	---	---	---	---	---	---	---	---	---
Vinyl Chloride	---	---	---	---	---	---	---	---	---
PAH -POM 1	---	---	---	---	---	---	0.015	---	0.015
POM 2	0.0000080	---	---	---	---	---	---	---	0.000008
POM 3	0.0000022	---	---	---	---	---	---	---	0.000002
POM 4	0.00000024	---	---	---	---	---	---	---	0.0000002
POM 5	0.00000032	---	---	---	---	---	---	---	0.0000003
POM 6	0.00000097	---	---	---	---	---	---	---	0.0000010
POM 7	0.00000024	---	---	---	---	---	---	---	0.0000002
Greenhouse Gases									
CO_2	16,127	105.3	1.61	11.24	36,935	---	930,560	116	983,856
CH_4	0.30	25.0	183.9	53.27	352.0	301.38	17.6	0.00066	933.3
N_2O	0.030	---	---	---	0.062	---	1.8	0.00010	1.8
CO_2e	16,143	630	3,864	1,130	44,345	6,329	931,472	116	1,004,029

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	668.6	511.1	90.8	1,270.5
CO	594.3	523.1	165.9	1,283.2
VOC	35.9	3,795.8	409.2	4,240.9
SO_2	1.2	2.9	1.2	5.3
PM_{10}	1,145.1	283.0	70.3	1,498.4
$PM_{2.5}$	128.4	61.8	42.4	232.7
Hazardous Air Pollutants				
Benzene	0.519	26.15	12.76	39.43
Toluene	0.188	48.84	10.63	59.66
Ethylbenzene	---	4.99	0.28	5.28
Xylene	0.1290	37.30	2.44	39.86
n-Hexane	---	93.56	10.65	104.21
Formaldehyde	0.0527	0.36	4.91	5.32
Acetaldehyde	0.0168	---	0.28	0.29
Acrolein	0.00527	---	0.044	0.049
Methanol	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---
1,3-Dichloropropene	---	---	---	---
1,3-Butadiene	---	---	0.0030	0.0030
2,2,4-Trimethylpentane	---	---	---	---
Biphenyl	---	---	---	---
Carbon Tetrachloride	---	---	---	---
Chlorobenzene	---	---	---	---
Chloroform	---	---	---	---
Dichlorobenzene	---	0.0058	0.00016	0.0060
Ethylene Dibromide	---	---	---	---
Methylene Chloride	---	---	---	---
Naphthalene	0.0869	0.0029	0.0091	0.10
Phenol	---	---	---	---
Propylene Oxide	---	---	0.20	0.20
Styrene	---	---	---	---
Tetrachloroethane	---	---	---	---
Vinyl Chloride	---	---	---	---
(PAH) POM 1	---	---	0.015	0.015
POM 2	0.0515	0.00029	0.000008	0.052
POM 3	---	0.000077	0.0000022	0.000079
POM 4	---	0.0000087	0.0000002	0.000009
POM 5	0.000403	0.000012	0.0000003	0.00042
POM 6	0.001580	0.000035	0.0000010	0.0016
POM 7	0.001023	0.000009	0.0000002	0.0010
Total HAPs	1.05	211.21	42.23	254.48
Greenhouse Gases				
CO_2	116,923	602,127	983,856	1,702,905
CH_4	4.60	7,152	933	8,090
N_2O	0.93	1.13	1.85	3.91
CO_2e	117,308	752,679	1,004,029	1,874,015

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	156	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	5.53	1.97	0.035	5.53	11.07
PM_{15}	0.50	0.009	1.41	0.50	0.009	1.41	2.82
PM_{10}	0.38	0.007	1.06	0.38	0.007	1.06	2.11
$PM_{2.5}$	0.21	0.00372	0.58	0.21	0.004	0.58	1.16

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	156	well pads/year
Oil well pads	0	well pads/year
Distance graded - Deep gas well	1.96	miles
Distance graded - Oil well	0.00	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Deep gas wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	5.27	0.15	0.0026	0.41
PM_{15}	2.52	0.07	0.0013	0.20
PM_{10}	1.51	0.042	0.00076	0.12
$PM_{2.5}$	0.16	0.005	0.000082	0.013

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	156	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.009	1.38	1.97	0.009	1.38	2.75
PM_{15}	0.50	0.002	0.35	0.50	0.002	0.35	0.70
PM_{10}	0.38	0.002	0.26	0.38	0.002	0.26	0.53
$PM_{2.5}$	0.21	0.0009	0.14	0.21	0.001	0.14	0.29

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.08
PM_{15}	0.48	0.05	0.00024	0.037
PM_{10}	0.29	0.032	0.00014	0.022
$PM_{2.5}$	0.03	0.003	0.000016	0.0024

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	156	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	3.44	1.97	0.022	3.44	6.88
PM_{15}	0.50	0.006	0.88	0.50	0.006	0.88	1.75
PM_{10}	0.38	0.0042	0.66	0.38	0.0042	0.66	1.31
$PM_{2.5}$	0.21	0.0023	0.36	0.21	0.0023	0.36	0.72

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.00	0.09	0.0010	0.16
PM_{15}	0.96	0.043	0.00048	0.07
PM_{10}	0.58	0.026	0.00029	0.04
$PM_{2.5}$	0.06	0.0028	0.000031	0.005

a Assumes maximum development scenario

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	156	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	13.81
$PM_{2.5}$	0.12	0.11	0.56	0.009	1.38

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.06
$PM_{2.5}$	0.0036	0.0035	0.006	0.00010	0.015

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.45	1.27	7.90	4.57	712.87
$PM_{2.5}$	0.15	0.13	0.79	0.46	71.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.023	0.022	0.041	0.0261	4.06
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	1.00

Project: GMBU - Alternative C -Gas Wells

7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$		Annual
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		Annual
$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$		Daily
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$		Daily
Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road		

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$		Daily
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$		Daily
Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year
W = average weight in tons of vehicles traveling the road		

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	156	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	10.37
$PM_{2.5}$	0.14	0.12	0.42	0.007	1.04

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.05
$PM_{2.5}$	0.0047	0.0046	0.005	0.00009	0.013

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	4
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	35,750	---
Total Round Trips	---	8

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.55	1.36	9.64	2.43	379.85
$PM_{2.5}$	0.16	0.14	0.96	0.24	37.98

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.026	0.025	0.05	0.02	2.36
$PM_{2.5}$	0.006	0.006	0.01	0.004	0.58

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	1116.90	6.54	1123.44
$PM_{2.5}$	111.69	1.60	113.29

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	468	acres total disturbance for well pads per year
	1,893,926	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2-period	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2-period
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	10.68	0.00
PM_{10}	5.34	0.00
$PM_{2.5}$	0.80	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	156	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.52
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.96
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.060
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00060
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.027
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.026
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	57.88
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0028
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0010
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	58.25

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	156	new pads per year
Backhoe miles per pad	0.77	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	3.1	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	3.1	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	22.49
CO	1.43	7.51
VOC	0.36	1.92
PM_{10}	0.22	1.16
$PM_{2.5}$	0.22	1.16
Greenhouse Gases		
CO_2	97.50	512.02
CO_2e [e]	97.50	512.02

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of deep gas wells drilled	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells[c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.0101	0.40	41.25
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.0993	0.25	26.04
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	2.44
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.0000	0.00030	0.030
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.0003	0.022	2.29
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.0002	0.022	2.22
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.2014	38.19	3932.16
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.0003	0.00077	0.079
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.0001	0.00023	0.024
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	3941.14

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Number of deep gas wells	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.004	0.48	21.46
CO	1.98E-02	0.12	0.04	7.26E-02	0.15	0.04	0.27	12.29
VOC [c]	3.16E-03	0.020	0.006	3.54E-03	0.007	0.0021	0.03	1.21
SO_2	4.57E-05	0.0003	0.00008	2.83E-05	0.00006	0.000017	0.0003	0.015
PM_{10}	4.22E-03	0.03	0.008	1.94E-04	0.0004	0.00012	0.03	1.20
$PM_{2.5}$	4.09E-03	0.03	0.007	1.79E-04	0.0004	0.00011	0.03	1.16
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	2029.05
CH_4	6.56E-05	0.0004	0.00012	2.08E-04	0.0004	0.00012	0.0008	0.04
N_2O	1.20E-05	0.00007	0.00002	8.05E-05	0.00017	0.00005	0.00024	0.011
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	2033

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	156	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.48
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.54
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.014	0.039
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00043
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.026
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.025
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	48.52
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0016
N_2O	1.20E-05	0.00002	0.0000004	8.05E-05	0.00017	0.0000030	0.00019	0.00054
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	48.72

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	1320	hours/deep gas well
Development Rate	156	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 , 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Gas Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	3.44	536.44
CO [a]	5.73E-03	5.21	3.44	536.44
VOC [a]	3.09E-04	0.28	0.19	28.89
PM_{10} [a]	6.61E-05	0.06	0.04	6.19
$PM_{2.5}$ [a]	6.61E-05	0.06	0.04	6.19
SO_2 [b]	1.21E-05	0.011	0.0073	1.14
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.0033	0.51
Toluene [c]	1.97E-06	0.0018	0.0012	0.18
Xylenes [c]	1.35E-06	0.0012	0.00081	0.13
Formaldehyde [c]	5.52E-07	0.00050	0.00033	0.052
Acetaldehyde [c]	1.76E-07	0.00016	0.00011	0.017
Acrolein [c]	5.52E-08	0.00005	0.000033	0.0052
Naphthalene [d]	9.10E-07	0.00083	0.00055	0.085
POM 2 [d,e,f]	5.39E-07	0.00049	0.00032	0.050
POM 5 [d,e,g]	4.22E-09	0.0000038	0.0000025	0.00040
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000099	0.0015
POM 7 [d,e,i]	1.07E-08	0.000010	0.0000064	0.0010
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	684.73	106,818
CH_4 [j,k]	4.63E-05	0.042	0.028	4.33
N_2O [j,k]	9.26E-06	0.0084	0.0056	0.87
CO_2e [m]	---	1040.96	687.03	107,177

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

15. Well Fracturing Engine

Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	156	wells/year (deep gas wells)

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Horsepower (hp)* Hours (hour/year) * Load Factor}}{\text{2000 lb/ton}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Gas Well Emissions (lb/hr)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.82	0.29	45.96
CO [a]	0.85	5.50E-03	2.25	0.07	10.53
VOC [a]	0.09	7.05E-04	0.29	0.009	1.35
PM_{10} [a]	0.10	0.0007	0.29	0.009	1.34
$PM_{2.5}$ [a]	0.10	0.0007	0.29	0.009	1.34
SO_2 [a]	1.52E-03	1.21E-05	0.0050	0.00015	0.023
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0022	0.000067	0.010
Toluene [b]	2.81E-04	1.97E-06	0.00080	0.000024	0.0038
Xylenes [b]	1.93E-04	1.35E-06	0.00055	0.000017	0.0026
Formaldehyde [b]	7.89E-05	5.52E-07	0.00023	0.0000068	0.0011
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000072	0.0000022	0.00034
Acrolein [b]	7.88E-06	5.52E-08	0.000023	0.00000068	0.00011
Naphthalene [c]	1.30E-04	9.10E-07	0.00037	0.000011	0.0017
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00022	0.0000066	0.0010
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000017	0.000000052	0.000008
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000068	0.00000020	0.000032
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000044	0.00000013	0.000021
Greenhouse Gases					
CO_2 [i]	163.05	1.14	753.3	22.60	3525.4
CH_4 [j]	6.61E-03	4.63E-05	0.031	0.00092	0.14
N_2O [j]	1.32E-03	9.26E-06	0.0061	0.00018	0.029
CO_2e [l]	---	---	755.8	22.7	3,537.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

16. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

17. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	261,747	miles/year-all wells
Operation Pickup Truck Mileage:	295,888	miles/year-all wells
Hours of Operation:	10	hours per day
Hours of Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	3.84	7.01	6.05E-03	0.49	0.90	4.33	7.91
CO	1.02E-02	0.73	1.33	4.48E-02	3.63	6.63	4.36	7.96
VOC [c]	1.55E-03	0.11	0.20	1.61E-03	0.13	0.24	0.24	0.44
SO_2	3.07E-05	0.002	0.004	1.84E-05	0.0015	0.0027	0.004	0.007
PM_{10}	2.57E-03	0.18	0.34	1.31E-04	0.011	0.019	0.19	0.36
$PM_{2.5}$	2.50E-03	0.18	0.33	1.21E-04	0.010	0.018	0.19	0.35
Greenhouse Gases								
CO_2	4.520	324.1	591.5	1.050	85.1	155.3	409.3	746.9
CH_4	2.59E-05	0.0019	0.003	9.38E-05	0.008	0.014	0.009	0.017
N_2O	4.01E-06	0.0003	0.0005	2.68E-05	0.0022	0.0040	0.0025	0.004
CO_2e [c]	---	324.3	591.8	---	86.0	156.9	410.2	748.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

18. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of producing wells	2500	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	29
Light Trucks	8,000	33
Mean Vehicle Weight	25,416	---
Total Round Trips	---	62

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.33	1.17	0.061	0.098	244.60
$PM_{2.5}$	0.13	0.12	0.0061	0.0098	24.46

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.00028	0.00052	1.29
$PM_{2.5}$	0.0045	0.0045	0.000069	0.000126	0.32

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

19. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	2500	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total Wellsite Emissions [a] (tons/yr)
VOC	0.71	0.00	1773.50
Hazardous Air Pollutants			
Benzene	0.0069	0.00	17.25
Toluene	0.012	0.00	28.75
Ethylbenzene	0.00050	0.00	1.25
Xylenes	0.0041	0.00	10.25
n-Hexane	0.018	0.00	45.50
Greenhouse Gases			
CO_2	0.14	0.00	358.3
CH_4	0.68	0.00	1698.3
CO_2e	14	0.00	36,022

a Total wellsite flashing emissions are based on 2500 uncontrolled tanks and 0 tanks controlled at 0%.

20. Condensate Truck Loadout

Assumptions:

Deep Gas Well Condensate Production Rate	2.0	bbl/day-well
Number of Deep Gas Wells	2500	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Condensate Loading [a]	0.6	5.2	66	520	4.94	2.0	0.076	189.22

	Condensate Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00074	1.84
Toluene	0.0012	3.07
Ethylbenzene	0.000053	0.13
Xylenes	0.00044	1.09
n-Hexane	0.0019	4.85
Greenhouse Gases		
CO2	0.015	38.22
CH4	0.072	181.19
CO2e	1.54	3843.3

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Assumes maximum development scenario

c Emissions estimated based on ratio of HAP/VOC in tank emissions

21. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.0546	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.0008	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.00520	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.00230	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
2,500	306.08	1,079.17	9.45	22,672

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

22. Production Heater Emissions

Assumptions

Deep Gas Well Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Gas wells with dehydrators	2500	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Deep Gas Well Dehydrator Heater			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	100	0.044	0.19	110.29	483.09
CO [a]	84	0.037	0.16	92.65	405.79
VOC [b]	5.5	0.0024	0.011	6.07	26.57
SO_2 [b]	0.6	0.00026	0.0012	0.66	2.90
PM_{10} [b]	7.6	0.0034	0.015	8.38	36.71
$PM_{2.5}$ [b]	7.6	0.0034	0.015	8.38	36.71
Hazardous Air Pollutants					
Benzene [c]	2.10E-03	9.26E-07	4.06E-06	0.0023	0.010
Toluene [c]	3.40E-03	1.50E-06	6.57E-06	0.0038	0.016
Hexane [c]	1.80E+00	7.94E-04	3.48E-03	1.99	8.70
Formaldehyde [c]	7.50E-02	3.31E-05	1.45E-04	0.083	0.36
Dichlorobenzene [c]	1.20E-03	5.29E-07	2.32E-06	0.0013	0.0058
Naphthalene [c]	6.10E-04	2.69E-07	1.18E-06	0.00067	0.0029
POM 2 [c,d,e]	5.90E-05	2.60E-08	1.14E-07	0.000065	0.00029
POM 3 [c,f]	1.60E-05	7.06E-09	3.09E-08	0.000018	0.00008
POM 4 [c,g]	1.80E-06	7.94E-10	3.48E-09	0.000002	0.00001
POM 5 [c,h]	2.40E-06	1.06E-09	4.64E-09	0.000003	0.00001
POM 6 [c,i]	7.20E-06	3.18E-09	1.39E-08	0.000008	0.00003
POM 7 [c,j]	1.8E-06	7.94E-10	3.48E-09	0.000002	0.00001
Greenhouse Gases					
CO_2 [l]	119,226	52.60	230.39	131,499	575,965
CH_4 [l]	2.25	0.0010	0.0043	2.48	10.86
N_2O [l]	0.22	0.00010	0.00043	0.25	1.09
CO_2e [m]	---	52.65	230.61	131,628	576,530

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

23. Deep Gas Well Fugitive Emissions

Number of Producting Wells 2500 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1452.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b Weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	3.97
Toluene Emissions	0.0001	0.0162	5.20
Ethylbenzene Emissions	----	0.0007	0.20
Xylene Emissions	0.00001	0.0058	1.69
n-Hexane Emissions	0.0035	0.0257	28.85

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**3870.96**	**33.87**	**81324**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

24. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.4 MMscf/day/well
Wells Requiring Dehydrators: 2,500 wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0043	0.019	47.28
Hazardous Air Pollutants			
Benzene	0.00025	0.0011	2.75
Toluene	0.0011	0.0047	11.64
Ethylbenzene	0.00031	0.0014	3.41
Xylenes	0.0022	0.010	24.25
Greenhouse Gases			
CH_4	0.0068	0.030	73.98
CO_2e	0.14	0.62	1553.48

25. Wellsite Flare Emissions

Assumptions:

Number of gas well dehydrators with controls	2500	well pads
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.002	0.01	4.59	20.09
CO [a]	0.37	0.01	0.04	24.96	109.31
Greenhouse Gases					
CO2 [b]	---	2.28	9.99	5,702	24,975
CH4 [b]	---	0.02	0.10	54.3	238.0
N2O [b]	---	0.00000	0.00002	0.0	0.042
CO2e [b]	---	2.74	11.99	6,846	29,986

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

26. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	20	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	26.07
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.254
Toluene	0.11	0.0053	0.423
Ethylbenzene	0.0046	0.00023	0.0184
Xylenes	0.038	0.0019	0.151
n-Hexane	0.17	0.0084	0.67
Greenhouse Gases			
CO_2	1.32	1.32	105.33
CH_4	6.24	0.31	24.96
CO_2e	132	7.87	629.6

a Assumes maximum development scenario

27. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 20 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	233.83
Hazardous Air Pollutants			
Benzene	0.13	0.56	11.20
Toluene	0.090	0.39	7.88
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	1.41
n-Hexane	0.078	0.34	6.79
Greenhouse Gases			
CH_4	3.28	14.35	287.02
CO_2e	68.81	301.38	6027.50

a Assumes maximum development scenario

28. Compressor Station Fugitive Emissions

Number of Compressor Stations 20 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.020
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**60.55**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.124
Toluene Emissions	0.0001	0.016	0.141
Ethylbenzene Emissions	----	0.00070	0.005
Xylene Emissions	0.00001	0.0058	0.043
n-Hexane Emissions	0.0035	0.026	1.17

28. Compressor Station Fugitive Emissions

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**181.85**	**1.591**	**3820.5**

a Number of components referenced from similar existing facilities

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

29. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Facilities	20	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	55.63

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.54
Toluene	0.045	0.90
Ethylbenzene	0.0020	0.039
Xylenes	0.016	0.32
n-Hexane	0.071	1.43
Greenhouse Gases		
CO2	0.56	11.24
CH4	2.664	53.27
CO2e	56.50	1129.92

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

30. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	51,302	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.75	1.37	6.05E-03	0.00	0.00	0.75	1.37
CO	1.02E-02	0.14	0.26	4.48E-02	0.00	0.00	0.14	0.26
VOC [c]	1.55E-03	0.022	0.040	1.61E-03	0.00	0.00	0.022	0.040
SO_2	3.07E-05	0.0004	0.001	1.84E-05	0.00	0.00	0.0004	0.0008
PM_{10}	2.57E-03	0.036	0.066	1.31E-04	0.00	0.00	0.036	0.066
$PM_{2.5}$	2.50E-03	0.035	0.064	1.21E-04	0.00	0.00	0.035	0.064
Greenhouse Gases								
CO_2	4.520	63.5	115.9	1.050	0.0	0.0	63.5	115.9
CH_4	2.59E-05	0.0004	0.001	9.38E-05	0.00	0.00	0.0004	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	63.6	116.0	---	0.0	0.0	63.6	116.0

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

31. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	20	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	6
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	6

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.96	1.54	30.80
$PM_{2.5}$	0.17	0.15	0.096	0.15	3.08

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0062	0.0112	0.22
$PM_{2.5}$	0.0081	0.0081	0.0015	0.0028	0.055

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

32. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

33. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

34. Central Facility Heater Emissions

Assumptions

Gas Processing Dehydrator Reboiler Size	1,500	Mbtu/hr
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
	1	Gas Processing Plant
	20	Compressor Station

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Compressor Station Reboiler			Gas Processing Plant Reboiler			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.15	0.64	100	0.15	0.64	3.09	13.53
CO [a]	84	0.12	0.54	84	0.12	0.54	2.59	11.36
VOC [b]	5.5	0.008	0.035	5.5	0.008	0.035	0.17	0.74
SO_2 [b]	0.6	0.001	0.0039	0.6	0.001	0.0039	0.019	0.081
PM_{10} [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
$PM_{2.5}$ [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	3.09E-06	1.35E-05	2.10E-03	3.09E-06	1.35E-05	0.000065	0.00028
Toluene [c]	3.40E-03	5.00E-06	2.19E-05	3.40E-03	5.00E-06	2.19E-05	0.00011	0.00046
Hexane [c]	1.80E+00	2.65E-03	1.16E-02	1.80E+00	2.65E-03	1.16E-02	0.056	0.24
Formaldehyde [c]	7.50E-02	1.10E-04	4.83E-04	7.50E-02	1.10E-04	4.83E-04	0.0023	0.010
Dichlorobenzene [c]	1.2E-03	1.76E-06	7.73E-06	1.2E-03	1.76E-06	7.73E-06	0.000037	0.00016
Naphthalene [c]	6.1E-04	8.97E-07	3.93E-06	6.1E-04	8.97E-07	3.93E-06	0.000019	0.000083
POM 2[c,d,e]	5.9E-05	8.68E-08	3.80E-07	5.9E-05	8.68E-08	3.80E-07	0.000002	0.000008
POM 3[c,f]	1.6E-05	2.35E-08	1.03E-07	1.6E-05	2.35E-08	1.03E-07	0.0000005	0.000002
POM 4[c,g]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
POM 5[c,h]	2.4E-06	3.53E-09	1.55E-08	2.4E-06	3.53E-09	1.55E-08	0.0000001	0.0000003
POM 6[c,i]	7.2E-06	1.06E-08	4.64E-08	7.2E-06	1.06E-08	4.64E-08	0.0000002	0.000001
POM 7[c,j]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
Greenhouse Gases								
CO_2 [l]	119,226	175.3	768.0	119,226	175.3	768.0	3,682	16,127
CH_4 [l]	2.25	0.0033	0.014	2.25	0.0033	0.014	0.07	0.30
N_2O [l]	0.22	0.0003	0.001	0.22	0.0003	0.001	0.01	0.03
CO_2e [m]	---	175.5	768.7	---	175.5	768.7	3,686	16,143

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)
c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98
d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.
f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.
g POM 4 includes: 3-Methylchloranthrene.
h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
j POM 7 includes: Chrysene.
k Assumes maximum development scenario
l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

35. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 20
Number of Gas Processing Plants 1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	18.76
CO [a]	0.37	1.11	4.86	102.10
Greenhouse Gases				
CO2 [b]	---	402	1,759	36,935
CH4 [b]	---	3.83	16.76	352.0
N2O [b]	---	0.0007	0.003	0.062
CO2e [b]	---	482	2,112	44,345

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

36. Electric Substation Turbines

Assumptions

Number of substations	6	Substations
Size of gas generators	20	MW
Size of steam generators	10	MW
Number of gas turbines per substation	2	turbines/substation
Number of steam turbines per substation	1	turbines/substation
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
20 MW turbine fuel input	189	MMBtu/hr
Turbine load factor	0.8	

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/MMBtu)} * \text{Fuel Input (MMBtu/hr)} * \text{turbines per facility} * \text{load factor} * \text{(hrs/year)}}{\text{2000 lbs/ton}}$$

	Emission Factor (lb/MMBtu)	Facility Emissions (lb/hr/facility)	Facility Emissions (tons/yr-facility)	Total Emissions [g] (lb/hr)	Total Emissions [g] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	0.0072	2.17	9.52	13.04	57.13
CO [a]	0.007	1.98	8.69	11.91	52.15
VOC [a]	0.0025	0.76	3.31	4.54	19.88
SO_2 [b]	0.00014	0.042	0.19	0.25	1.11
PM_{10} [c]	0.0048	1.45	6.37	8.72	38.21
$PM_{2.5}$ [c]	0.0048	1.45	6.37	8.72	38.21
Hazardous Air Pollutants [d]					
1,3-Butadiene	4.3E-07	0.00011	0.00049	0.00068	0.0030
Acetaldehyde	4.0E-05	0.011	0.046	0.063	0.28
Acrolein	6.4E-06	0.0017	0.0074	0.010	0.044
Benzene	1.2E-05	0.0032	0.014	0.019	0.083
Ethylbenzene	3.2E-05	0.0084	0.037	0.050	0.22
Formaldehyde	7.1E-04	0.19	0.817	1.12	4.90
Naphthalene	1.3E-06	0.00034	0.0015	0.0020	0.0090
PAH	2.2E-06	0.00058	0.0025	0.0035	0.015
Propylene Oxide	2.9E-05	0.0076	0.033	0.046	0.20
Toluene	1.3E-04	0.034	0.15	0.20	0.90
Xylene	6.4E-05	0.017	0.074	0.10	0.44
Greenhouse Gases					
CO2 [e]	117	35,409	155,093	212,457	930,560
CH_4 [e]	0.002	0.67	2.93	4.01	17.55
N_2O [e]	0.0002	0.067	0.29	0.40	1.76
CO_2e [f]	----	35,444	155,245	212,665	931,472

a Emission factors based on typical turbine specifications for turbines with catalysts to meet BACT levels - (2 ppmv NOx and VOC and 3 ppmv CO)

b Emission factor based on typical turbine manufacturer specifications

c Emission factor based on typical turbine manufacturer specifications and BACT levels

d Emission factors from AP-42, Table 3.1-3, HAPs from natural gas turbines, April 2000, with 13.3% control from the catalyst. Catalyst control efficiency from typical manufacturer data.

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH4 as 1.0E-03 kg/MMBtu and for N2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Assumes maximum development scenario. Emissions are from the 20 MW turbines as the 10 MW steam generators do not add any additional emissions

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

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50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX E

ALTERNATIVE D – RESOURCE PROTECTION ALTERNATIVE EMISSIONS

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APPENDIX E-1

RESOURCE PROTECTION ALTERNATIVE OIL WELL EMISSIONS

116133.3/LIT13R0350

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Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative D - Oil Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	2.5	0.9	0.2	0.0001	1.9	0.5
	Drilling	103.2	103.2	5.8	0.2	181.3	19.7
	Completion	46.9	23.3	8.3	0.028	327.1	34.6
	Interim Reclamation	0.8	0.9	0.06	0.0007	1.0	0.1
	Wind Erosion	---	---	---	---	0.3	0.1
Wellsite Production Emissions	Pump Unit Engines	1,586.3	2,165.4	429.4	2.1	172.9	172.9
	Production Heaters	522.8	439.1	28.8	3.1	39.7	39.7
	Wellsite Tanks	---	---	2,737.9	---	---	---
	Pneumatics	---	---	430.8	---	---	---
	Fugitives	---	---	1,297.2	---	---	---
	Wellsite Truck Loading	---	---	325.8	---	---	---
	Wellsite Flares	2.8	15.1	---	---	---	---
	Operations Vehicle	25.5	10.8	0.9	0.017	618.2	63.4
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	216.5	---	---	---
	Water Treatment Fugitives	---	---	9.2	---	---	---
	Water Treatment Generator	187.8	375.6	131.5	0.5	14.9	14.9
Gas and Oil Separation Plants	GOSP Heaters	113.4	95.2	6.2	0.7	8.6	8.6
	GOSP Fugitives	---	---	92.9	---	---	---
	GOSP Generators	150.2	300.5	105.2	0.4	11.9	11.9
	GOSP Flare	7.1	38.9	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	10.2	1.9	31.2	0.01	217.7	22.4
	Total Emissions	**2,759.4**	**3,570.9**	**5,857.8**	**7.0**	**1,595.7**	**388.8**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	2.5	103.2	46.9	0.8	---	153.3
CO	0.9	103.2	23.3	0.9	---	128.2
VOC	0.2	5.8	8.3	0.06	---	14.4
SO_2	0.0001	0.2	0.03	0.0007	---	0.2
PM_{10}	1.9	181.3	327.1	1.0	0.3	511.8
$PM_{2.5}$	0.5	19.7	34.6	0.1	0.1	55.0
Hazardous Air Pollutants						
Benzene	---	0.09	0.014	---	---	0.104
Toluene	---	0.03	0.006	---	---	0.039
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.02	0.0022	---	---	0.024
n-Hexane	---	---	0.117	---	---	0.117
Formaldehyde	---	0.009	0.0008	---	---	0.0098
Acetaldehyde	---	0.003	0.00025	---	---	0.0031
Acrolein	---	0.0009	0.00008	---	---	0.00098
Naphthalene	---	0.015	0.0013	---	---	0.016
POM 2	---	0.009	0.0007	---	---	0.0096
POM 5	---	0.00007	0.000006	---	---	0.000075
POM 6	---	0.0003	0.000023	---	---	0.00029
POM 7	---	0.0002	0.000015	---	---	0.00019
Greenhouses Gases						
CO_2	60.4	19,656	3,156	78	---	22,950
CH_4	0.000	0.79	22.35	0.003	---	23.14
N_2O	0.0001	0.16	0.03	0.0009	---	0.19
CO_2e	60.4	19,722	3,634	78	---	23,495

a Assumes maximum development scenario of 251 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Pump Engines	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	1586.3	522.8	---	---	---	---	2.8	25.5	2,137.3
CO	2165.4	439.1	---	---	---	---	15.1	10.8	2,630.5
VOC	429.4	28.8	2737.9	1297.2	325.8	430.8	---	0.9	5,250.8
SO_2	2.1	3.1	---	---	---	---	---	0.017	5.3
PM_{10}	172.9	39.7	---	---	---	---	---	618.2	830.8
$PM_{2.5}$	172.9	39.7	---	---	---	---	---	63.4	276.1
Hazardous Air Pollutants									
Benzene	6.94	0.0110	8.70	3.59	1.04	0.46	---	---	20.74
Toluene	3.45	0.018	8.04	3.21	0.96	0.24	---	---	15.91
Ethylbenzene	0.39	---	0.45	0.17	0.05	---	---	---	1.06
Xylene	0.96	---	2.57	1.00	0.31	0.024	---	---	4.85
n-Hexane	1.59	9.41	137.02	56.90	16.30	7.96	---	---	229.19
Formaldehyde	197.54	0.39	---	---	---	---	---	---	197.93
Acetaldehyde	27.77	---	---	---	---	---	---	---	27.77
Acrolein	27.84	---	---	---	---	---	---	---	27.84
Methanol	8.87	---	---	---	---	---	---	---	8.87
1,1,2,2-Tetrachloroethane	0.24	---	---	---	---	---	---	---	0.24
1,1,2-Trichloroethane	0.19	---	---	---	---	---	---	---	0.19
1,3-Dichloropropene	0.16	---	---	---	---	---	---	---	0.16
1,3-Butadiene	2.93	---	---	---	---	---	---	---	2.93
2,2,4-Trimethylpentane	3.03	---	---	---	---	---	---	---	3.03
Biphenyl	0.014	---	---	---	---	---	---	---	0.014
Carbon Tetrachloride	0.22	---	---	---	---	---	---	---	0.22
Chlorobenzene	0.16	---	---	---	---	---	---	---	0.16
Chloroform	0.17	---	---	---	---	---	---	---	0.17
Dichlorobenzene	---	0.0063	---	---	---	---	---	---	0.0063
Ethylene Dibromide	0.26	---	---	---	---	---	---	---	0.26
Methylene Chloride	0.53	---	---	---	---	---	---	---	0.53
Naphthalene	0.34	0.0032	---	---	---	---	---	---	0.35
Phenol	0.15	---	---	---	---	---	---	---	0.15
Styrene	0.20	---	---	---	---	---	---	---	0.20
Vinyl Chloride	0.088	---	---	---	---	---	---	---	0.088
PAH -POM 1	0.48	---	---	---	---	---	---	---	0.48
POM 2	0.12	0.00031	---	---	---	---	---	---	0.12
POM 3	---	0.000084	---	---	---	---	---	---	0.000084
POM 4	---	0.0000094	---	---	---	---	---	---	0.0000094
POM 5	0.000020	0.0000125	---	---	---	---	---	---	0.000033
POM 6	0.0013	0.000038	---	---	---	---	---	---	0.0013
POM 7	0.0024	0.0000094	---	---	---	---	---	---	0.0024
Greenhouse Gases									
CO_2	418,291	623,271	36.4	18.3	2.53	13.31	5,220	2,225	1,049,077
CH_4	7.89	11.76	655.6	2088.8	78.01	1,519	16.0	0.0248	4,377
N_2O	0.79	1.18	---	---	---	---	0.0053	0.0055	1.98
CO_2e	418,701	623,882	13,804	43,883	1,641	31,913	5,558	2,227	1,141,609

a Assumes maximum development scenario of 3519 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]							
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Generators	Central Facility Flares	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC								
NO_X	113.4	---	---	---	338.1	7.1	10.2	468.8
CO	95.2	---	---	---	676.1	38.9	1.9	812.2
VOC	6.2	216.5	102.1	30.9	236.6	---	0.3	592.7
SO_2	0.7	---	---	---	0.8	---	0.01	1.5
PM_{10}	8.6	---	---	---	26.8	---	217.7	253.1
$PM_{2.5}$	8.6	---	---	---	26.8	---	22.4	57.8
Hazardous Air Pollutants								
Benzene	0.002	0.69	0.26	0.10	1.09	---	---	2.14
Toluene	0.004	0.64	0.22	0.09	0.39	---	---	1.34
Ethylbenzene	---	0.035	0.011	0.005	0.017	---	---	0.07
Xylene	---	0.20	0.07	0.03	0.13	---	---	0.43
n-Hexane	2.04	10.84	4.10	1.55	---	---	---	18.52
Formaldehyde	0.09	---	---	---	14.15	---	---	14.23
Acetaldehyde	---	---	---	---	1.93	---	---	1.93
Acrolein	---	---	---	---	1.81	---	---	1.81
Methanol	---	---	---	---	2.11	---	---	2.11
1,1,2,2-Tetrachloroethane	---	---	---	---	0.017	---	---	0.017
1,1,2-Trichloroethane	---	---	---	---	0.011	---	---	0.011
1,3-Dichloropropene	---	---	---	---	0.009	---	---	0.009
1,3-Butadiene	---	---	---	---	0.46	---	---	0.46
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	0.00
Biphenyl	---	---	---	---	---	---	---	0.00
Carbon Tetrachloride	---	---	---	---	0.012	---	---	0.012
Chlorobenzene	---	---	---	---	0.009	---	---	0.009
Chloroform	---	---	---	---	0.009	---	---	0.009
Dichlorobenzene	0.0014	---	---	---	---	---	---	0.0014
Ethylene Dibromide	---	---	---	---	0.015	---	---	0.015
Methylene Chloride	---	---	---	---	0.028	---	---	0.03
Naphthalene	0.0007	---	---	---	0.067	---	---	0.07
Phenol	---	---	---	---	---	---	---	0.000
Styrene	---	---	---	---	0.008	---	---	0.008
Tetrachloroethane	---	---	---	---	---	---	---	0.0000
Vinyl Chloride	---	---	---	---	0.005	---	---	0.005
PAH -POM 1	---	---	---	---	0.10	---	---	0.10
POM 2	0.00007	---	---	---	---	---	---	0.000
POM 3	0.000018	---	---	---	---	---	---	0.000018
POM 4	0.0000020	---	---	---	---	---	---	0.0000020
POM 5	0.0000027	---	---	---	---	---	---	0.0000027
POM 6	0.000008	---	---	---	---	---	---	0.00001
POM 7	0.000002	---	---	---	---	---	---	0.00000
Greenhouse Gases								
CO_2	135,160	1.68	1.4	0.240	161,313	17,813	861	315,150
CH_4	2.55	51.85	164.1	7.393	3.04	114	0.005	342.7
N_2O	0.25	---	---	---	0.30	0.02	0.001	0.6
CO_2e	135,292	1,091	3,447	155	161,471	20,209	862	322,527

a Assumes maximum development scenario of 3519 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	153.3	2,137.3	468.8	2,759.4
CO	128.2	2,630.5	812.2	3,570.9
VOC	14.4	5,250.8	592.7	5,857.8
SO_2	0.2	5.3	1.5	7.0
PM_{10}	511.8	830.8	253.1	1,595.7
$PM_{2.5}$	55.0	276.1	57.8	388.8
Hazardous Air Pollutants				
Benzene	0.104	20.74	2.14	22.98
Toluene	0.039	15.91	1.34	17.29
Ethylbenzene	---	1.06	0.07	1.13
Xylene	0.024	4.85	0.43	5.31
n-Hexane	0.117	229.19	18.52	247.83
Formaldehyde	0.0098	197.93	14.23	212.17
Acetaldehyde	0.0031	27.77	1.93	29.70
Acrolein	0.00098	27.84	1.81	29.66
Methanol	---	8.87	2.11	10.99
1,1,2,2-Tetrachloroethane	---	0.237	0.017	0.25
1,1,2-Trichloroethane	---	0.189	0.011	0.20
1,3-Dichloropropene	---	0.157	0.009	0.17
1,3-Butadiene	---	2.93	0.46	3.39
2,2,4-Trimethylpentane	---	3.03	0.00	3.03
Biphenyl	---	0.014	0.00	0.01
Carbon Tetrachloride	---	0.217	0.012	0.23
Chlorobenzene	---	0.159	0.009	0.17
Chloroform	---	0.169	0.009	0.18
Dichlorobenzene	---	0.0063	0.0014	0.0076
Ethylene Dibromide	---	0.263	0.015	0.28
Methylene Chloride	---	0.53	0.028	0.55
Naphthalene	0.0162	0.35	0.07	0.43
Phenol	---	0.151	0.000	0.15
Styrene	---	0.196	0.008	0.20
Vinyl Chloride	---	0.088	0.005	0.09
(PAH) POM 1	---	0.48	0.10	0.58
POM 2	0.0096	0.118	0.000	0.13
POM 3	---	0.000084	0.000018	0.000102
POM 4	---	0.0000094	0.0000020	0.0000115
POM 5	0.000075	0.000033	0.0000027	0.000111
POM 6	0.000295	0.00129	0.00001	0.0016
POM 7	0.000191	0.00241	0.0000	0.0026
Total HAPs	0.32	543.44	43.33	587.09
Greenhouse Gases				
CO_2	22,950	1,049,077	315,150	1,387,177
CH_4	23.14	4,377	343	4,743.0
N_2O	0.189	1.98	0.58	2.75
CO_2e	23495	1,141,609	322,527	1,487,631

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	15	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)$^{1.2}$ * (soil moisture content %)$^{-1.3}$* Control Efficiency

Emissions (PM_{15} lbs/hr) = 1.0 * (soil silt content %)$^{1.5}$ * (soil moisture content %)$^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	0.53	1.97	0.035	0.53	1.06
PM_{15}	0.50	0.009	0.14	0.50	0.009	0.14	0.27
PM_{10}	0.38	0.007	0.10	0.38	0.007	0.10	0.20
$PM_{2.5}$	0.21	0.004	0.06	0.21	0.004	0.06	0.11

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	0	well pads/year
Oil well pads	15	well pads/year
Distance graded - Oil well	1.19	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Oil wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	3.21	0.09	0.0016	0.024
PM_{15}	1.53	0.043	0.00077	0.012
PM_{10}	0.92	0.026	0.00046	0.007
$PM_{2.5}$	0.10	0.003	0.000050	0.0007

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.23	miles of road per well pad
	11	hours per well pad road
Annual amount of well pads with roads	15	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.011	0.16	1.97	0.011	0.16	0.33
PM_{15}	0.50	0.003	0.04	0.50	0.003	0.04	0.08
PM_{10}	0.38	0.002	0.03	0.38	0.002	0.03	0.06
$PM_{2.5}$	0.21	0.0012	0.02	0.21	0.001	0.02	0.035

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	11	hours per well pad roads
Road construction grading distance	0.23	miles road per well pad
Annual well pads	15	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	0.62	0.06	0.0003	0.005
PM_{15}	0.30	0.03	0.00015	0.002
PM_{10}	0.18	0.016	0.00009	0.0013
$PM_{2.5}$	0.02	0.002	0.000010	0.00014

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.23	miles of pipeline per well pad
	28	hours per well pad pipeline
Annual amount of well pads withpipeline	15	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.027	0.41	1.97	0.027	0.41	0.82
PM_{15}	0.50	0.007	0.10	0.50	0.007	0.10	0.21
PM_{10}	0.38	0.0052	0.08	0.38	0.0052	0.08	0.16
$PM_{2.5}$	0.21	0.0029	0.04	0.21	0.0029	0.04	0.09

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	28	hours per well pad pipeline
Pipeline construction grading distance	0.93	miles pipeline per well pad
Annual well pads	15	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.49	0.09	0.0012	0.019
PM_{15}	1.19	0.043	0.00060	0.009
PM_{10}	0.72	0.026	0.00036	0.005
$PM_{2.5}$	0.08	0.0028	0.000039	0.0006

a Assumes maximum development scenario

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads

Round Trip Miles 19

Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads

Round Trip Miles 6

Precipitation Days (P) 45 days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	15	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	1.33
$PM_{2.5}$	0.12	0.11	0.56	0.009	0.13

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.01
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.001

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	251	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.32	1.16	11.29	0.71	178.86
$PM_{2.5}$	0.13	0.12	1.13	0.07	17.89

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.052	0.0036	0.90
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.22

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	15	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	1.00
$PM_{2.5}$	0.14	0.12	0.42	0.007	0.10

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.01
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.001

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	251	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	323.53
$PM_{2.5}$	0.14	0.12	1.75	0.13	32.35

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.77
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.44

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	504.71	2.69	507.40
$PM_{2.5}$	50.47	0.66	51.13

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	264	acres total disturbance for roads and pipelines per year
	1,067,501	square meters total initial disturbance for roads and pipelines
	30	acres total disturbance for well pads per year
	121,406	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	0.68	0.00
PM_{10}	0.34	0.00
$PM_{2.5}$	0.05	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	15	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.05
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.09
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.006
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00006
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.003
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.002
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	5.57
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0003
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0001
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	5.60

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	15	new pads per year
Backhoe miles per pad	0.59	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	74.9	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	2.4	miles
Dozer Hours	74.9	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	2.4	miles
Motor Grader Hours	74.9	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0104	8.38	1.48	0.056	8.38	2.52	0.094
CO	3.49	0.14	0.0053	2.7	0.48	0.018	2.70	0.81	0.030
VOC [b]	0.99	0.040	0.0015	0.68	0.12	0.0045	0.68	0.20	0.0077
PM_{10}	0.722	0.029	0.0011	0.402	0.071	0.0027	0.402	0.12	0.0045
$PM_{2.5}$	0.722	0.029	0.0011	0.402	0.071	0.0027	0.402	0.12	0.0045
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.28	188.2	33.31	1.25	188.2	56.59	2.12
CO_2e [e]	---	7.59	0.28	---	33.31	1.25	---	56.59	2.12

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	2.41
CO	1.43	0.80
VOC	0.36	0.21
PM_{10}	0.22	0.12
$PM_{2.5}$	0.22	0.12
Greenhouse Gases		
CO_2	97.50	54.80
CO_2e [e]	97.50	54.80

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of oil wells drilled	251	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total-Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	9.05
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	9.02
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.69
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0078
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.49
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.48
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	906.59
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.027
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0089
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	909.91

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Number of oil wells	251	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total_Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	15.75
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	14.99
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	1.16
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.013
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.86
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.83
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1568.95
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.045
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.015
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1574.44

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	251	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.77
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.86
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.063
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00069
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.041
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.040
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	78.06
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0026
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00087
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	78.38

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	144	hours/oil well
Development Rate	251	oil wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 4)				
Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Total Emissions [1] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	0.38	94.16
CO [a]	5.73E-03	5.21	0.38	94.16
VOC [a]	3.09E-04	0.28	0.02	5.07
PM_{10} [a]	6.61E-05	0.06	0.004	1.09
$PM_{2.5}$ [a]	6.61E-05	0.06	0.004	1.09
SO_2 [b]	1.21E-05	0.011	0.00079	0.20
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.00036	0.089
Toluene [c]	1.97E-06	0.0018	0.00013	0.032
Xylenes [c]	1.35E-06	0.0012	0.000088	0.022
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.0091
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.0029
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.00091
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.015
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.0089
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.000069
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.00027
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.00018
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	74.70	18,749
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.76
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.15
CO_2e [m]	---	1040.96	74.95	18,812

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	251	wells/year (oil wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Engine Emissions (lb/hr)	Engine Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.84	0.12	31.15
CO [a]	0.85	5.50E-03	2.62	0.033	8.27
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.88
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.97
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.97
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.015
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.0076
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.0027
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.0019
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.00077
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.00025
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.000077
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.0013
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.00075
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.0000059
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.000023
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.000015
Greenhouse Gases					
CO_2 [i]	163.05	1.14	501.6	6.32	1587.1
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.064
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.013
CO_2e [l]	---	---	503.3	6.3	1,592.4

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	251	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	22.25
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	3.95
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	3.14
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.66
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.23
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.40
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.45
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.19
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.090
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.016
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0017
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00024
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0067
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0035
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00035
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.117
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.30
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.19
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0028
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**6.31**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.13**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**33.00**

a Assumes maximum development scenario

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	920,604	miles/year-all wells
Operation Pickup Truck Mileage:	274,466	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	13.52	24.67	6.05E-03	0.45	0.83	13.97	25.50
CO	1.02E-02	2.57	4.70	4.48E-02	3.37	6.15	5.94	10.84
VOC [c]	1.55E-03	0.39	0.71	1.61E-03	0.12	0.22	0.51	0.93
SO_2	3.07E-05	0.008	0.014	1.84E-05	0.0014	0.0025	0.009	0.017
PM_{10}	2.57E-03	0.65	1.18	1.31E-04	0.010	0.018	0.66	1.20
$PM_{2.5}$	2.50E-03	0.63	1.15	1.21E-04	0.009	0.017	0.64	1.17
Greenhouse Gases								
CO_2	4.520	1,140.0	2,080.6	1.050	79.0	144.1	1,219.0	2,224.7
CH_4	2.59E-05	0.0065	0.012	9.38E-05	0.007	0.013	0.014	0.025
N_2O	4.01E-06	0.0010	0.0018	2.68E-05	0.0020	0.0037	0.0030	0.0055
CO_2e [c]	---	1140.5	2,081.4	---	79.7	145.5	1220.2	2226.9

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

19. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	2319	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	101
Light Trucks	8,000	30
Mean Vehicle Weight	36,473	---
Total Round Trips	---	131

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.56	1.37	0.17	0.26	613.03
$PM_{2.5}$	0.16	0.14	0.017	0.026	61.30

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.027	0.027	0.00094	0.0017	3.97
$PM_{2.5}$	0.0066	0.0066	0.00023	0.00042	0.97

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	21,103	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1739	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	580	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	93,015	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.028	1336.18
Hazardous Air Pollutants [b]			
Benzene	0.0018	0.000089	4.25
Toluene	0.0017	0.000083	3.92
Ethylbenzene	0.000092	0.0000046	0.22
Xylenes	0.00053	0.000026	1.25
n-Hexane	0.028	0.0014	66.87
Greenhouse Gases [b]			
CO_2	0.0044	0.0044	15.20
CH_4	0.13	0.0067	319.95
CO_2e	2.83	0.15	6734.11

a Total wellsite working and breathing emissions are based on 2318 uncontrolled tanks and 1160 tanks controlled at 95%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	21,103	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1739	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	580	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 163.76 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	63.69	491.31
Ethane	30.07	16.516	4.97	13.20	27.05	391.12
Propane	44.10	16.909	7.46	19.81	27.69	587.25
i-Butane	58.12	3.694	2.15	5.71	6.05	169.08
n-Butane	58.12	9.044	5.26	13.97	14.81	413.95
i-Pentane	72.15	3.269	2.36	6.27	5.35	185.75
n-Pentane	72.15	4.297	3.10	8.24	7.04	244.16
Cyclopentane	70.10	0.361	0.25	0.67	0.59	19.93
Hexanes	86.18	2.285	1.97	5.23	3.74	155.08
Heptanes	100.20	1.423	1.43	3.79	2.33	112.29
Octanes	114.23	0.403	0.46	1.22	0.66	36.25
Nonanes	128.26	0.076	0.10	0.26	0.124	7.68
Decanes +	142.29	0.026	0.037	0.098	0.043	2.91
Benzene	78.11	0.106	0.083	0.22	0.174	6.52
Toluene	92.14	0.083	0.076	0.20	0.136	6.02
Ethylbenzene	106.17	0.004	0.004	0.011	0.0066	0.33
Xylenes	106.17	0.023	0.024	0.065	0.0377	1.92
n-Hexane	86.18	1.513	1.30	3.46	2.48	102.69
Nitrogen	28.01	0.612	0.17	0.46	1.00	13.50
Carbon Dioxide	44.01	0.460	0.20	0.54	0.75	15.94
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**71.26**	**2051.82**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**2.83**	**117.49**
TOTAL		**100.0**	**37.63**	**100.0**	**163.76**	**2963.68**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1367.48	34.22	1401.70
Hazardous Air Pollutants [b]			
Benzene	4.35	0.109	4.45
Toluene	4.01	0.100	4.11
Ethylbenzene	0.22	0.0056	0.23
Xylenes	1.28	0.032	1.31
n-Hexane	68.44	1.71	70.15
Greenhouse Gases [b]			
CO_2	10.63	10.63	21.25
CH_4	327.44	8.19	335.64
CO_2e	6886.95	182.68	7069.6

a Total wellsite flashing emissions are based on 2318 uncontrolled tanks and 1160 tanks controlled at 95%.

Project: GMBU - Alternative D - Oil Wells

Date: 7/15/2013

22. Oil Truck Loadout

Assumptions:

Oil Well Production Rate	9.1	bbl/day-well
Number of Oil Wells not going to a GOSP	2319	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Oil Loading [a]	0.6	2.8	50	520	2.01	9.1	0.14	325.78

	Oil Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00045	1.04
Toluene	0.00041	0.96
Ethylbenzene	0.000023	0.053
Xylenes	0.00013	0.31
n-Hexane	0.0070	16.30
Greenhouse Gases		
CO2	0.00109	2.53
CH4	0.034	78.01
CO2e	0.71	1640.7

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60° F.

b Assumes maximum development scenario

c Emissions estimated based on flashing analysis weight fractions

23. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	3,519	430.83	1,519.04	13.31	31,913

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine power:	65.0	hp
Number of Wells Requiring Pumping Unit Engines:	3519	wells
Load Factor:	0.38	

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp) * 8760 (hr/yr) * load factor}}{\text{453.6 (g/lb) * 2000 (lb/ton)}}$$

Pollutant	Emission Factor [a] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/well)	Emissions (ton/yr-well)	Total Emissions [h] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [b]	-	1.89	0.10	0.45	1,586.28
CO [b]	-	2.58	0.14	0.62	2,165.39
VOC [a]	0.12	5.12E-01	0.028	0.12	429.43
PM_{10} [a,d]	4.83E-02	2.06E-01	0.011	0.049	172.88
$PM_{2.5}$ [a,d]	4.83E-02	2.06E-01	0.011	0.049	172.88
SO_2 [a]	5.88E-04	2.51E-03	0.00014	0.0006	2.10
Hazardous Air Pollutants [a]					
Benzene	1.94E-03	8.27E-03	0.00045	0.0020	6.94
Toluene	9.63E-04	4.11E-03	0.00022	0.0010	3.45
Ethylbenzene	1.08E-04	4.60E-04	0.000025	0.00011	0.39
Xylenes	2.68E-04	1.14E-03	0.000062	0.00027	0.96
Formaldehyde	5.52E-02	2.35E-01	0.013	0.056	197.54
Acetaldehyde	7.76E-03	3.31E-02	0.0018	0.0079	27.77
Acrolein	7.78E-03	3.32E-02	0.0018	0.0079	27.84
Benzo(a)pyrene/POM5	5.68E-09	2.42E-08	1.32E-09	0.00000001	0.000020
Biphenyl	3.95E-06	1.68E-05	0.0000009	0.0000040	0.014
Methanol	2.48E-03	1.06E-02	0.00058	0.0025	8.87
1,1,2,2-Tetrachloroethane	6.63E-05	2.83E-04	0.000015	0.000067	0.24
1,1,2-Trichloroethane	5.27E-05	2.25E-04	0.000012	0.000054	0.19
1,3-Dichloropropene	4.38E-05	1.87E-04	0.000010	0.000045	0.16
1,3-Butadiene	8.20E-04	3.50E-03	0.00019	0.00083	2.93
2,2,4-Trimethylpentane	8.46E-04	3.61E-03	0.00020	0.00086	3.03
Carbon Tetrachloride	6.07E-05	2.59E-04	0.000014	0.000062	0.22
Chlorobenzene	4.44E-05	1.89E-04	0.000010	0.000045	0.16
Chloroform	4.71E-05	2.01E-04	0.000011	0.000048	0.17
Chrysene/POM7	6.72E-07	2.87E-06	0.00000016	0.0000007	0.0024
Ethylene Dibromide	7.34E-05	3.13E-04	0.000017	0.000075	0.26
Methylene Chloride	1.47E-04	6.27E-04	0.000034	0.00015	0.53
n-Hexane	4.45E-04	1.90E-03	0.00010	0.00045	1.59
Naphthalene	9.63E-05	4.11E-04	0.000022	0.000098	0.34
Phenol	4.21E-05	1.80E-04	0.000010	0.000043	0.15
Styrene	5.48E-05	2.34E-04	0.000013	0.000056	0.20
Vinyl Chloride	2.47E-05	1.05E-04	0.0000057	0.000025	0.088
PAH	1.34E-04	5.71E-04	0.000031	0.00014	0.48
POM -2 [e]	3.28E-05	1.40E-04	0.0000076	0.000033	0.12
POM-6 [f]	3.50E-07	1.49E-06	0.00000008	0.0000004	0.0013
Greenhouse Gases					
CO_2 [g]	117	498	27.14	118.9	418,291
CH_4 [g]	0.002	0.01	0.00051	0.0022	7.89
N_2O [g]	0.0002	0.0009	0.000051	0.00022	0.79
CO_2e [i]	----	----	27.17	118.98	418,701

a AP-42 Table 3.2-1 Uncontrolled Emission Factors for 2-Stroke Lean-Burn Engines, 7/00

b Emission factors (g/hp-hr) from manufacturer specifications

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, benzo(a)fluoranthene, benzo(e)pyrene, fluorene, phenanthrene, perylene, and pyrene.

f POM 6 includes: Benz(a)anthracene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Estimated at full project production.

i Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

25. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters	2319	wells
Oil well tanks	3,478	tanks
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Oil Well Separator Heater			Oil Well Tank Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.029	0.13	100	0.029	0.13	119.35	522.77
CO [a]	84	0.025	0.11	84	0.025	0.11	100.26	439.12
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	6.56	28.75
SO_2 [b]	0.6	0.00018	0.00077	0.6	0.00018	0.00077	0.72	3.14
PM_{10} [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	9.07	39.73
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	9.07	39.73
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	2.10E-03	6.18E-07	2.71E-06	0.0025	0.0110
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	3.40E-03	1.00E-06	4.38E-06	0.0041	0.018
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	1.80E+00	5.29E-04	2.32E-03	2.15	9.41
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	7.50E-02	2.21E-05	9.66E-05	0.090	0.39
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	1.20E-03	3.53E-07	1.55E-06	0.00143	0.0063
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	6.10E-04	1.79E-07	7.86E-07	0.00073	0.0032
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	5.90E-05	1.74E-08	7.60E-08	0.000070	0.00031
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	1.60E-05	4.71E-09	2.06E-08	0.000019	0.000084
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	1.80E-06	5.29E-10	2.32E-09	0.000002	0.000009
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	2.40E-06	7.06E-10	3.09E-09	0.000003	0.000013
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	7.20E-06	2.12E-09	9.28E-09	0.000009	0.000038
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	1.8E-06	5.29E-10	2.32E-09	0.000002	0.000009
Greenhouse Gases								
CO_2 [l]	119,226	35.07	153.59	119,226	35.07	153.59	142,299	623,271
CH_4 [l]	2.25	0.00066	0.0029	2.25	0.00066	0.0029	2.68	11.76
N_2O [l]	0.22	0.000066	0.00029	0.22	0.000066	0.00029	0.27	1.18
CO_2e [m]	---	35.10	153.74	---	35.10	153.74	142,439	623,882

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

26. Oil Well Fugitives

Number of Producting Wells 3519 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1297.15**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	3.59
Toluene Emissions	0.00011	0.0020	3.21
Ethylbenzene Emissions	----	0.00011	0.17
Xylene Emissions	0.000011	0.00065	1.00
n-Hexane Emissions	0.0035	0.035	56.90

Project: GMBU - Alternative D - Oil Wells
Date: 7/15/2013

26. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**2088.82**	**18.27**	**43,883**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

27. Wellsite Flare Emissions

Assumptions:

Number of oil well pads with controls	580	well pads
Vent gas from each well pad	7.66	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.0011	0.005	0.63	2.78
CO [a]	0.37	0.006	0.026	3.45	15.13
Greenhouse Gases					
CO2 [b]	---	2.05	9.00	1,192	5,220
CH4 [b]	---	0.0063	0.028	3.66	16.02
N2O [b]	---	0.000002	0.000009	0.0012	0.0053
CO2e [b]	---	2.19	9.58	1,269	5,558

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

28. Gas and Oil Separation Facility Generators

Assumptions:

Number of GOSPs	8	Facilities
Generator size	1,945	Horsepower
Number of Generators per GOSP	1	engines/Facility

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (tons/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	150.25
CO [a]	-	2.0	8.58	37.56	300.50
VOC [a]	-	0.7	3.00	13.15	105.17
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	11.91
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	11.91
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.36
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.48
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.17
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.008
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.060
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	6.29
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	0.86
Acrolein	2.63E-03	1.07E-02	0.023	0.10	0.81
Methanol	3.06E-03	1.25E-02	0.027	0.12	0.94
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.008
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0047
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0039
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.20
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0054
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0040
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0042
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.007
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.013
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.030
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0036
Vinyl Chloride	7.18E-06	2.93E-05	0.00006	0.00028	0.0022
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.043
Greenhouse Gases					
CO_2 [e]	117	477.2	2046	8,962	71,695
CH_4 [e]	0.002	0.0090	0.0386	0.17	1.35
N_2O [e]	0.0002	0.00090	0.00386	0.02	0.14
CO_2e [f]	---	---	2048	2048.08	71765

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

29. GOSP Truck Loadout

Assumptions:		
Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	8	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	30.88

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.10
Toluene	0.011	0.09
Ethylbenzene	0.00063	0.0050
Xylenes	0.0036	0.029
n-Hexane	0.19	1.55
Greenhouse Gases		
CO2	0.030	0.24
CH4	0.92	7.39
CO2e	19.44	155.50

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

30. GOSP Fugitives

Number of GOSP Facilities 8 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**92.88**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.23
Toluene Emissions	0.00011	0.0020	0.20
Ethylbenzene Emissions	----	0.00011	0.010
Xylene Emissions	0.000011	0.00065	0.061
n-Hexane Emissions	0.0035	0.035	3.70

30. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**142.40**	**1.25**	**2991.73**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

31. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	381,104	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	5.60	10.21	6.05E-03	0.00	0.00	5.60	10.21
CO	1.02E-02	1.07	1.94	4.48E-02	0.00	0.00	1.07	1.94
VOC [c]	1.55E-03	0.16	0.30	1.61E-03	0.00	0.00	0.16	0.30
SO_2	3.07E-05	0.003	0.006	1.84E-05	0.0000	0.0000	0.003	0.006
PM_{10}	2.57E-03	0.27	0.49	1.31E-04	0.000	0.000	0.27	0.49
$PM_{2.5}$	2.50E-03	0.26	0.48	1.21E-04	0.000	0.000	0.26	0.48
Greenhouse Gases								
CO_2	4.520	471.9	861.3	1.050	0.0	0.0	471.9	861.3
CH_4	2.59E-05	0.0027	0.005	9.38E-05	0.000	0.000	0.003	0.005
N_2O	4.01E-06	0.0004	0.0008	2.68E-05	0.0000	0.0000	0.0004	0.0008
CO_2e [c]	---	472.1	861.6	---	0.0	0.0	472.1	861.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

32. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	8	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	42
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	42

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	16.85	26.95	215.63
$PM_{2.5}$	0.17	0.15	1.685	2.695	21.56

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.11	0.20	1.57
$PM_{2.5}$	0.0081	0.0081	0.026	0.048	0.39

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

33. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :		
Facility Production Rate	160	bbls oil per day per facility
Total Facilities	10	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.097	60.97
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.19
Toluene	0.0030	0.018	0.18
Ethylbenzene	0.00017	0.00099	0.010
Xylenes	0.0010	0.0057	0.057
n-Hexane	0.051	0.31	3.05
Greenhouse Gases			
CO_2	0.0079	0.047	0.47
CH_4	0.24	1.46	14.60
CO_2e	5.12	30.70	307.03

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

Project: GMBU - Alternative D - Oil Wells

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34. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	1241.60 scf/day-facility

* Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.151
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.275
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.0582
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.0221
Benzene	78.11	0.106	0.083	0.0022	1.32	0.0494
Toluene	92.14	0.083	0.076	0.0020	1.03	0.0457
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.00254
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.0146
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.779
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.102
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.121
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	10

Total Flashing Emissions for All Tanks (tons/yr)

VOC	155.57
Hazardous Air Pollutants	
Benzene	0.49
Toluene	0.46
Ethylbenzene	0.025
Xylenes	0.15
n-Hexane	7.79
HAPs	8.91
Greenhouse Gases	
CO2	1.21
CH4	37.25
CO2e	783.5

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35. Water Treatment Facility Fugitives

Number Water Treatment Facilities 10 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**9.21**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.025
Toluene Emissions	0.00011	0.0020	0.023
Ethylbenzene Emissions	----	0.00011	0.0012
Xylene Emissions	0.000011	0.00065	0.0070
n-Hexane Emissions	0.0035	0.0346	0.40

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35. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**21.66**	**0.19**	**455.1**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

36. Water Treatment Plant Generator

Assumptions:

Number of facilities 10

Generator horsepower 1,945 hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	187.81
CO [a]	-	2.0	8.58	37.56	375.62
VOC [a]	-	0.7	3.00	13.15	131.47
PM_{10} [b,d]	1.94E-02	7.92E-02	0.340	1.49	14.88
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.340	1.49	14.88
SO_2 [b]	5.88E-04	2.40E-03	0.0103	0.045	0.451
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.61
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.21
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.010
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.075
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	7.86
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.07
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.01
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.17
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.010
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0059
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0049
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.25
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0068
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0049
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0053
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.008
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.016
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.037
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0046
Vinyl Chloride	7.18E-06	2.93E-05	0.000063	0.00028	0.0028
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.054
Greenhouse Gases					
CO_2 [e]	117	477.2	2,046	8,962	89,618
CH_4 [e]	0.002	9.00E-03	0.0386	0.17	1.69
N_2O [e]	0.0002	9.00E-04	0.00386	0.017	0.17
CO_2e [f]	---	---	2,048	8,971	89,706

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

37. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	8	GOSP Facilities
	0	Compressor Stations

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	25.88	113.36
CO [a]	84	2.72	11.90	84	0.124	0.54	21.74	95.23
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	1.42	6.24
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.16	0.68
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	1.97	8.62
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	1.97	8.62
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	5.44E-04	0.0024
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	8.80E-04	0.0039
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	4.66E-01	2.04
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	1.94E-02	0.09
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	3.11E-04	0.0014
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	1.58E-04	0.0007
POM 2[c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	1.53E-05	0.00007
POM 3[c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	4.14E-06	0.000018
POM 4[c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	4.66E-07	0.0000020
POM 5[c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	6.21E-07	0.0000027
POM 6[c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	1.86E-06	0.000008
POM 7[c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	4.66E-07	0.0000020
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	30858.4	135160
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.58	2.55
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.058	0.25
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	30889	135292

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

38. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 0
Number of GOSPs 8

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	7.15
CO [a]	0.37	1.11	4.86	38.89
Greenhouse Gases				
CO2 [b]	---	508	2,227	17,813
CH4 [b]	---	3.25	14.22	113.76
N2O [b]	---	0.0007	0.003	0.02
CO2e [b]	---	577	2,526	20,209

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

---

50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

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

Identification

User Identification:	GMBU Water treatment tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 500 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		25.00
Diameter (ft):		12.00
Liquid Height (ft) :		24.00
Avg. Liquid Height (ft):		12.00
Volume (gallons):		20,304.71
Turnovers:		20.13
Net Throughput(gal/yr):		408,800.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	2,032.1687

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

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

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

Identification

User Identification:	GMBU Alt D Oil Well Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		5.79
Net Throughput(gal/yr):		93,015.00
Is Tank Heated (y/n):	N	

Paint Characteristics

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

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

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

GMBU Alt D Oil Well Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

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
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

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

GMBU Alt D Oil Well Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
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):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	243.3514
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	93,015.0000
Annual Turnovers:	5.7865
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500

Total Losses (lb):	1,124.7251

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

Emissions Report for: Annual

GMBU Alt D Oil Well Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	243.35	881.37	1,124.73

APPENDIX E-2

RESOURCE PROTECTION ALTERNATIVE GAS WELL EMISSIONS

116133.3/LIT13R0350

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Project: GMBU - Alternative D -Gas Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative D - Gas Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	17.6	6.4	1.5	0.0004	13.9	3.6
	Drilling	407.3	396.6	22.1	0.8	511.5	56.9
	Completion	47.5	16.1	1.8	0.027	271.3	29.0
	Interim Reclamation	0.3	0.4	0.03	0.0003	7.4	0.8
	Wind Erosion	---	---	---	---	3.8	0.6
Wellsite Production Emissions	Production Heaters	297.4	249.8	16.4	1.8	22.6	22.6
	Wellsite Tanks	---	---	1,091.8	---	---	---
	Pneumatics	---	---	188.4	---	---	---
	Fugitives	---	---	894.3	---	---	---
	Wellsite Truck Loading	---	---	116.5	---	---	---
	Wellsite Dehydrators	---	---	29.1	---	---	---
	Wellsite Flares	12.4	67.3	---	---	---	---
	Operations Vehicle	5.2	7.4	0.4	0.005	186.1	18.9
Gas Processing Plant Emissions	Gas Plant Compressor Engines	11.6	23.2	8.1	0.03	0.9	0.9
	Gas Plant Flares	0.9	4.9	---	---	---	---
	Gas Plant Fugitives	---	---	0.8	---	---	---
	Gas Plant Dehydrator Heater	0.6	0.5	0.04	0.004	0.05	0.05
	Gas Plant Dehydrator	---	---	11.7	---	---	---
Compressor Station Emissions	Compressor Station Engines	1,313.2	2,626.5	919.3	2.8	47.4	47.4
	Compressor Station Tanks	---	---	22.2	---	---	---
	Compressor Station Dehydrator	---	---	198.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	1.2	0.2	47.3	0.0	25.9	2.7
	Compressor Station Dehydrator Heater	11.0	9.2	0.6	0.1	0.8	0.8
	Compressor Station Flare	15.2	82.7	---	---	---	---
	Compressor Station Fugitives	---	---	51.5	---	---	---
	Total Emissions	**2,141.5**	**3,491.2**	**3,622.4**	**5.5**	**1,091.6**	**184.2**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D -Gas Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	17.6	407.3	47.5	0.3	---	472.8
CO	6.4	396.6	16.1	0.4	---	419.5
VOC	1.5	22.1	1.8	0.03	---	25.4
SO_2	0.0004	0.8	0.03	0.0003	---	0.9
PM_{10}	13.9	511.5	271.3	7.4	3.8	807.8
$PM_{2.5}$	3.6	56.9	29.0	0.8	0.6	90.7
Hazardous Air Pollutants						
Benzene	---	0.36	0.007	---	---	0.37
Toluene	---	0.13	0.003	---	---	0.13
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.09	0.0018	---	---	0.09
n-Hexane	---	---	---	---	---	---
Formaldehyde	---	0.036	0.0007	---	---	0.037
Acetaldehyde	---	0.012	0.00024	---	---	0.012
Acrolein	---	0.0036	0.00007	---	---	0.0037
Naphthalene	---	0.060	0.0012	---	---	0.061
POM 2	---	0.036	0.0007	---	---	0.036
POM 5	---	0.00028	0.000006	---	---	0.00028
POM 6	---	0.0011	0.000022	---	---	0.0011
POM 7	---	0.0007	0.000014	---	---	0.0007
Greenhouses Gases						
CO_2	433.4	78,093	3,917	34	---	82,477
CH_4	0.0020	3.11	0.13	0.00112	---	3.24
N_2O	0.0007	0.63	0.03	0.00038	---	0.66
CO_2e	433.6	78,353	3,928	34	---	82,749

a Assumes maximum development scenario of 110 wells in one year

b Emissions in summary tables may vary slightly due to rounding differences.

c Total drilling emissions includes Tier IV drill rig engines

Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Wellsite Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	297.4	---	---	---	---	12.4	---	5.2	315.0
CO	249.8	---	---	---	---	67.3	---	7.4	324.5
VOC	16.4	1091.8	894.3	116.5	188.4	---	29.1	0.4	2,336.8
SO_2	1.8	---	---	---	---	---	---	0.005	1.8
PM_{10}	22.6	---	---	---	---	---	---	186.1	208.7
$PM_{2.5}$	22.6	---	---	---	---	---	---	18.9	41.5
Hazardous Air Pollutants									
Benzene	0.006	10.62	2.45	1.13	0.20	---	1.69	---	16.10
Toluene	0.010	17.70	3.20	1.89	0.10	---	7.16	---	30.06
Ethylbenzene	---	0.77	0.12	0.08	---	---	2.10	---	3.07
Xylene	---	6.31	1.04	0.67	0.010	---	14.93	---	22.96
n-Hexane	5.35	28.01	17.76	2.99	3.48	---	---	---	57.59
Formaldehyde	0.22	---	---	---	---	---	---	---	0.22
Dichlorobenzene	0.0036	---	---	---	---	---	---	---	0.0036
Naphthalene	0.0018	---	---	---	---	---	---	---	0.0018
POM 2	0.00018	---	---	---	---	---	---	---	0.00018
POM 3	0.000048	---	---	---	---	---	---	---	0.000048
POM 4	0.0000054	---	---	---	---	---	---	---	0.0000054
POM 5	0.000007	---	---	---	---	---	---	---	0.000007
POM 6	0.000021	---	---	---	---	---	---	---	0.000021
POM 7	0.0000054	---	---	---	---	---	---	---	0.000005
Greenhouse Gases									
CO_2	354,564.1	220.5	20.8	23.5	5.8	15,374.6	---	519.5	370,729
CH_4	6.69	1045.4	2383.0	111.54	664.34	146.5	45.54	0.0160	4,403
N_2O	0.67	---	---	---	---	0.0	---	0.0043	0.70
CO_2e	354,912	22,175	50,063	2,366	13,957	18,459	956	521	463,409

a Assumes maximum development scenario of 1539 gas wells
b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D -Gas Wells

Date: 7/15/2013

Total Project Infrastructure Related Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	11.6	---	---	---	16.1	---	1324.8	1.2	1,353.7
CO	9.7	---	---	---	87.5	---	2649.6	0.2	2,747.1
VOC	0.6	22.2	52.3	47.3	---	210.4	927.4	0.03	1,260.2
SO_2	0.07	---	---	---	---	---	2.8	0.0007	2.9
PM_{10}	0.9	---	---	---	---	---	48.3	25.9	75.1
$PM_{2.5}$	0.9	---	---	---	---	---	48.3	2.7	51.9
Hazardous Air Pollutants									
Benzene	0.00024	0.216	0.106	0.46	---	10.08	1.09	---	11.95
Toluene	0.00039	0.359	0.121	0.77	---	7.09	0.99	---	9.32
Ethylbenzene	---	0.0156	0.0041	0.0333	---	---	0.10	---	0.15
Xylene	---	0.128	0.036	0.273	---	1.27	0.44	---	2.15
n-Hexane	0.21	0.57	1.01	1.21	---	6.11	2.64	---	11.76
Formaldehyde	0.009	---	---	---	---	---	126.29	---	126.30
Acetaldehyde	---	---	---	---	---	---	19.99	---	19.99
Acrolein	---	---	---	---	---	---	12.31	---	12.31
Methanol	---	---	---	---	---	---	6.03	---	6.03
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	0.10	---	0.10
1,1,2-Trichloroethane	---	---	---	---	---	---	0.076	---	0.076
1,3-Dichloropropene	---	---	---	---	---	---	0.063	---	0.063
1,3-Butadiene	---	---	---	---	---	---	0.65	---	0.65
2,2,4-Trimethylpentane	---	---	---	---	---	---	0.60	---	0.60
Biphenyl	---	---	---	---	---	---	0.51	---	0.51
Carbon Tetrachloride	---	---	---	---	---	---	0.09	---	0.09
Chlorobenzene	---	---	---	---	---	---	0.073	---	0.073
Chloroform	---	---	---	---	---	---	0.068	---	0.068
Dichlorobenzene	0.00014	---	---	---	---	---	---	---	0.00014
Ethylene Dibromide	---	---	---	---	---	---	0.11	---	0.11
Methylene Chloride	---	---	---	---	---	---	0.049	---	0.049
Naphthalene	0.000071	---	---	---	---	---	0.18	---	0.18
Phenol	---	---	---	---	---	---	0.057	---	0.057
Styrene	---	---	---	---	---	---	0.057	---	0.057
Tetrachloroethane	---	---	---	---	---	---	0.0059	---	0.0059
Vinyl Chloride	---	---	---	---	---	---	0.036	---	0.036
PAH -POM 1	---	---	---	---	---	---	0.067	---	0.067
POM 2	0.0000068	---	---	---	---	---	0.14	---	0.14
POM 3	0.0000019	---	---	---	---	---	---	---	0.0000019
POM 4	0.00000021	---	---	---	---	---	---	---	0.00000021
POM 5	0.00000028	---	---	---	---	---	---	---	0.00000028
POM 6	0.00000083	---	---	---	---	---	0.00040	---	0.00040
POM 7	0.00000021	---	---	---	---	---	0.0017	---	0.0017
Greenhouse Gases									
CO_2	13,823	89.5	1.37	9.55	31,658	---	562,551	99	608,232
CH_4	0.261	21.2	156.6	45.28	301.7	258.32	10.61	0.00056	794.0
N_2O	0.026	---	---	---	0.053	---	1.06	0.00009	1.1
CO_2e	13,837	535	3,291	960	38,010	5,425	563,103	99	625,260

a Assumes maximum development scenario of 1539 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative D -Gas Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	472.8	315.0	1,353.7	2,141.5
CO	419.5	324.5	2,747.1	3,491.2
VOC	25.4	2,336.8	1,260.2	3,622.4
SO_2	0.9	1.8	2.9	5.5
PM_{10}	807.8	208.7	75.1	1,091.6
$PM_{2.5}$	90.7	41.5	51.9	184.2
Hazardous Air Pollutants				
Benzene	0.37	16.10	11.95	28.41
Toluene	0.13	30.06	9.32	39.52
Ethylbenzene	---	3.07	0.15	3.22
Xylene	0.09	22.96	2.15	25.20
n-Hexane	---	57.59	11.76	69.35
Formaldehyde	0.037	0.22	126.30	126.56
Acetaldehyde	0.012	---	19.99	20.00
Acrolein	0.0037	---	12.31	12.31
Methanol	---	---	6.03	6.03
1,1,2,2-Tetrachloroethane	---	---	0.10	0.10
1,1,2-Trichloroethane	---	---	0.076	0.076
1,3-Dichloropropene	---	---	0.063	0.063
1,3-Butadiene	---	---	0.65	0.65
2,2,4-Trimethylpentane	---	---	0.60	0.60
Biphenyl	---	---	0.51	0.51
Carbon Tetrachloride	---	---	0.09	0.09
Chlorobenzene	---	---	0.073	0.073
Chloroform	---	---	0.068	0.068
Dichlorobenzene	---	0.0036	0.00014	0.0037
Ethylene Dibromide	---	---	0.11	0.11
Methylene Chloride	---	---	0.049	0.049
Naphthalene	0.061	0.0018	0.18	0.24
Phenol	---	---	0.057	0.057
Styrene	---	---	0.057	0.057
Tetrachloroethane	---	---	0.0059	0.0059
Vinyl Chloride	---	---	0.036	0.036
(PAH) POM 1	---	---	0.067	0.067
POM 2	0.036	0.00018	0.14	0.18
POM 3	---	0.000048	0.0000019	0.000049
POM 4	---	0.0000054	0.0000002	0.000006
POM 5	0.00028	0.000007	0.0000003	0.00029
POM 6	0.0011	0.000021	0.00040	0.0015
POM 7	0.0007	0.000005	0.0017	0.0024
Total HAPs	0.74	130.02	202.86	333.62
Greenhouse Gases				
CO_2	82,477	370,729	608,232	1,061,438
CH_4	3.24	4,403	794	5,200
N_2O	0.657	0.70	1.14	2.50
CO_2e	82,749	463,409	625,260	1,171,418

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	110	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	3.90	1.97	0.035	3.90	7.80
PM_{15}	0.50	0.009	0.99	0.50	0.009	0.99	1.99
PM_{10}	0.38	0.007	0.75	0.38	0.007	0.75	1.49
$PM_{2.5}$	0.21	0.00372	0.41	0.21	0.004	0.41	0.82

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	110	well pads/year
Oil well pads	0	well pads/year
Distance graded - Deep gas well	1.96	miles
Distance graded - Oil well	0.00	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Deep gas wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	5.27	0.15	0.0026	0.29
PM_{15}	2.52	0.07	0.0013	0.14
PM_{10}	1.51	0.042	0.00076	0.08
$PM_{2.5}$	0.16	0.005	0.000082	0.009

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.22	miles of road per well pad
	11	hours per well pad road
Annual amount of well pads with roads	110	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.010	1.15	1.97	0.010	1.15	2.30
PM_{15}	0.50	0.003	0.29	0.50	0.003	0.29	0.59
PM_{10}	0.38	0.002	0.22	0.38	0.002	0.22	0.44
$PM_{2.5}$	0.21	0.0011	0.12	0.21	0.001	0.12	0.24

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	11	hours per well pad roads
Road construction grading distance	0.22	miles road per well pad
Annual well pads	110	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	0.59	0.06	0.0003	0.03
PM_{15}	0.28	0.03	0.00014	0.016
PM_{10}	0.17	0.016	0.00009	0.009
$PM_{2.5}$	0.02	0.002	0.000009	0.0010

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.22	miles of pipeline per well pad
	27	hours per well pad pipeline
Annual amount of well pads withpipeline	110	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.026	2.88	1.97	0.026	2.88	5.76
PM_{15}	0.50	0.007	0.73	0.50	0.007	0.73	1.47
PM_{10}	0.38	0.0050	0.55	0.38	0.0050	0.55	1.10
$PM_{2.5}$	0.21	0.0027	0.30	0.21	0.0027	0.30	0.60

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	27	hours per well pad pipeline
Pipeline construction grading distance	0.89	miles pipeline per well pad
Annual well pads	110	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.38	0.09	0.0012	0.13
PM_{15}	1.14	0.043	0.00057	0.06
PM_{10}	0.68	0.026	0.00034	0.04
$PM_{2.5}$	0.07	0.0028	0.000037	0.004

a Assumes maximum development scenario

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	110	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	9.74
$PM_{2.5}$	0.12	0.11	0.56	0.009	0.97

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.04
$PM_{2.5}$	0.0036	0.0035	0.006	0.00010	0.011

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	110	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.45	1.27	7.90	4.57	502.66
$PM_{2.5}$	0.15	0.13	0.79	0.46	50.27

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.023	0.022	0.041	0.0261	2.87
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	0.70

Project: GMBU - Alternative D -Gas Wells

7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	110	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	7.32
$PM_{2.5}$	0.14	0.12	0.42	0.007	0.73

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.04
$PM_{2.5}$	0.0047	0.0046	0.005	0.00009	0.009

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	110	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	4
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	35,750	---
Total Round Trips	---	8

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.55	1.36	9.64	2.43	267.84
$PM_{2.5}$	0.16	0.14	0.96	0.24	26.78

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.026	0.025	0.05	0.02	1.66
$PM_{2.5}$	0.006	0.006	0.01	0.004	0.41

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	787.56	4.61	792.17
$PM_{2.5}$	78.76	1.13	79.89

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	264	acres total disturbance for roads and pipelines per year
	1,067,501	square meters total initial disturbance for roads and pipelines
	330	acres total disturbance for well pads per year
	1,335,461	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2-period	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2-period
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	7.53	0.00
PM_{10}	3.76	0.00
$PM_{2.5}$	0.56	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	110	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.37
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.68
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.042
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00042
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.019
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.018
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	40.81
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0020
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0007
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	41.08

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	110	new pads per year
Backhoe miles per pad	0.77	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	73.2	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	3.1	miles
Dozer Hours	73.2	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	3.1	miles
Motor Grader Hours	73.2	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{\text{453.6 (g/lb)} * \text{2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0102	8.38	1.48	0.054	8.38	2.52	0.092
CO	3.49	0.14	0.0052	2.7	0.48	0.017	2.70	0.81	0.030
VOC [b]	0.99	0.040	0.0015	0.68	0.12	0.0044	0.68	0.20	0.0075
PM_{10}	0.722	0.029	0.0011	0.402	0.071	0.0026	0.402	0.12	0.0044
$PM_{2.5}$	0.722	0.029	0.0011	0.402	0.071	0.0026	0.402	0.12	0.0044
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.28	188.2	33.31	1.22	188.2	56.59	2.07
CO_2e [e]	---	7.59	0.28	---	33.31	1.22	---	56.59	2.07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	17.24
CO	1.43	5.76
VOC	0.36	1.47
PM_{10}	0.22	0.89
$PM_{2.5}$	0.22	0.89
Greenhouse Gases		
CO_2	97.50	392.57
CO_2e [e]	97.50	392.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of deep gas wells drilled	110	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells[c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.0101	0.40	29.09
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.0993	0.25	18.36
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	1.72
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.0000	0.00030	0.021
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.0003	0.022	1.62
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.0002	0.022	1.56
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.2014	38.19	2772.68
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.0003	0.00077	0.056
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.0001	0.00023	0.017
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	2779.01

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Number of deep gas wells	110	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.004	0.48	15.13
CO	1.98E-02	0.12	0.04	7.26E-02	0.15	0.04	0.27	8.66
VOC [c]	3.16E-03	0.020	0.006	3.54E-03	0.007	0.0021	0.03	0.85
SO_2	4.57E-05	0.0003	0.00008	2.83E-05	0.00006	0.000017	0.0003	0.011
PM_{10}	4.22E-03	0.03	0.008	1.94E-04	0.0004	0.00012	0.03	0.84
$PM_{2.5}$	4.09E-03	0.03	0.007	1.79E-04	0.0004	0.00011	0.03	0.82
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	1430.74
CH_4	6.56E-05	0.0004	0.00012	2.08E-04	0.0004	0.00012	0.0008	0.03
N_2O	1.20E-05	0.00007	0.00002	8.05E-05	0.00017	0.00005	0.00024	0.008
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	1434

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	110	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.34
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.38
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.014	0.027
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00030
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.018
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.018
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	34.21
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0011
N_2O	1.20E-05	0.00002	0.0000004	8.05E-05	0.00017	0.0000030	0.00019	0.00038
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	34.35

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	1320	hours/deep gas well
Development Rate	110	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 , 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Gas Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	3.44	378.26
CO [a]	5.73E-03	5.21	3.44	378.26
VOC [a]	3.09E-04	0.28	0.19	20.37
PM_{10} [a]	6.61E-05	0.06	0.04	4.36
$PM_{2.5}$ [a]	6.61E-05	0.06	0.04	4.36
SO_2 [b]	1.21E-05	0.011	0.0073	0.80
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.0033	0.36
Toluene [c]	1.97E-06	0.0018	0.0012	0.13
Xylenes [c]	1.35E-06	0.0012	0.00081	0.09
Formaldehyde [c]	5.52E-07	0.00050	0.00033	0.036
Acetaldehyde [c]	1.76E-07	0.00016	0.00011	0.012
Acrolein [c]	5.52E-08	0.00005	0.000033	0.0036
Naphthalene [d]	9.10E-07	0.00083	0.00055	0.060
POM 2 [d,e,f]	5.39E-07	0.00049	0.00032	0.036
POM 5 [d,e,g]	4.22E-09	0.0000038	0.0000025	0.00028
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000099	0.0011
POM 7 [d,e,i]	1.07E-08	0.000010	0.0000064	0.0007
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	684.73	75,320
CH_4 [j,k]	4.63E-05	0.042	0.028	3.06
N_2O [j,k]	9.26E-06	0.0084	0.0056	0.61
CO_2e [m]	---	1040.96	687.03	75,574

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative D -Gas Wells

Date: 7/15/2013

15. Well Fracturing Engine

Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	110	wells/year (deep gas wells)

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Horsepower (hp)* Hours (hour/year) * Load Factor}}{\text{2000 lb/ton}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Gas Well Emissions (lb/hr)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.82	0.29	32.41
CO [a]	0.85	5.50E-03	2.25	0.07	7.43
VOC [a]	0.09	7.05E-04	0.29	0.009	0.95
PM_{10} [a]	0.10	0.0007	0.29	0.009	0.95
$PM_{2.5}$ [a]	0.10	0.0007	0.29	0.009	0.95
SO_2 [a]	1.52E-03	1.21E-05	0.0050	0.00015	0.016
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0022	0.000067	0.007
Toluene [b]	2.81E-04	1.97E-06	0.00080	0.000024	0.0027
Xylenes [b]	1.93E-04	1.35E-06	0.00055	0.000017	0.0018
Formaldehyde [b]	7.89E-05	5.52E-07	0.00023	0.0000068	0.0007
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000072	0.0000022	0.00024
Acrolein [b]	7.88E-06	5.52E-08	0.000023	0.00000068	0.00007
Naphthalene [c]	1.30E-04	9.10E-07	0.00037	0.000011	0.0012
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00022	0.0000066	0.0007
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000017	0.000000052	0.000006
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000068	0.00000020	0.000022
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000044	0.00000013	0.000014
Greenhouse Gases					
CO_2 [i]	163.05	1.14	753.3	22.60	2485.9
CH_4 [j]	6.61E-03	4.63E-05	0.031	0.00092	0.10
N_2O [j]	1.32E-03	9.26E-06	0.0061	0.00018	0.020
CO_2e [l]	---	---	755.8	22.7	2,494.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative D -Gas Wells

Date: 7/15/2013

16. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

17. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	161,132	miles/year-all wells
Operation Pickup Truck Mileage:	295,888	miles/year-all wells
Hours of Operation:	10	hours per day
Hours of Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [d]**	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	2.37	4.32	6.05E-03	0.49	0.90	2.86	5.21
CO	1.02E-02	0.45	0.82	4.48E-02	3.63	6.63	4.08	7.45
VOC [c]	1.55E-03	0.07	0.12	1.61E-03	0.13	0.24	0.20	0.36
SO_2	3.07E-05	0.001	0.002	1.84E-05	0.0015	0.0027	0.003	0.005
PM_{10}	2.57E-03	0.11	0.21	1.31E-04	0.011	0.019	0.12	0.23
$PM_{2.5}$	2.50E-03	0.11	0.20	1.21E-04	0.010	0.018	0.12	0.22
Greenhouse Gases								
CO_2	4.520	199.5	364.2	1.050	85.1	155.3	284.7	519.5
CH_4	2.59E-05	0.0011	0.002	9.38E-05	0.008	0.014	0.009	0.016
N_2O	4.01E-06	0.0002	0.0003	2.68E-05	0.0022	0.0040	0.0023	0.004
CO_2e [c]	---	199.6	364.3	---	86.0	156.9	285.6	521.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

18. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of producing wells	1539	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	18
Light Trucks	8,000	33
Mean Vehicle Weight	21,160	---
Total Round Trips	---	51

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.22	1.07	0.075	0.120	185.02
$PM_{2.5}$	0.12	0.11	0.0075	0.0120	18.50

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.015	0.015	0.00031	0.00057	0.88
$PM_{2.5}$	0.0038	0.0038	0.000077	0.000140	0.22

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

19. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	1539	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total Wellsite Emissions [a] (tons/yr)
VOC	0.71	0.00	1091.77
Hazardous Air Pollutants			
Benzene	0.0069	0.00	10.62
Toluene	0.012	0.00	17.70
Ethylbenzene	0.00050	0.00	0.77
Xylenes	0.0041	0.00	6.31
n-Hexane	0.018	0.00	28.01
Greenhouse Gases			
CO_2	0.14	0.00	220.5
CH_4	0.68	0.00	1045.4
CO_2e	14	0.00	22,175

a Total wellsite flashing emissions are based on 1539 uncontrolled tanks and 0 tanks controlled at 0%.

20. Condensate Truck Loadout

Assumptions:

Deep Gas Well Condensate Production Rate	2.0	bbl/day-well
Number of Deep Gas Wells	1539	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Condensate Loading [a]	0.6	5.2	66	520	4.94	2.0	0.076	116.48

	Condensate Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00074	1.13
Toluene	0.0012	1.89
Ethylbenzene	0.000053	0.08
Xylenes	0.00044	0.67
n-Hexane	0.0019	2.99
Greenhouse Gases		
CO2	0.015	23.53
CH4	0.072	111.54
CO2e	1.54	2365.9

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Assumes maximum development scenario

c Emissions estimated based on ratio of HAP/VOC in tank emissions

21. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.0546	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.0008	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.00520	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.00230	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
1,539	188.42	664.34	5.82	13,957

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

22. Production Heater Emissions

Assumptions

Deep Gas Well Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Gas wells with dehydrators	1539	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Deep Gas Well Dehydrator Heater			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	100	0.044	0.19	67.90	297.39
CO [a]	84	0.037	0.16	57.03	249.81
VOC [b]	5.5	0.0024	0.011	3.73	16.36
SO_2 [b]	0.6	0.00026	0.0012	0.41	1.78
PM_{10} [b]	7.6	0.0034	0.015	5.16	22.60
$PM_{2.5}$ [b]	7.6	0.0034	0.015	5.16	22.60
Hazardous Air Pollutants					
Benzene [c]	2.10E-03	9.26E-07	4.06E-06	0.0014	0.006
Toluene [c]	3.40E-03	1.50E-06	6.57E-06	0.0023	0.010
Hexane [c]	1.80E+00	7.94E-04	3.48E-03	1.22	5.35
Formaldehyde [c]	7.50E-02	3.31E-05	1.45E-04	0.051	0.22
Dichlorobenzene [c]	1.20E-03	5.29E-07	2.32E-06	0.0008	0.0036
Naphthalene [c]	6.10E-04	2.69E-07	1.18E-06	0.00041	0.0018
POM 2[c,d,e]	5.90E-05	2.60E-08	1.14E-07	0.000040	0.00018
POM 3[c,f]	1.60E-05	7.06E-09	3.09E-08	0.000011	0.00005
POM 4[c,g]	1.80E-06	7.94E-10	3.48E-09	0.000001	0.00001
POM 5[c,h]	2.40E-06	1.06E-09	4.64E-09	0.000002	0.00001
POM 6[c,i]	7.20E-06	3.18E-09	1.39E-08	0.000005	0.00002
POM 7[c,j]	1.8E-06	7.94E-10	3.48E-09	0.000001	0.00001
Greenhouse Gases					
CO_2 [l]	119,226	52.60	230.39	80,951	354,564
CH_4 [l]	2.25	0.0010	0.0043	1.53	6.69
N_2O [l]	0.22	0.00010	0.00043	0.15	0.67
CO_2e [m]	---	52.65	230.61	81,030	354,912

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

23. Deep Gas Well Fugitive Emissions

Number of Producting Wells 1539 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**894.28**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b Weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	2.45
Toluene Emissions	0.0001	0.0162	3.20
Ethylbenzene Emissions	----	0.0007	0.12
Xylene Emissions	0.00001	0.0058	1.04
n-Hexane Emissions	0.0035	0.0257	17.76

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**2382.96**	**20.85**	**50063**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

24. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.4 MMscf/day/well
Wells Requiring Dehydrators: 1,539 wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0043	0.019	29.10
Hazardous Air Pollutants			
Benzene	0.00025	0.0011	1.69
Toluene	0.0011	0.0047	7.16
Ethylbenzene	0.00031	0.0014	2.10
Xylenes	0.0022	0.010	14.93
Greenhouse Gases			
CH_4	0.0068	0.030	45.54
CO_2e	0.14	0.62	956.32

25. Wellsite Flare Emissions

Assumptions:

Number of gas well dehydrators with controls	1539	well pads
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.002	0.01	2.82	12.37
CO [a]	0.37	0.01	0.04	15.36	67.29
Greenhouse Gases					
CO2 [b]	---	2.28	9.99	3,510	15,375
CH4 [b]	---	0.02	0.10	33.5	146.5
N2O [b]	---	0.00000	0.00002	0.0	0.026
CO2e [b]	---	2.74	11.99	4,214	18,459

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

26. Compressor Station Engines

Assumptions:

Number of new compressor stations	17	facilities
Number of expanded compressor stations	0	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission factor conversion:

g/hp-hr = AP-42 emission factor (lb/MMbtu) * 8000 Average BTU/hp-hr / 1,000,000 * 453.59 g/lb

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp) * 8760 (hr/yr)}}{\text{453.6 g/lb * 2000 (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions per Facility (lb/hr-facility)	Emissions per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	1313.23
CO [a]	-	2.0	35.27	154.50	2626.46
VOC [a]	-	0.7	12.35	54.07	919.26
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	47.40
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	47.40
SO_2 [b]	5.88E-04	0.002	0.04	0.16	2.80
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	1.05
Toluene	4.08E-04	1.48E-03	0.013	0.057	0.97
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.09
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.44
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	2.64
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	125.81
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	19.92
Acrolein	5.14E-03	1.87E-02	0.16	0.72	12.25
Methanol	2.50E-03	9.07E-03	0.080	0.35	5.96
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.10
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.076
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.063
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.64
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.60
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.51
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.09
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.072
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.068
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.11
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.048
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.18
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.057
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.056
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0059
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.036
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.064
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.14
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.000005	0.000023	0.00040
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.0017
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	557,022
CH_4 [g]	0.002	0.0080	0.14	0.62	10.51
N_2O [g]	0.0002	0.00080	0.014	0.062	1.05
CO_2e [h]	---	---	7,488	32,798	557,569

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

27. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :		
Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	17	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	22.16
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.216
Toluene	0.11	0.0053	0.359
Ethylbenzene	0.0046	0.00023	0.0156
Xylenes	0.038	0.0019	0.128
n-Hexane	0.17	0.0084	0.57
Greenhouse Gases			
CO_2	1.32	1.32	89.53
CH_4	6.24	0.31	21.22
CO_2e	132	7.87	535.1

a Assumes maximum development scenario

28. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 17 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	198.76
Hazardous Air Pollutants			
Benzene	0.13	0.56	9.52
Toluene	0.090	0.39	6.69
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	1.20
n-Hexane	0.078	0.34	5.77
Greenhouse Gases			
CH_4	3.28	14.35	243.97
CO_2e	68.81	301.38	5123.38

a Assumes maximum development scenario

29. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Facilities	17	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	47.29

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.46
Toluene	0.045	0.77
Ethylbenzene	0.0020	0.033
Xylenes	0.016	0.27
n-Hexane	0.071	1.21
Greenhouse Gases		
CO2	0.56	9.55
CH4	2.664	45.28
CO2e	56.50	960.43

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60° F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

30. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	43,607	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.64	1.17	6.05E-03	0.00	0.00	0.64	1.17
CO	1.02E-02	0.12	0.22	4.48E-02	0.00	0.00	0.12	0.22
VOC [c]	1.55E-03	0.019	0.034	1.61E-03	0.00	0.00	0.019	0.034
SO_2	3.07E-05	0.0004	0.001	1.84E-05	0.00	0.00	0.0004	0.0007
PM_{10}	2.57E-03	0.031	0.056	1.31E-04	0.00	0.00	0.031	0.056
$PM_{2.5}$	2.50E-03	0.030	0.055	1.21E-04	0.00	0.00	0.030	0.055
Greenhouse Gases								
CO_2	4.520	54.0	98.6	1.050	0.0	0.0	54.0	98.6
CH_4	2.59E-05	0.0003	0.001	9.38E-05	0.00	0.00	0.0003	0.001
N_2O	4.01E-06	0.0000	0.0001	2.68E-05	0.00	0.00	0.0000	0.0001
CO_2e [c]	---	54.0	98.6	---	0.0	0.0	54.0	98.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

31. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf. Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	17	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	5
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	5

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.94	1.51	25.67
$PM_{2.5}$	0.17	0.15	0.094	0.15	2.57

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0060	0.0110	0.19
$PM_{2.5}$	0.0081	0.0081	0.0015	0.0027	0.046

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

32. Compressor Station Fugitive Emissions

Number of Compressor Stations 17 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.020
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**51.47**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.105
Toluene Emissions	0.0001	0.016	0.120
Ethylbenzene Emissions	----	0.00070	0.004
Xylene Emissions	0.00001	0.0058	0.036
n-Hexane Emissions	0.0035	0.026	0.99

32. Compressor Station Fugitive Emissions

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**154.58**	**1.352**	**3247.5**

a Number of components referenced from similar existing facilities

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

33. Gas Processing Plant Compression

Assumptions:

Number of compressors	4	engines
Compressor horsepower	300	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	0.66	2.90	11.59
CO [a]	-	2.0	1.32	5.79	23.17
VOC [a]	-	0.7	0.46	2.03	8.11
PM_{10} [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
SO_2 [b]	5.88E-04	2.40E-03	0.0016	0.007	0.028
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.0021	0.0093	0.037
Toluene	5.58E-04	2.28E-03	0.00075	0.0033	0.013
Ethylbenzene	2.48E-05	1.01E-04	0.000033	0.00015	0.00059
Xylenes	1.95E-04	7.96E-04	0.00026	0.0012	0.0046
Formaldehyde	2.05E-02	8.37E-02	0.028	0.12	0.48
Acetaldehyde	2.79E-03	1.14E-02	0.0038	0.016	0.066
Acrolein	2.63E-03	1.07E-02	0.0036	0.016	0.062
Methanol	3.06E-03	1.25E-02	0.0041	0.018	0.072
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.000034	0.00015	0.00060
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.000021	0.000090	0.00036
1,3-Dichloropropene	1.27E-05	5.18E-05	0.000017	0.000075	0.00030
1,3-Butadiene	6.63E-04	2.71E-03	0.00090	0.0039	0.016
Carbon Tetrachloride	1.77E-05	7.23E-05	0.000024	0.00010	0.00042
Chlorobenzene	1.29E-05	5.27E-05	0.000017	0.000076	0.00031
Chloroform	1.37E-05	5.59E-05	0.000018	0.000081	0.00032
Ethylene Dibromide	2.13E-05	8.70E-05	0.000029	0.00013	0.00050
Methylene Chloride	4.12E-05	1.68E-04	0.000056	0.00024	0.0010
Naphthalene	9.71E-05	3.96E-04	0.00013	0.00057	0.0023
Styrene	1.19E-05	4.86E-05	0.000016	0.000070	0.00028
Vinyl Chloride	7.18E-06	2.93E-05	0.000010	0.000042	0.00017
PAH -POM 1	1.41E-04	5.76E-04	0.00019	0.00083	0.0033
Greenhouse Gases					
CO_2 [e]	117	477.2	315.59	1382	5529.1
CH_4 [e]	0.002	9.00E-03	0.0060	0.026	0.10
N_2O [e]	0.0002	9.00E-04	0.00060	0.003	0.010
CO_2e [f]	---	---	315.9	1384	5535

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

34. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

35. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

36. Central Facility Heater Emissions

Assumptions

Gas Processing Dehydrator Reboiler Size	1,500	Mbtu/hr
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
	1	Gas Processing Plant
	17	Compressor Station

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Compressor Station Reboiler			Gas Processing Plant Reboiler			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.15	0.64	100	0.15	0.64	2.65	11.59
CO [a]	84	0.12	0.54	84	0.12	0.54	2.22	9.74
VOC [b]	5.5	0.008	0.035	5.5	0.008	0.035	0.15	0.64
SO_2 [b]	0.6	0.001	0.0039	0.6	0.001	0.0039	0.016	0.070
PM_{10} [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.20	0.88
$PM_{2.5}$ [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.20	0.88
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	3.09E-06	1.35E-05	2.10E-03	3.09E-06	1.35E-05	0.000056	0.00024
Toluene [c]	3.40E-03	5.00E-06	2.19E-05	3.40E-03	5.00E-06	2.19E-05	0.00009	0.00039
Hexane [c]	1.80E+00	2.65E-03	1.16E-02	1.80E+00	2.65E-03	1.16E-02	0.048	0.21
Formaldehyde [c]	7.50E-02	1.10E-04	4.83E-04	7.50E-02	1.10E-04	4.83E-04	0.0020	0.009
Dichlorobenzene [c]	1.2E-03	1.76E-06	7.73E-06	1.2E-03	1.76E-06	7.73E-06	0.000032	0.00014
Naphthalene [c]	6.1E-04	8.97E-07	3.93E-06	6.1E-04	8.97E-07	3.93E-06	0.000016	0.000071
POM 2[c,d,e]	5.9E-05	8.68E-08	3.80E-07	5.9E-05	8.68E-08	3.80E-07	0.000002	0.000007
POM 3[c,f]	1.6E-05	2.35E-08	1.03E-07	1.6E-05	2.35E-08	1.03E-07	0.0000004	0.000002
POM 4[c,g]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000000	0.0000002
POM 5[c,h]	2.4E-06	3.53E-09	1.55E-08	2.4E-06	3.53E-09	1.55E-08	0.0000001	0.0000003
POM 6[c,i]	7.2E-06	1.06E-08	4.64E-08	7.2E-06	1.06E-08	4.64E-08	0.0000002	0.000001
POM 7[c,j]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000000	0.0000002
Greenhouse Gases								
CO_2 [l]	119,226	175.3	768.0	119,226	175.3	768.0	3,156	13,823
CH_4 [l]	2.25	0.0033	0.014	2.25	0.0033	0.014	0.06	0.26
N_2O [l]	0.22	0.0003	0.001	0.22	0.0003	0.001	0.01	0.03
CO_2e [m]	---	175.5	768.7	---	175.5	768.7	3,159	13,837

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)
c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98
d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.
f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.
g POM 4 includes: 3-Methylchloranthrene.
h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
j POM 7 includes: Chrysene.
k Assumes maximum development scenario
l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

37. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 17
Number of Gas Processing Plants 1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	16.08
CO [a]	0.37	1.11	4.86	87.51
Greenhouse Gases				
CO2 [b]	---	402	1,759	31,658
CH4 [b]	---	3.83	16.76	301.7
N2O [b]	---	0.0007	0.003	0.053
CO2e [b]	---	482	2,112	38,010

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

---

50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd

2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX F

ELECTRONIC MODELING FILES

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