APPENDIX A – AFFECTED RESOURCES CHECKLIST

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APPENDIX A. Affected Resource List

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
Physical Resources	Air Quality	N/A	Yes	PI	No	3.1.1; 4.1.1		Analyze in the Environmental Assessment (EA). Potential effects from construction and development including fugitive dust; production and operations; emissions of criteria pollutants and hazardous air pollutants; and greenhouse gas emissions. An emissions inventory will be required. No standards have been set by the US Environmental Protection Agency (EPA) or other regulatory agencies for greenhouse gases. In addition, the assessment of greenhouse gas emissions and climate change is still in its earlier stages of formulation. Global scientific models are inconsistent, and regional or local scientific models are lacking so that it is not technically feasible to determine the net impacts to climate due to greenhouse gas emissions. It is anticipated that greenhouse gas emissions associated with this action and its alternative would be negligible.
	Geologic Resources	N/A	Yes	PI	No	3.1.2; 4.1.2		Analyze in the EA. Potential effects to surficial and subsurface geology of the Project Area due to construction and extraction activities, and plugging and abandoning of wells and other related reclamation activities.
	Soils	N/A	Yes	PI	No	3.1.3; 4.1.3		Analyze in the EA. Potential effects to soils from disturbance and the displacement of soils, and from wind and water erosion. Identify erosion hazards and areas with poor reclamation potential. Identify Dominant Soils and Ecological Sites in the Proposal Area, any areas of

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								Limited Reclamation Potential (LRP), and slopes in excess of 25% if any. Discuss Reclamation Suitability (Source Material).
	Water	N/A	Yes	PI	No	3.1.4; 4.1.4		Analyze in the EA, accordingly. *Floodplains*: there are no Federal emergency Management Agency (FEMA) mapped 100-year flood zones in the Project Area. *Groundwater Quality*: This action and its alternative could intercept aquifers, potentially impacting the quality of water in the aquifers through the introduction of compounds and communication between aquifers. Hydraulic fracturing from well completion could adversely impact groundwater quality. Water depletions could also affect groundwater resources. *Hydrologic (Stormwater) Conditions*: Construction activities could interrupt and rechannel existing surface water runoff patterns, creating increased erosion and sediment yield to area drainages. *Surface Water Quality*: Potential effects from increased soil erosion, sediment yield, and changes to surface water runoff patterns. This action and its alternative would also increase the potential for contamination of surface water from petroleum products, fuels, and other chemicals and surface disturbance. Water depletions could also affect surface water resources.

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
								Waters of the US: US Geological Survey (USGS) mapped perennial streams and National Wetlands Inventory (NWI) mapped wetlands are present within the Project Area and may be jurisdictional Waters of the US.
Mineral Resources	Locatable	N/A	Yes	PI	No	3.2.1; 4.2.1		Analyze in the EA. There is a potential for non-metallic minerals such as bentonite, gypsum, limestone to occur within the Project Area; however, no former or active mines for these minerals are present within the Project Area. There is a potential for some metallic minerals such as uranium to occur, but same situation. There are several uranium in-situ recovery operations near the Project Area, and numerous of Mining Claims within the Project Area (likely for uranium, given the area and the Claims' Claimants).
	Leasable	Coal	Yes	PI	No	3.2.2; 4.2.2		Analyze in the EA. A large portion of the Project Area overlaps a "Coal Development Potential Area." The remainder of the Project Area is considered unsuitable for coal development.
		Geothermal	No	NI	Yes	3.2.3; 4.2.3		The three areas of natural thermal springs in the Casper Field Office (CFO) Planning Area are not located in the Project Area. The entire Project Area has low potential for the occurrence and development of Geothermal Resources, given the deep depths at which higher temperatures exist.
		Oil and Gas	Yes	PI	No	3.2.4; 4.2.4		Analyze in the EA. Numerous oil, conventional gas, and coal bed natural gas (CBNG) wells are present within the Project Area. This action and its

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
								alternative would result in the depletion of these resources, and could increase the potential for management challenges, such as conflict resolution between resource programs (e.g., oil and gas leases vs. coal leases), split-estate issues, and restrictions imposed by other resource programs (e.g., wildlife stipulations).
		Other Solid Leasables	Yes	NI	No	3.2.5; 4.2.5		Analyze in the EA, accordingly. Sodium and phosphate-bearing rocks occur in the Project Area's subsurface, and the potential for these to be explored for or developed is low to very low. These minerals are likely not present in commercially amounts. Tar sands are not known to occur within the Project Area. Oil shale exists subsurface – see Oil and Gas.
	Salable	N/A	Yes	NI or PI	No	3.2.6; 4.2.6		Sand and gravel have the potential to occur within the Project Area; however, no active sand or gravel pits, or deposits of building stone, petrified wood, or decorative stone have been identified in the Project Area. There are some sand/gravel pits near the Project Area. Identify if present on United States Forest Service (USFS) lands, including the Thunder Basin National Grassland (TBNG).
Fire Management and Ecology	Unplanned/ Wildlife Fire	N/A	Yes	NI	Yes	3.3.1; 4.3.1		The CFO fire management program would not have jurisdiction with the Project Area, as no Bureau of Land Management (BLM) administered surface lands occur within the Project Area.

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
	Planned/ Prescribed Fire	N/A	No	NP	Yes	3.3.2; 4.3.2		The CFO fire management program would not have jurisdiction with the Project Area, as no BLM-administered surface lands occur within the Project Area.
	Rehabilitation	N/A	No	NP	Yes	3.3.3; 4.3.3		The CFO rehabilitation program would not have jurisdiction within the Project Area, as no BLM-administered surface lands occur within the Project Area.
Biological Resources	Vegetation	Forests, Woodlands, and Forest Products	No	NP	Yes	3.4.1; 4.4.1		The CFO would not manage treed areas within the Project Area, as no BLM-administered surface lands occur within the Project Area.
		Grassland and Shrubland Communities	Yes	PI	No	3.4.2; 4.4.2		Analyze in the EA. The Project Area is dominated by grassland and shrubland communities. Potential effects to vegetation from surface disturbance and the displacement of soils.
		Riparian and Wetland Communities	Yes	PI	No	3.4.3; 4.4.3		Analyze in the EA. Potential effects to riparian and wetland communities from increased soil erosion, sediment yield, and changes to surface water runoff patterns. This action and its alternative would also increase the potential for contamination of surface water from petroleum products, fuels, and other chemicals and surface disturbance. Identify if roads or corridors cross channel drainages.
		Invasive, Nonnative Plant Species and Pest Control	Yes	PI	No	3.4.4; 4.4.4		Analyze in the EA. Surface-disturbing activities could result in the introduction or spread of invasive and noxious weed species. The proponent would be responsible for noxious weed control per landowner and/or appropriate surface management agency specifications.
	Fish and Wildlife Resources	Fish	Yes	PI	No	3.4.5; 4.4.5		Analyze in the EA. Perennial streams within or downstream of the Project Area may contain fish that could be affected by

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
								this action and its alternative.
		Wildlife	Yes	PI	No	3.4.6; 4.4.6		Analyze in the EA. The Project Area contains habitats for pronghorn, mule deer, and white-tailed deer. In addition, there are several raptor nests scattered throughout the Project Area.
	Special Status Species	Plants	Yes	PI	No	3.4.7; 4.4.7		Analyze the following species in the EA: Ute ladies'-tresses and Barr's milkvetch.
		Fish	Yes	PI	No	3.4.8; 4.4.8		Analyze the following species in the EA: mountain sucker, plains topminnow, plains minnow, and flathead chub.
		Wildlife	Yes	PI	No	3.4.9; 4.4.9		Analyze the following species in the EA: greater sage-grouse, black-tailed prairie dog, northern river otter, swift fox, western burrowing owl, ferruginous hawk, bald eagle, golden eagle golden eagle, loggerhead shrike, Lewis's woodpecker, sagebrush birds (sage sparrow, sage thrasher, Brewer's sparrow), grassland birds (Baird's sparrow, grasshopper sparrow, McCown's longspur, chestnut-collared longspur, mountain plover, and long-billed curlew), and northern leopard frog.
Heritage and Visual Resources	Cultural Resources	N/A	Yes	PI	No	3.5.1; 4.5.1		Analyze in the EA. Potential effects on archaeological resources associated with ground-disturbing activities.
	Paleontological Resources	N/A	Yes	NI	Yes	3.5.2; 4.5.2		Although the Project Area contains Class 4/5 (high or very high potential) and Class 3 (moderate or unknown potential) formations, there are no BLM-administered surface lands in the Project Area boundary. Paleontological resources are the property of the private landowner.
	Visual Resources	N/A	Yes	NI	Yes	3.5.3; 4.5.3		Although approximately 138 acres of Class II and approximately 759 acres of Class III are located within the Project Area, there are no BLM-administered

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
								surface lands in the Project Area boundary that would be subject to BLM Visual Resource Management objectives.
Land Resources	Lands and Realty	N/A	Yes	NI	Yes	3.6.1; 4.6.1		Two primary land uses exist on private lands in the Project Area: ranching and oil/gas production. Several ranches are located in the vicinity of the Project Area. These land uses will be adequately discussed in other resource sections in this EA (e.g., livestock grazing and minerals).
	Renewable Energy	N/A	No	NP	Yes	3.6.2; 4.6.2		There are no renewable energy projects, or reasonable potential for future projects, within the Project Area.
	Rights-of-Way and Corridors	N/A	Yes	NI	Yes	3.6.3; 4.6.3		The proponent would be responsible for obtaining right-of-way easements prior to initiating surface-disturbing activities.
	Transportation	N/A	Yes	NI	Yes	3.6.4; 4.6.4		There is an existing system of state highways and county roads that provide access to destinations within and through the Project Area. Additional impacts to these systems are anticipated to be minor.
	Off-Highway Vehicle (OHV) and Travel Management Areas	N/A	No	NP	Yes	3.6.5; 4.6.5		As the majority of the Project Area consists of privately owned surface lands, opportunities for OHV activities are limited. On private lands, OHV use is prohibited without permission of the landowner. Off-road and trail travel is prohibited on USFS lands, including the TBNG. On state lands, motorized vehicles are confined to established roads.
	Livestock Grazing	N/A	Yes	PI	No	3.6.6; 4.6.6		Analyze in the EA. Currently, there are four grazing allotments within the Project Area that could be affected by this action and its alternative. Three grazing allotments are managed by the USFS and one is managed by the BLM. Range improvements also occur throughout the Project Area on federal, state, and private

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
								surfaces.
	Recreation	N/A	Yes	NI	Yes	3.6.7; 4.6.7		There are no developed recreational facilities within the Project Area. However, there are opportunities for dispersed hunting, hiking, OHV use, and other dispersed activities. Given the limited extent perennial streams, lack of recreational facilities, and abundance of private landownership, public recreation opportunities would likely be limited.
Special Designations and Other Management Areas	Areas of Critical Environmental Concern (ACEC) and Other Management Areas	N/A	No	NP	Yes	3.7.1; 4.7.1		There are no ACECs or other management areas within the Project Area. None of the USFS lands within the Project Area have received special designation.
	National Back Country Byways	N/A	No	NP	Yes	3.7.2; 4.7.2		There are no National Back Country Byways within the Project Area.
	National Historic Trails and Other Historic Trails	N/A	No	NP	Yes	3.7.3; 4.7.3		There are no National Historic Trails or Other Historic Trails within the Project Area.
	Wild and Scenic Rivers	N/A	No	NP	Yes	3.7.4; 4.7.4		There are no Wild and Scenic Rivers within the Project Area.
Socioeconomic Resources	Special Conditions	N/A	No	NP	Yes	3.8.1; 4.8.1		There are no special conditions within the Project Area.
	Economic Conditions	N/A	Yes	NI	Yes	3.8.2; 4.8.2		This action and its alternative could help meet the nation's demand for oil and natural gas, and contribute to the national, state, and local economies. The project would result in creation of employment opportunities and public revenue streams. These impacts have been adequately addressed in the Casper Approved RMP/ROD.

Resource Category	Resource	Sub Resource	Resource Present	Resource Affected[1]	Casper Approved RMP/ROD Sufficient[2]	Casper FEIS	Signature	Rationale for Determination
	Health and Safety	N/A	Yes	NI / NI	Yes	3.8.3; 4.8.3		The proponent would be responsible for implementing industry standard Best Management Practices (BMPs) to protect workers, the surrounding community, and the natural environment. Geological hazards exist in the Project Area, but to an overall low degree.
	Environmental Justice	N/A	No	NP	Yes	3.8.4; 4.8.4		There are no environmental justice concerns associated with this action and its alternative.
	Tribal Treaty Rights	N/A	No	NP	Yes	3.8.5; 4.8.5		There are no Tribal treaty rights within the Project Area.

[1]Determination of Staff:

- NP = not present in the area impacted by the proposed or alternative actions
- NI = present, but not affected to a degree that detailed analysis is required
- PI = present with potential for relevant impact that need to be analyzed in detail in the EA

[2]Impact analyses used to derive management objectives in the Casper Approved RMP/ROD are sufficient and do not need to be carried forward in this EA.

APPENDIX B – SITE-SPECIFIC ONSITE COMMENTS

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Well Pad Name	Onsite Comments
Blade 20 NENE	The proposed access road would be rock lined where necessary. Production tanks will be located in the southern portion of the location, on the facilities pad, to block the view from FEHA nest (#3910) located approximately 800 feet to the south of the proposed well pad, along a drainage.
Blade 21 SENE	No raptor stipulation. FEHA nest (#3947) located approximately 795 feet to the north was out of line of sight for the proposed well pad.
Blade 22 NWNW	A road share agreement would be obtained with Devon. Raptor stipulation recommended, FEHA nest (#3947) located approximately 795 feet west of the proposed well pad.
Blade 23 NWNW	Water would be diverted away from the proposed well pad.
Marys Draw 8 SESW	Production tanks would be placed in the northern portion of the location, on the facilities pad, blocking the view from golden eagle (GOEA) nest #3737, 4149, 4595 and GOEA nest #274 located approximately 2,590 feet and 2,670 feet to the northeast of the well pad, respectively. Red-tail hawk (RTHA) nest #4005 located approximately 2,240 feet to the south-southeast of the well pad. Unknown nest #3656 located approximately 2,240 feet to the south-southeast of the well pad.
Marys Draw 14 SWSW	Production tanks would be placed on the east side of proposed well pad. New raptor nest observed approximately 1,266 feet to the northeast of the proposed well pad.
Marys Draw 24 NWNW	The existing EOG pipeline would be moved to the eastern edge of the well pad expansion.
Marys Draw 13 SWSE	The existing topsoil pile would be relocated to the eastern portion of the well pad using 3:1 slope and spreading the topsoil.

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APPENDIX C - SUMMARY OF THE POTENTIAL FOR AND/OR OCCURRENCE OF SPECIAL STATUS WILDLIFE AND PLANT SPECIES WITHIN THE PROJECT AREA

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Appendix C – Special Status Species and Their Potential to Occur within the 2016 Crossbow 2016 Interim Oil and Gas Exploration Project

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
MAMMALS						
Pygmy rabbit	*Brachylagus idahoensis*	--	Yes	--	None. This species occurs in southwestern Wyoming.	Yes
Gray wolf	*Canis lupus*	Yes	--	--	None. This species is known to occur in the western half of Wyoming.	Yes
American hog-nosed skunk	*Conepatus leuconotus*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Townsend's big-eared bat	*Corynorhinus townsendii*	Yes	Yes	--	None. The Project Area is outside of the mapped boundary for this species.	Yes
Gunnison's prairie dog	*Cynomys gunnisoni*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
White-tailed prairie dog	*Cynomys leucurus*	Yes	Yes	--	None. This species is primarily found in western and central Wyoming.	Yes
Black-tailed prairie dog	*Cynomys ludovicianus*	Yes	Yes	--	High. This species is common within Converse and Campbell Counties.	**No**
Spotted bat	*Euderma maculatum*	Yes	Yes	--	None. This species is known to occur in the western part of the state.	Yes
Hoary bat	*Lasiurus cinereus*	Yes	--	--	Moderate. This species is known to occur in sagebrush communities and eastern great-plains grasslands across the U.S.	Yes
Northern river otter	*Lontra canadensis*	Yes	--	--	Moderate. Species has the potential to occur within Project Area streams.	**No**
Canada lynx	*Lynx Canadensis*	--	--	Threatened	None. Coniferous forests are not present within the Project Area.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
American marten	*Martes americana*	Yes	--	--	None. No old-growth conifer forests are present in the Project Area.	Yes
Water vole	*Microtus richardsoni*	Yes	--	--	None. Only occurs within the northwestern half of the state.	Yes
Black-footed ferret	*Mustela nigripes*	--	--	Experimental	None. The experimental population only occurs in Natrona, Carbon, and Albany Counties.	Yes
Long-eared myotis	*Myotis evotis*	--	Yes	--	None. This species inhabits coniferous forests and woodlands.	Yes
Fringed myotis	*Myotis thysanodes*	Yes	Yes	--	None. This species primarily occurs in mature forest systems.	Yes
Northern long-eared bat	*Myotis septentrionalis*	--	--	Proposed Endangered	None. This species primarily occurs in mature forest systems.	Yes
Rocky Mountain bighorn sheep	*Ovis canadensis canadensis*	Yes	--	--	None. This species has been extirpated from Eastern Wyoming and is not found on TBNG.	Yes
Desert bighorn sheep	*Ovis canadensis nelsoni*	Yes	--	--	None. This species has been extirpated from Eastern Wyoming and is not found on TBNG.	Yes
Pygmy shrew	*Sorex hoyi*	Yes	--	--	None. This species is only found in the southern half of Wyoming.	Yes
Wyoming pocket gopher	*Thomomys clusius*	Yes	Yes	--	None. This species does not occur in Converse or Campbell County.	Yes
Idaho pocket gopher	*Thomomys idahoensis*	--	Yes	--	None. This species does not occur in Converse or Campbell County.	Yes
Grizzly bear	*Ursus arctos horribilis*	--	--	Threatened	None. In Wyoming, this species only occupies the montane forests in the western edge of the state.	Yes
Kit fox	*Vulpes macrotis*	Yes	--	--	None. This species does not occur in Wyoming.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Swift fox	*Vulpes velox*	Yes	Yes	--	Moderate. This species has been observed throughout eastern Wyoming. Great plains grasslands are present within the Project Area.	**No**
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Preble's meadow jumping mouse	*Zapus hudsonius preblei* (Wyoming SPR)	--	Yes	Threatened	None. This species primarily occurs in the Southeastern part of the state.	Yes
Birds						
Northern goshawk	*Accipiter gentilis*	Yes	Yes	--	None. This species occurs in deciduous and coniferous forests.	Yes
Boreal owl	*Aegolius funereus*	Yes	--	--	None. Montane forests are not present in the Project Area.	Yes
Cassin's sparrow	*Aimophila cassinii*	Yes	--	--	Low. This species is considered an accidental breeder and has only been observed in Natrona and Goshen Counties.	Yes
Baird's sparrow	*Ammodramus bairdii*	--	Yes	--	Moderate. This migrant species occurs in grasslands in eastern Wyoming.	**No**
Grasshopper sparrow	*Ammodramus savannarum*	Yes	--	--	Moderate. This species is known to breed in grasslands across eastern Wyoming.	**No**
Sage sparrow	*Amphispiza belli*	Yes	Yes	--	Moderate. This is a common sagebrush species in Wyoming.	**No**
Golden Eagle	*Aquila chrysaestos*	--	--	--	High. Nests have been identified within the Project Area.	**No**
Short-eared owl	*Asio flammeus*	Yes	--	--	Low. An uncommon resident of Wyoming Grasslands.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Western burrowing owl	*Athene cunicularia*	Yes	Yes	--	High. Species nests in prairie-dog burrows across Wyoming. Nests have been observed east of the Project Area.	**No**
American bittern	*Botaurus lentiginosus*	Yes	--	--	None. This species is considered uncommon to rare and has not been observed breeding in Converse or Campbell County.	Yes
Ferruginous hawk	*Buteo regalis*	Yes	Yes	--	High. Known nests occur within the Project Area	**No**
McCown's longspur	*Calcarius mccownii*	Yes	--	--	Moderate. Common breeder in short-grass prairies in Wyoming.	**No**
Chestnut-collared longspur	*Calcarius ornatus*	Yes	--	--	Moderate. Known to breed in prairie habitats in eastern Wyoming.	**No**
Greater sage-grouse	*Centrocercus urophasianus*	Yes	Yes	Candidate	High. A greater sage-grouse lek has been observed within the Project Area.	**No**
Piping plover	*Charadrius melodus*	--	--	Endangered	None. Project Area does not occur within the Platte River System.	Yes
Mountain plover	*Charadrius montanus*	Yes	Yes	--	High. This species was observed nesting 5 miles east of the Project Area.	**No**
Black tern	*Chlidonias niger*	Yes	--	--	None. The Wyoming Natural Diversity Database does not identify the Project area as potential habitat.	Yes
Northern harrier	*Circus cyaneus*	Yes	--	--	Moderate. This species is common and widespread throughout Wyoming.	Yes
Yellow-billed cuckoo	*Coccyzus americanus*	Yes	Yes	Threatened (Western Distinct Population)	None. The protected population of this species occurs west of the Continental Divide.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Olive-sided flycatcher	*Contopus cooperi*	Yes	--	--	None. Coniferous and mixed-coniferous forests are not present in the Project Area.	Yes
Trumpeter swan	*Cygnus buccinator*	Yes	Yes	--	None. This species is not known to occur in Campbell and Converse Counties.	Yes
Black swift	*Cypseloides niger*	Yes	--	--	Low. This species occupies montane habitats within Wyoming.	Yes
American peregrine falcon	*Falco peregrinus anatum*	Yes	Yes	--	None. Tall cliffs (>150ft) are not prevalent within the Project Area. This species primarily breeds in the western half of the state.	Yes
Bald eagle	*Haliaeetus leucocephalus*	Yes	Yes	--	Moderate. Foraging and Roosting habitat occurs within the Project Area. This species is known to occur within the region.	**No**
Harlequin duck	*Histrionicus histrionicus*	Yes	--	--	None. This species is known to inhabit the northwestern quarter of the Wyoming.	Yes
White-tailed ptarmigan	*Lagopus leucura*	Yes	--	--	None. Alpine habitat is not present within the Project Area.	Yes
Loggerhead shrike	*Lanius ludovicianus*	Yes	Yes	--	Moderate. This species is known to breed within the western half of Wyoming.	**No**
Lewis's woodpecker	*Melanerpes lewis*	Yes	--	--	Moderate. This species may use riparian woodland habitats within the Project Area.	**No**
Long-billed curlew	*Numenius americanus*	Yes	Yes	--	Moderate. Grassland/Prairie habitat suitable for nesting exists within the Project Area.	**No**
Sage thrasher	*Oreoscoptes montanus*	--	Yes	--	Moderate. Sagebrush habitat is present within the Project Area.	**No**
Flammulated owl	*Otus flammeolus*	Yes	--	--	None. Mid-elevation montane forests are not present within the Project Area.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Black-backed woodpecker	*Picoides arcticus*	Yes	--	--	None. Old-growth montane forests do not exist within the Project Area.	Yes
White-faced ibis	*plegadis chichi*	--	Yes	--	Low. This species is found in the southern half of Wyoming with two breeding locations in the southwest and southeast quadrants of the state.	Yes
Purple martin	*Progne subis*	Yes	--	--	None. This species primarily breeds in south-central Wyoming in montane areas.	Yes
Brewer's sparrow	*Spizella breweri*	Yes	Yes	--	Moderate. This species is known to occur in eastern Wyoming where sagebrush habitat is present.	**No**
Least tern	*Sterna Antillarum*	--	--	Endangered	None. Project Area does not occur within the Platte River drainage system.	Yes
Greater prairie-chicken	*Tympanuchus cupido*	Yes	--	--	None. Greater prairie-chickens are absent from Wyoming.	Yes
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*	Yes	Yes	--	None. This species is only known to occur in Carbon County.	Yes
Whooping crane	*Grus americana*	--	--	Endangered	None. This species primarily migrates through the western half of the state.	Yes
Amphibians						
Boreal toad	*Anaxyrus boreas boreas*	Yes	Yes		None. This species is found in the western half of Wyoming	Yes
Wyoming toad	*Bufo baxteri*	--	--	Endangered	None. This species is only found at Mortenson Lake, Wyoming.	Yes
Plains leopard frog	*Lithobates blairi*	Yes	--	--	None. This species is not known to occur in Wyoming.	Yes
Columbia spotted frog	*Rana luteiventris*	Yes	Yes	--	None. This species occurs in the western and north-central parts of Wyoming.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Wood frog	*Lithobates sylvatica*	Yes	--	--	None. This species only occurs in the northern central part of Wyoming.	Yes
Northern leopard frog	*Rana pipiens*	Yes	Yes	--	Moderate. This species is known to occur in fishless ponds in most of Wyoming.	**No**
Great Basin spadefoot	*Spea intermontana*	--	Yes	--	None. This species only occurs west of the continental divide.	Yes
Reptiles						
Midget faded rattlesnake	*Crotalus viridis concolor*	--	Yes	--	None. This species occurs in the Green River valley.	Yes
Desert massasauga rattlesnake	*Sistrurus catenatus edwardii*	Yes	--	--	None. This species is not known to occur in Wyoming.	Yes
Black Hills red-bellied snake	*Storeria occipitomaculata pahasapae*	Yes	--	--	None. Species has only been observed in Crook County, Wyoming in the Black Hills.	Yes
Fishes						
Bluehead sucker	*Catostomus discobolus*	Yes	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Flannelmouth sucker	*Catostomus latipinnis*	Yes	--	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Mountain sucker	*Catostomus platyrhynchus*	Yes	--	--	High. This species is known to occur in the Cheyenne River system.	**No**
Rio Grande sucker	*Catostomus plebeius*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Lake chub	*Couesius plumbeus*	Yes	--	--	None. This species is known to occur in the Cheyenne River system; however it is only documented in the Belle-fourche River, which is not downstream of the Project area.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Plains Topminnow	*Fundulus sciadicus*	Yes	--	--	Moderate. An introduced population has been observed within the Cheyenne River System.	**No**
Humpback chub	*Gila cypha*	--	--	Endangered	None. This species is not known to occur in the Cheyenne River system.	Yes
Bonytail chub	*Gila elegans*	--	--	Endangered	None. This species is not known to occur in the Cheyenne River system.	Yes
Rio Grande chub	*Gila pandora*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Roundtail chub	*Gila robusta*	Yes	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Plains minnow	*Hybognathus placitus*	Yes	--	--	High. This species is known to occur in the Cheyenne River system.	**No**
Northern leatherside chub	*Lepidomeda copei*	--	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Sturgeon chub	*Macrhybopsis gelida*	Yes	--	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Pearl dace	*Margariscus margarita*	Yes	--	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Hornyhead chub	*Nocomis biguttatus*	Yes	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Fine-spotted Snake River cutthroat trout	*Oncorhynchus clarkii behnkei*	--	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*	Yes	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes

Common Name	Scientific Name	USFS Region 2 Sensitive Species	BLM Wyoming Sensitive Species	USFWS Designation	Potential to Occur within Project Area	Dismissed from Detailed Analysis?
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	Yes	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Bonneville cutthroat trout	*Oncorhynchus clarkii Utah*	--	Yes	--	None. This species is not known to occur in the Cheyenne River system.	Yes
Rio Grande cutthroat trout	*Oncorhynchus clarkii virginalis*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Northern redbelly dace	*Phoxinus eos*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Southern redbelly dace	*Phoxinus erythrogaster*	Yes	--	--	None. This species does not occur in Wyoming.	Yes
Finescale dace	*Phoxinus neogaeus*	Yes	--	--	None. Species is known to occur in the Cheyenne River system; however it is only documented in the Belle-fourche River, which is not downstream of the Project area.	Yes
Flathead chub	*Platygobio gracilis*	Yes	--	--	High. Species is known to occur in the Cheyenne River system.	**No**
Colorado pikeminnow	*Ptychocheilus lucius*	--	--	Endangered	None. Species is not known to occur in the Cheyenne River system.	Yes
Kendall warm springs dace	*Rhinichthys osculus thermalis*	--	--	Endangered	None. This species is only known to occur in Sublette County.	Yes
Pallid sturgeon	*Scaphirhynchus albus*	--	--	Endangered	None. Project area does not drain into the Platte River system	Yes
Razorback sucker	*Xyrauchen texanus*	--	--	Endangered	None. Species is not known to occur in the Cheyenne River system.	Yes

[1] U.S. Fish and Wildlife Service (USFWS). 2014. Federally Listed, Proposed and Candidate Species Webpage. United States Fish and Wildlife Service, Wyoming Ecological Services. Accessed December 15, 2014 at http://www.fws.gov/wyominges/pages/species/Species_Endangered.html.

[2] Bureau of Land Management (BLM). 2010. BLM Wyoming Sensitive Species Policy and List. Bureau of Land Management, Wyoming State Office. Accessed December 15, 2014 at http://www.blm.gov/style/medialib/blm/wy/resources/efoia/IMs/2010.Par.41285.File.dat/wy2010-027atch2.pdf.

[3] U.S. Forest Service (USFS). 2011. Forest Service Manual Rocky Mountain Region (Region 2), FSM 2600 – Wildlife, Fish, and Sensitive Plant Habitat Management. U.S. Forest Service, Region 2 Office. Supplement number 2600-2011-1.

[4] Wyoming Game and Fish Department (WGFD). 2010. State Wildlife Action Plan. Accessed December 23, at http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SWAP_2010_FULL_OCT0003090.pdf.

[5] Orabona, A., C. Rudd, M. Grenier, Z. Walker, S. Patla, and B. Oakleaf. 2012. Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming. Wyoming Game and Fish Department, Nongame Program, Biological Services Section. Accessed December 15, 2014 at http://www.fs.fed.us/r2/projects/scp/assessments/index.shtml.

APPENDIX D – AIR EMISSIONS INVENTORY FOR THE NO ACTION ALTERNATIVE

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Pollutant	Construction Emissions (tons/year) [a,b]					Construction Total (tons/year)	**Overall Total (tons/year)**
	Wind Erosion	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC							
NO_X	----	1.6	37.0	66.7	0.02	105.2	**156.8**
CO	----	0.5	20.3	34.1	0.02	54.9	**95.9**
VOC	----	0.1	2.3	3.9	0.003	6.3	**191.7**
SO_2	----	0.002	0.04	0.1	0.00004	0.1	**0.2**
PM_{10}	2.6	2.3	5.2	28.1	0.03	38.3	**71.2**
$PM_{2.5}$	0.4	0.5	1.8	6.3	0.01	8.9	**17.0**
Hazardous Air Pollutants							
Benzene	----	0.00071	0.020	0.034	0.000020	0.055	**1.23**
Toluene	----	----	0.0066	0.010	----	0.017	**3.96**
Ethylbenzene	----	----	----	----	----	----	**0.15**
Xylene	----	----	0.0045	0.0070	----	0.012	**3.06**
n-Hexane	----	----	----	----	----	----	**3.04**
Formaldehyde	----	0.0055	0.010	0.048	0.000054	0.063	**1.08**
Acetaldehyde	----	0.0025	0.0042	0.021	0.000027	0.028	**0.20**
Acrolein	----	0.00045	0.00081	0.0040	0.0000043	0.0052	**0.13**
Methanol	----	----	----	----	----	----	**0.13**
2,2,4-Trimethylpentane	----	----	----	----	----	----	**0.21**
Greenhouse Gases							
CO_2	----	179	3,996	7,164	5.3	11,343	**36,779**
CH_4	----	0.0021	0.16	0.26	0.000019	0.42	**26.8**
N_2O	----	0.00033	0.032	0.051	0.000011	0.083	**0.13**
CO_2e	----	179	4,009	7,185	5.3	11,379	**37,487**

a Assumes scenario of an average of 8 producing wells and 8 wells drilled.
b Emissions in summary tables may vary slightly due to rounding differences.

Pollutant	Operations Emissions (tons/year) [a,b]										Production Total (tons/year)
	Truck Loading	Workovers [c]	Generator Engines	Fugitive Emissions	Pneumatics	Combustors	Heaters	Storage Tanks	Dehydrators	Production Traffic	
Criteria Pollutants & VOC											
NO_X	----	----	11.6	----	----	11.9	11.3	----	----	16.8	51.6
CO	----	----	23.2	----	----	3.0	9.5	----	----	5.3	41.0
VOC	31.2	----	8.1	17.5	6.9	----	0.6	110.9	8.7	1.6	185.4
SO_2	----	----	0.03	----	----	----	0.1	----	----	0.02	0.1
PM_{10}	----	----	0.8	----	----	----	0.9	----	----	31.2	32.9
$PM_{2.5}$	----	----	0.8	----	----	----	0.9	----	----	6.4	8.1
Hazardous Air Pollutants											
Benzene	0.063	----	0.068	0.028	0.0074	----	0.00024	0.29	0.70	0.013	1.17
Toluene	0.20	----	0.024	0.052	0.022	----	0.00039	0.47	3.17	----	3.94
Ethylbenzene	0.016	----	0.0011	0.0018	0.00080	----	----	0.025	0.10	----	0.15
Xylene	0.11	----	0.0084	0.024	0.011	----	----	0.20	2.70	----	3.05
n-Hexane	0.65	----	----	0.37	0.18	----	0.20	1.58	0.054	----	3.04
Formaldehyde	----	----	0.9	----	----	----	0.0085	----	----	0.13	1.02
Acetaldehyde	----	----	0.12	----	----	----	----	----	----	0.056	0.18
Acrolein	----	----	0.11	----	----	----	----	----	----	0.010	0.12
Methanol	----	----	0.13	----	----	----	----	----	----	----	0.13
2,2,4-Trimethylpentane	0.08	----	----	----	----	----	----	0.13	----	----	0.21
Greenhouse Gases											
CO_2	0.19	----	5,054	0.72	0.33	9,945	8,608	45.88	26.21	1,756	25,436
CH_4	1.84	----	0.10	10.37	5.14	0.19	0.16	6.28	2.24	0.038	26.4
N_2O	----	----	0.010	----	----	0.019	0.016	----	----	0.0042	0.049
CO_2e	46	----	5,059	260	129	9,955	8,616	203	82	1,758	26,109

a Assumes scenario of an average of 8 producing wells and 8 wells drilled.
b Emissions in summary tables may vary slightly due to rounding differences.
c Workovers do not occur in Year 1 of the Project as workovers occur on average every 1.5 years on each well.

Road Construction Emissions - Equipment Fugitive Dust

Dozer, Backhoe Hours of Road Construction	4.0	days per road mile
	32.0	hours per road mile
Scraper, Grader Hours of Road Construction	4.0	days per road mile
	32.0	hours per road mile
Total road mileage	0.37	miles
	8	hours per day
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 (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

	Dozer Emissions		Backhoe Emissions	
	lbs/hr/mile	**tons/mile**	**lbs/hr/mile**	**tons/mile**
TSP	1.97	0.032	1.97	0.032
PM_{15}	0.50	0.0080	0.50	0.0080
PM_{10}	0.38	0.0060	0.38	0.0060
$PM_{2.5}$	0.21	0.0033	0.21	0.0033

Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance graded and scraped	1.9	miles graded/mile road
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 grading

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 Emissions			Scraper Emissions		
	lbs/mile	**lbs/hr/mile**	**tons/mile**	**lbs/mile**	**lbs/hr/mile**	**tons/mile**
TSP	4.97	0.16	0.002	4.97	0.16	0.002
PM_{15}	2.38	0.07	0.0012	2.38	0.07	0.0012
PM_{10}	1.43	0.04	0.0007	1.43	0.04	0.0007
$PM_{2.5}$	0.15	0.005	0.00008	0.15	0.005	0.00008

	PM_{10}		$PM_{2.5}$	
Emissions for total road mileage	0.0050	tons/year	0.0025	tons/year

Road Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Road Construction Paved Roads

Hours per day	8	hour/day
Days per mile of road constructed	4.0	days/road mile

Vehicle Type	Weight (lbs)	Round Trips per Road Mile
Trucks - Water [a,b]	50,000	0
Trucks - Semi [a]	56,000	193
Trucks - Fuel [a]	23,500	12
Pickup Trucks	8,000	7
Mean Vehicle Weight	52,575	---
Total Round Trips	---	212

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-road mile	ton/road mile
PM_{10}	0.039	0.037	27.24	0.41
$PM_{2.5}$	0.0095	0.0090	6.69	0.10

Road Construction Public Unpaved Roads

Hours per day	8	hour/day
Days per mile of road constructed	4.0	days/road mile

Vehicle Type	Weight (lbs)	Round Trips per Road Mile
Trucks - Water [a]	50,000	0
Trucks - Semi [a]	56,000	0
Trucks - Fuel [a]	23,500	0
Pickup Trucks	8,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-road mile	ton/road mile
PM_{10}	0.56	0.44	0.00	0.00
$PM_{2.5}$	0.056	0.044	0.00	0.00

Road Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Road Construction Industrial Unpaved Roads

Hours per day	8	hour/day
Days per mile of road constructed	4.0	days/road mile

Vehicle Type	Weight (lbs)	Round Trips per Road Mile
Trucks - Water [a]	50,000	30
Trucks - Semi [a]	56,000	193
Trucks - Fuel [a]	23,500	12
Pickup Trucks	8,000	7
Mean Vehicle Weight	52,256	---
Total Round Trips	---	242

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-road mile	ton/road mile
PM_{10}	0.92	0.72	20.86	0.26
$PM_{2.5}$	0.092	0.072	2.09	0.03

Total Road Construction Fugitive Dust Emissions (tons/year)

a Truck weight is average of full load and empty weight
assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area,
so there won't be any water trucks on paved roads coming into the Project Area

	Unpaved Total	Paved Total	Total
	ton/year	ton/year	ton/year
PM_{10}	0.10	0.15	0.25
$PM_{2.5}$	0.010	0.037	0.047

Total road mileage 0.37 miles

Road Construction Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	3	miles
Hours of Operation	32	hours per mile
Number of combo/trailer truck trips	193	trips/mile of road
Number of heavy haul truck trips	12	trips/mile of road
Number of heavy haul water trucks	30	trips/mile of road
Number of pickup trips	7	trips/mile of road
Total road mileage	0.37	miles

Equations:

$$\text{Emissions (tons/road mile)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/mile of road)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-road mile)	Emissions (tons/road mile)	E. Factor [e] (gram/mile)	Emissions (lb/hr-road mile)	Emissions (tons/road mile)	E. Factor [f] (gram/mile)	Emissions (lb/hr-road mile)	Emissions (tons/road mile)	Emissions (lb/hr-road mile)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	1.11	0.018	20.09	28.32	0.45	2.57	0.13	0.0021	29.56	0.18
CO	3.44	0.32	0.0052	4.53	6.39	0.102	11.57	0.59	0.0095	7.30	0.043
VOC	1.09	0.10	0.0016	0.79	1.11	0.018	0.78	0.040	0.00064	1.25	0.0074
SO_2	0.011	0.0010	0.000017	0.019	0.026	0.00042	0.0074	0.00038	0.0000060	0.028	0.00016
PM_{10}	0.71	0.07	0.00107	1.25	1.76	0.028	0.15	0.0077	0.00012	1.83	0.011
$PM_{2.5}$	0.51	0.05	0.00076	0.93	1.31	0.021	0.076	0.0039	0.000062	1.36	0.0081
Hazardous Air Pollutants											
Benzene	0.0086	0.0008	0.000013	0.0063	0.0089	0.00014	0.015	0.00077	0.000012	0.010	0.000062
Formaldehyde	0.088	0.008	0.00013	0.065	0.091	0.0015	0.041	0.0021	0.000033	0.10	0.00060
Acetaldehyde	0.039	0.004	0.000059	0.029	0.041	0.00065	0.021	0.00105	0.000017	0.045	0.00027
Acrolein	0.0073	0.0007	0.000011	0.0053	0.0075	0.00012	0.0033	0.00017	0.0000027	0.0083	0.000049
Greenhouse Gases											
CO_2	1,231.12	115.5	1.85	2,049.36	2,888	46.22	535.08	27.35	0.44	3,031	17.9
CH_4	0.026	0.0025	0.000040	0.025	0.036	0.00057	0.014	0.00074	0.000012	0.039	0.00023
N_2O	0.0027	0.00026	0.0000041	0.0027	0.0039	0.000062	0.0081	0.00041	0.0000066	0.0045	0.000027
CO_2e [g]	---	115.7	1.85	---	2,891	46.25	---	27.49	0.44	3,034	18.0

a Heavy Haul trucks include water and fuel trucks

b Combo/Trailer trucks include semi trucks

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Road Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Total road mileage	0.37	miles

Scraper Hours	32.0	hours per mile	Grader Hours	32.0	hours per mile
Scraper HP [a]	422.5		Grader HP [a]	231.2	
Load Factor [b]	0.43		Load Factor [b]	0.43	
Dozer Hours	32.0	hours per mile	Backhoe Hours	32.0	hours per mile
Dozer HP [a]	136.1		Backhoe HP [a]	137.6	
Load Factor [b]	0.43		Load Factor [b]	0.43	

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

Heavy Const. Vehicles	Scraper			Dozer			Grader		
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)
Criteria Pollutants & VOC									
NOx	2.27	0.91	0.015	1.70	0.22	0.0035	1.52	0.33	0.0053
CO	0.91	0.36	0.0058	0.74	0.095	0.0015	0.51	0.11	0.0018
VOC [d]	0.17	0.069	0.0011	0.18	0.023	0.00038	0.17	0.037	0.00059
PM_{10}	0.13	0.052	0.00083	0.18	0.023	0.00036	0.096	0.021	0.00034
$PM_{2.5}$	0.13	0.050	0.00081	0.17	0.022	0.00035	0.093	0.020	0.00033
SO_2	0.0031	0.0013	0.000020	0.0030	0.00039	0.0000063	0.0029	0.00064	0.000010
Greenhouse Gases									
CO_2	536.3	214.80	3.44	536.3	69.19	1.11	536.3	117.55	1.88
CO_2e [e]	---	214.80	3.44	---	69.19	1.11	---	117.55	1.88

Heavy Const. Vehicles	Backhoe			Total	
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)	Emissions (lb/hr/mile)	Emissions (tons/year)
Criteria Pollutants & VOC					
NOx	1.49	0.19	0.0031	1.66	0.010
CO	0.65	0.085	0.0014	0.66	0.0039
VOC [d]	0.17	0.022	0.00036	0.15	0.00090
PM_{10}	0.15	0.020	0.00032	0.12	0.00068
$PM_{2.5}$	0.15	0.019	0.00031	0.11	0.00066
SO_2	0.0030	0.00039	0.0000062	0.0027	0.000016
Greenhouse Gases					
CO_2	536.3	69.96	1.12	471.5	2.79
CO_2e [e]	---	69.96	1.12	471.5	2.79

a Load factors from Table 9 of "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling", EPA-420-R-10-016, July 2010. Load factor as 7-cycle average.

b Horsepower from base year 2000 population counts from EPA-420-R-10-017, July 2010.

c Emission factors developed using NONROAD model, assuming Diesel Construction Equipment in Converse and Campbell County for calendar year 2016.

d Emission Factor represents total Hydrocarbon Emissions multiplied by the VOC factor of 1.053 referenced from EPA-420-R-10-015, July 2010.

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

Pad Construction Emissions - Equipment Fugitive Dust

Total acreage for all new and expanded well pads	18.81	acres
Total acreage for all facility pads	0.00	acres
Total acreage for all frac pads	0.00	acres
Dozer, Backhoe Hours of Well Pad Construction	0.31	days per acre
	2.5	hours per acre
Scraper, Grader Hours of Well Pad Construction	0.77	days per acre
	6.2	hours per acre
	8	hours per day
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 (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

	Dozer Emissions		Backhoe Emissions	
	lbs/hr	**tons/acre**	**lbs/hr**	**tons/acre**
TSP	1.97	0.0024	1.97	0.0024
PM_{15}	0.50	0.00062	0.50	0.00062
PM_{10}	0.38	0.00046	0.38	0.00046
$PM_{2.5}$	0.21	0.00025	0.21	0.00025

Distance graded and scraped	0.61	miles/acre
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 grading

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 Emissions			Scraper Emissions		
	lbs/acre	**lbs/hr/acre**	**tons/acre**	**lbs/acre**	**lbs/hr/acre**	**tons/acre**
TSP	1.63	0.26	0.00081	1.63	0.26	0.00081
PM_{15}	0.78	0.13	0.00039	0.78	0.13	0.00039
PM_{10}	0.47	0.076	0.00023	0.47	0.076	0.00023
$PM_{2.5}$	0.050	0.0082	0.000025	0.050	0.0082	0.000025

	PM_{10}		$PM_{2.5}$	
Total for all Well Pads	0.026	tons/yr	0.011	tons/yr

Pad Construction Traffic Fugitive Dust Emissions

Industrial Unpaved
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	3	miles
Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
W = average weight in tons of vehicles traveling the road		
Control efficiency for water on unpaved roads		50 %

Public Road Unpaved
AP-42 Chapter 13.2.2, November 2006

$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$ Annual

$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$ Annual

$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$ Daily

$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$ Daily

Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
Average Speed (S)	30	mph
Round Trip Miles	0	miles
Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
Control efficiency for water on unpaved roads		0 %

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 13.2.1-2 baseline low volume roads
Round Trip Miles	106	miles
Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
W = average weight in tons of vehicles traveling the road		

Pad Construction Paved Roads

Hours per day	8	hour/day
Days per acre	0.9	days/acre
Total acreage for all pads	18.8	acres

Vehicle Type	Weight (lbs)	Round Trips per Acre
Trucks - Water [a,b]	50,000	0
Trucks - Semi [a]	56,000	27
Trucks - Fuel [a]	23,500	2
Pickup Trucks	8,000	7
Scraper	88,000	0
Grader	45,000	0
Backhoe	24,000	0
Dozer	30,000	0
Mean Vehicle Weight	44,861	---
Total Round Trips	---	36

	Emission Factor		Paved Road Emisions	
	Daily lb/VMT	Annual lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.033	0.031	17.54	0.059
$PM_{2.5}$	0.0081	0.0077	4.30	0.015

Pad Construction Public Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.9	days/acre
Total acreage for all pads	18.8	acres

Vehicle Type	Weight (lbs)	Round Trips per Acre
Trucks - Water [a]	50,000	0
Trucks - Semi [a]	56,000	0
Trucks - Fuel [a]	23,500	0
Pickup Trucks	8,000	0
Scraper	88,000	0
Grader	45,000	0
Backhoe	24,000	0
Dozer	30,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily lb/VMT	Annual lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.56	0.44	0.00	0.00
$PM_{2.5}$	0.056	0.044	0.00	0.00

Pad Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Pad Construction Industrial Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.9	days/acre
Total acreage for all pads	18.8	acres

Vehicle Type	Weight (lbs)	Round Trips per Acre
Trucks - Water [a]	50,000	4
Trucks - Semi [a]	56,000	27
Trucks - Fuel [a]	23,500	2
Pickup Trucks	8,000	7
Scraper	88,000	1
Grader	45,000	1
Backhoe	24,000	1
Dozer	30,000	1
Mean Vehicle Weight	45,500	---
Total Round Trips	---	44

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.86	0.67	15.89	0.04
$PM_{2.5}$	0.086	0.067	1.59	0.004

Total Well Pad Construction Fugitive Dust Emissions (tons/year)

	Unpaved Total	Paved Total	Total
	ton/year	ton/year	ton/year
PM_{10}	0.84	1.12	1.96
$PM_{2.5}$	0.08	0.27	0.36

a Truck weight is average of full load and empty weight
assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area,
so there won't be any water trucks on paved roads coming into the Project Area

Pad Construction Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	3	miles
Hours of Operation	7.2	hours per acre
Number of combo/trailer truck trips	27	trips/acre
Number of heavy haul truck trips	2	trips/acre Number
of heavy haul water trucks	4	trips/acre
Number of pickup trips	7	trips/acre
Total acreage for all pads	18.8	acres

Equations:

$$\text{Emissions (tons/pad)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/pad)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-acre)	Emissions (tons/acre)	E. Factor [e] (gram/mile)	Emissions (lb/hr-acre)	Emissions (tons/acre)	E. Factor [f] (gram/mile)	Emissions (lb/hr-acre)	Emissions (tons/acre)	Emissions (lb/hr-acre)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.81	0.0029	20.09	17.66	0.063	2.57	0.58	0.0021	19.06	1.29
CO	3.44	0.24	0.00085	4.53	3.98	0.014	11.57	2.64	0.0095	6.86	0.46
VOC	1.09	0.075	0.00027	0.79	0.69	0.0025	0.78	0.18	0.00064	0.95	0.064
SO_2	0.011	0.00077	0.0000028	0.019	0.016	0.000058	0.0074	0.0017	0.0000060	0.019	0.0013
PM_{10}	0.71	0.049	0.00018	1.25	1.09	0.0039	0.15	0.034	0.00012	1.18	0.08
$PM_{2.5}$	0.51	0.035	0.00013	0.93	0.82	0.0029	0.076	0.017	0.000062	0.87	0.059
Hazardous Air Pollutants											
Benzene	0.0086	0.00059	0.0000021	0.0063	0.0055	0.000020	0.015	0.0034	0.000012	0.0096	0.00065
Formaldehyde	0.088	0.0061	0.000022	0.065	0.057	0.00020	0.041	0.0093	0.000033	0.072	0.0049
Acetaldehyde	0.039	0.0027	0.000010	0.029	0.025	0.000091	0.021	0.0047	0.000017	0.033	0.0022
Acrolein	0.0073	0.00050	0.0000018	0.0053	0.0047	0.000017	0.0033	0.00074	0.0000027	0.0059	0.00040
Greenhouse Gases											
CO_2	1,231.1	84.7	0.30	2,049.4	1,801	6.5	535.08	121.92	0.44	2,008	136
CH_4	0.026	0.0018	0.0000065	0.025	0.022	0.000080	0.014	0.0033	0.000012	0.027	0.0018
N_2O	0.0027	0.00019	0.00000068	0.0027	0.0024	0.0000086	0.0081	0.0018	0.0000066	0.0044	0.00030
CO_2e [g]	---	84.8	0.30	---	1,802	6.47	---	122.55	0.44	2,010	136

a Heavy Haul trucks include water and fuel trucks

b Combo/Trailer trucks include semi trucks

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Pad Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Total acreage for all pads 18.8 acres

Scraper Hours	6.2	hours per acre	Grader Hours	6.2	hours per acre
Scraper HP [a]	422.5		Grader HP [a]	231.2	
Load Factor [b]	0.43		Load Factor [b]	0.43	
Dozer Hours	2.5	hours per acre	Backhoe Hours	2.5	hours per acre
Dozer HP [a]	136.1		Backhoe HP [a]	137.6	
Load Factor [b]	0.43		Load Factor [b]	0.43	

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

Heavy Const. Vehicles	Scraper			Dozer			Grader		
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)
Criteria Pollutants & VOC									
NOx	2.27	0.91	0.0028	1.70	0.22	0.00027	1.52	0.33	0.0010
CO	0.91	0.36	0.0011	0.74	0.095	0.00012	0.51	0.11	0.00034
VOC [d]	0.17	0.069	0.00021	0.18	0.023	0.000029	0.17	0.037	0.00011
PM_{10}	0.13	0.052	0.00016	0.18	0.023	0.000028	0.096	0.021	0.000064
$PM_{2.5}$	0.13	0.050	0.00016	0.17	0.022	0.000027	0.093	0.020	0.000063
SO_2	0.0031	0.0013	0.0000039	0.0030	0.00039	0.00000048	0.0029	0.00064	0.0000020
Greenhouse Gases									
CO_2	536.3	214.8	0.66	536.3	69.2	0.085	536.3	117.5	0.36
CO_2e [e]	---	214.8	0.66	---	69.2	0.085	---	117.5	0.36

Heavy Const. Vehicles	Backhoe			Total	
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	Emissions (lb/hr/acre)	Emissions (tons/year)
Criteria Pollutants & VOC					
NOx	1.49	0.19	0.00024	1.66	0.08
CO	0.65	0.085	0.00010	0.66	0.032
VOC [d]	0.17	0.022	0.000027	0.15	0.0072
PM_{10}	0.15	0.020	0.000025	0.12	0.0052
$PM_{2.5}$	0.15	0.019	0.000024	0.11	0.0051
SO_2	0.0030	0.00039	0.00000048	0.0027	0.00013
Greenhouse Gases					
CO_2	536.3	70.0	0.086	471.5	22.5
CO_2e [e]	---	70.0	0.086	471.5	22.5

a Load factors from Table 9 of "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling", EPA-420-R-10-016, July 2010. Load factor as 7-cycle average.

b Horsepower from base year 2000 population counts from EPA-420-R-10-017, July 2010.

c Emission factors developed using NONROAD model, assuming Diesel Construction Equipment in Converse and Campbell County for calendar year 2016.

d Emission Factor represents total Hydrocarbon Emissions multiplied by the VOC factor of 1.053 referenced from EPA-420-R-10-015, July 2010.

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

Interim Reclamation Emissions - Equipment Fugitive Dust

Dozer Hours of Interim Reclamation	0.50	days per acre
	4.00	hours per acre
Scraper, Grader Hours of Interim Reclamation	0.83	days per acre
	6.67	hours per acre
Total acres reclaimed	3.70	acres
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 (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

	Dozer Emissions	
	lbs/hr	**tons/acre**
TSP	1.97	0.0039
PM_{15}	0.50	0.0010
PM_{10}	0.38	0.00075
$PM_{2.5}$	0.21	0.00041

Distance graded and scraped	0.60	miles/acre
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 grading

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 Emissions			Scraper Emissions		
	lbs/acre	**lbs/hr/acre**	**tons/acre**	**lbs/acre**	**lbs/hr/acre**	**tons/acre**
TSP	1.60	0.24	0.00080	1.60	0.24	0.00080
PM_{15}	0.77	0.12	0.00038	0.77	0.12	0.00038
PM_{10}	0.46	0.069	0.00023	0.46	0.069	0.00023
$PM_{2.5}$	0.050	0.0075	0.000025	0.050	0.0075	0.000025

	PM_{10}		$PM_{2.5}$	
Total for all reclaimed acres	0.0045	tons/year	0.0017	tons/year

Interim Reclamation Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$	Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$	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	3	miles
Precipitation Days (P)	80	days per year (Douglas Converse Airport data)

W = average weight in tons of vehicles traveling the road
Control efficiency for water on unpaved roads 50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$	Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$	Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$	Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$	Daily

Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
Average Speed (S)	30	mph
Round Trip Miles	0	miles
Precipitation Days (P)	80	days per year (Douglas Converse Airport data)

Control efficiency for water on unpaved roads 0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$	Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$	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 13.2.1-2 baseline low volume roads
Round Trip Miles	106	miles
Precipitation Days (P)	80	days per year (Douglas Converse Airport data)

W = average weight in tons of vehicles traveling the road

Interim Reclamation Paved Roads

Hours per day	8	hour/day
Days per acre	0.83	days/acre
Total reclaimed acreage	3.70	acres

Vehicle Type	Weight (lbs)	Round Trips per acre
Trucks - Water [a,b]	50,000	0
Pickup Trucks	8,000	3
Scraper	88,000	0
Grader	45,000	0
Dozer	30,000	0
Mean Vehicle Weight	8,000	---
Total Round Trips	---	3

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.0057	0.0054	0.27	0.00085
$PM_{2.5}$	0.0014	0.0013	0.067	0.00021

Interim Reclamation Public Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.83	days/acre

Vehicle Type	Weight (lbs)	Round Trips per acre
Trucks - Water [a]	50,000	0
Pickup Trucks	8,000	0
Scraper	88,000	0
Grader	45,000	0
Dozer	30,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.56	0.44	0.0	0.00
$PM_{2.5}$	0.056	0.044	0.0	0.00

Interim Reclamation Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %
Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %
Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Interim Reclamation Industrial Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.83	days/acre

Vehicle Type	Weight (lbs)	Round Trips per acre
Trucks - Water [a]	50,000	1
Pickup Trucks	8,000	3
Scraper	88,000	1
Grader	45,000	1
Dozer	30,000	1
Mean Vehicle Weight	33,857	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.76	0.59	2.38	0.006
$PM_{2.5}$	0.076	0.059	0.24	0.0006

Total Interim Reclamation Fugitive Dust Emissions (tons/year)

	Unpaved Total ton/year	Paved Total ton/year	Total ton/year
PM_{10}	0.023	0.0032	0.026
$PM_{2.5}$	0.0023	0.00078	0.0031

a Truck weight is average of full load and empty weight
assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area,
so there won't be any water trucks on paved roads coming into the Project Area

Interim Reclamation Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	3	miles
Hours of Operation	0.83	days per acre
Number of combo/trailer truck trips	0	trips/acre
Number of heavy haul water truck trips	1	trips/acre
Number of pickup trips	3	trips/acre
Total reclaimed acreage	3.70	acres

Equations:

$$\text{Emissions (tons/acre)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/acre)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/day-acre)	Emissions (tons/acre)	E. Factor [e] (gram/mile)	Emissions (lb/day-acre)	Emissions (tons/acre)	E. Factor [f] (gram/mile)	Emissions (lb/day-acre)	Emissions (tons/acre)	Emissions (lb/day-acre)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.09	0.000039	20.09	0.0	0.0	2.57	2.16	0.00090	2.25	0.0035
CO	3.44	0.027	0.000011	4.53	0.0	0.0	11.57	9.74	0.0041	9.77	0.015
VOC	1.09	0.009	0.0000036	0.79	0.0	0.0	0.78	0.66	0.00027	0.67	0.0010
SO_2	0.011	0.00009	0.00000004	0.019	0.0	0.0	0.0074	0.0062	0.0000026	0.0063	0.000010
PM_{10}	0.71	0.0056	0.0000023	1.25	0.0	0.0	0.15	0.13	0.000053	0.13	0.00020
$PM_{2.5}$	0.51	0.0040	0.0000017	0.93	0.0	0.0	0.076	0.064	0.000027	0.068	0.00011
Hazardous Air Pollutants											
Benzene	0.0086	0.00007	0.00000003	0.0063	0.0	0.0	0.015	0.013	0.0000053	0.013	0.000020
Formaldehyde	0.088	0.0007	0.00000029	0.065	0.0	0.0	0.041	0.034	0.000014	0.035	0.000054
Acetaldehyde	0.039	0.00031	0.00000013	0.029	0.0	0.0	0.021	0.017	0.0000072	0.018	0.000027
Acrolein	0.0073	0.00006	0.00000002	0.0053	0.0	0.0	0.0033	0.0027	0.0000011	0.0028	0.0000043
Greenhouse Gases											
CO_2	1,231.12	9.8	0.00	2,049.36	0.0	0.0	535.08	450.2	0.19	459.9	0.71
CH_4	0.026	0.00021	0.00000009	0.025	0.0	0.0	0.014	0.012	0.0000051	0.012	0.000019
N_2O	0.0027	0.000022	0.00000001	0.0027	0.0	0.0	0.0081	0.0068	0.0000028	0.0068	0.000011
CO_2e [g]	---	9.8	0.00	---	0.0	0.0	---	452.5	0.19	462.3	0.71

a Heavy Haul trucks include water trucks

b No Combo/Trailer trucks used in interim reclamation

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Interim Reclamation Heavy Equipment Tailpipe Emissions

Assumptions:

Total reclaimed acreage	3.70	acres

Scraper Hours	6.67	hours per acre	Grader Hours	6.67	hours per acre
Scraper HP [a]	422.5		Scraper HP [a]	231.2	
Load Factor [b]	0.43		Load Factor [b]	0.43	
Dozer Hours	4.00	hours per acre	Backhoe Hours	0.0	hours per acre
Scraper HP [a]	136.1		Scraper HP [a]	137.6	
Load Factor [b]	0.43		Load Factor [b]	0.43	

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

Heavy Const. Vehicles	Scraper			Dozer			Grader		
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)
Criteria Pollutants & VOC									
NOx	2.27	0.91	0.0030	1.70	0.22	0.00044	1.52	0.33	0.0011
CO	0.91	0.36	0.0012	0.74	0.095	0.00019	0.51	0.11	0.00037
VOC [d]	0.17	0.069	0.00023	0.18	0.023	0.000047	0.17	0.037	0.00012
PM_{10}	0.13	0.052	0.00017	0.18	0.023	0.000045	0.10	0.021	0.000070
$PM_{2.5}$	0.13	0.050	0.00017	0.17	0.022	0.000044	0.093	0.020	0.000068
SO_2	0.0031	0.0013	0.0000042	0.0030	0.00039	0.0000008	0.0029	0.00064	0.0000021
Greenhouse Gases									
CO_2	536.3	214.80	0.72	536.3	69.19	0.14	536.3	117.55	0.39
CO_2e [e]	---	214.80	0.72	---	69.19	0.14	---	117.55	0.39

Heavy Const. Vehicles	Backhoe			Total	
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	Emissions (lb/hr/acre)	Emissions (tons/year)
Criteria Pollutants & VOC					
NOx	1.49	0.0	0.0	1.46	0.017
CO	0.65	0.0	0.0	0.57	0.0066
VOC [d]	0.17	0.0	0.0	0.13	0.0015
PM_{10}	0.15	0.0	0.0	0.096	0.0011
$PM_{2.5}$	0.15	0.0	0.0	0.093	0.0010
SO_2	0.0030	0.0	0.0	0.0023	0.000026
Greenhouse Gases					
CO_2	536.3	0.0	0.0	401.54	4.61
CO_2e [e]	---	0.0	0.0	401.54	4.61

a Load factors from Table 9 of "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling", EPA-420-R-10-016, July 2010. Load factor as 7-cycle average.
b Horsepower from base year 2000 population counts from EPA-420-R-10-017, July 2010.

c Emission factors developed using NONROAD model, assuming Diesel Construction Equipment in Converse and Campbell County for calendar year 2016.
d Emission Factor represents total Hydrocarbon Emissions multiplied by the VOC factor of 1.053 referenced from EPA-420-R-10-015, July 2010.
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Wind Erosion Fugitive Dust Emissions - Construction

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for 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)
Disturbance Area	2.7	acres short term disturbance for roads
	10,846	square meters disturbance for roads
	18.8	acres short term disturbance for pads
	76,105	square meters disturbance for pads
Number of days above threshold	13.7	Number of days per year 2 minute wind is >= 40 mph (disturbances/year)
Meteorological Data	July 1999 - Dec 2008 Douglas Converse County Airport, WY	
Fastest Mile Wind Speed ($U_{10}^{+)}$	23.7	meters/sec (53 mph) reported as average 2-minute wind speed for Douglas Airport, WY
Control for Watering	50	% control

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	Pad U_t^* Threshold Velocity m/s	Pad Erosion Potential g/m^2	Road U_t^* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
23.70	1.26	1.02	9.14	1.33	0.00

Wind Erosion Emissions

Particulate Species	Pads (tons/year)	Roads (tons/year)
PM_{10}	2.62	0.00
$PM_{2.5}$	0.39	0.00

Drilling Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %
Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %
Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Drilling Traffic Dust Emissions

Hours per day	24	hour/day
Days per well	13.5	days/well (average)
Number of wells drilled	8	wells/year

Vehicle Type	Weight (lbs)	Round Trips per Well
Semi Trucks - Mud [a]	56,000	18
Water Trucks-unpaved[a,b]	50,000	20
Water Trucks-paved[a,b]	50,000	0
Semi Trucks - Casing [a]	56,000	12
Semi Trucks - Cement [a]	56,000	8
Septic Trucks [a]	31,000	6
Fuel Trucks [a]	23,500	4
Semis-cuttings, etc Trucks [a]	56,000	27
Pickup Trucks	8,000	70
Mean Vehicle Weight-paved	30,897	---
Mean Vehicle Weight-unpaved	33,212	---
Total Round Trips-paved	---	145
Total Round Trips-unpaved	---	165

	Emission Factor		Emissions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-well	ton/well
Paved Road PM_{10}	0.023	0.021	1.07	0.16
Paved Road $PM_{2.5}$	0.0055	0.0052	0.26	0.040
Unpaved Public Road PM_{10}	0.56	0.44	0.00	0.00
Unpaved Public Road $PM_{2.5}$	0.056	0.044	0.00	0.00
Unpaved Industrial PM_{10}	0.75	0.59	1.15	0.14
Unpaved Industrial $PM_{2.5}$	0.075	0.059	0.11	0.014

	PM_{10}		$PM_{2.5}$	
Total per well	0.31	tons/well	0.055	tons/well
Total all wells	2.47	tons/year	0.44	tons/year

a Truck weight is average of full load and empty weight assuming it will be full on one leg and empty of the other leg of the round trip

b Water will come from the water wells internal to the Project Area, so there won't be any water trucks on paved roads coming into the Project Area
Additionally, 50% of the water needed in drilling will be piped through temporary surface pipes and not trucked.

Drilling Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	3	miles
Hours of Operation	324	hours per well (average)
Number of combo/trailer truck trips	65	trips/well
Number of heavy haul truck trips	10	trips/well
Number of heavy haul water trucks	20	trips/well
Number of pickup trips	70	trips/well
Number of wells	8	wells/year

Equations:

$$\text{Emissions (tons/well)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d]	Emissions	Emissions	E. Factor [e]	Emissions	Emissions	E. Factor [f]	Emissions	Emissions	Emissions	Emissions
	(gram/mile)	(lb/hr-well)	(tons/well)	(gram/mile)	(lb/hr-well)	(tons/well)	(gram/mile)	(lb/hr-well)	(tons/well)	(lb/hr-well)	(tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.090	0.015	20.09	0.94	0.15	2.57	0.13	0.021	1.16	1.51
CO	3.44	0.026	0.0042	4.53	0.21	0.034	11.57	0.58	0.09	0.82	1.07
VOC	1.09	0.0083	0.0013	0.79	0.037	0.0060	0.78	0.040	0.0064	0.085	0.11
SO_2	0.011	0.000085	0.000014	0.019	0.00087	0.00014	0.0074	0.00037	0.000060	0.0013	0.0017
PM_{10}	0.71	0.0054	0.00088	1.25	0.058	0.009	0.15	0.0076	0.0012	0.071	0.093
$PM_{2.5}$	0.51	0.0039	0.00063	0.93	0.044	0.0071	0.076	0.0039	0.00062	0.051	0.067
Hazardous Air Pollutants											
Benzene	0.0086	0.000066	0.000011	0.0063	0.00030	0.000048	0.015	0.00076	0.00012	0.0011	0.0015
Formaldehyde	0.088	0.00067	0.00011	0.065	0.0030	0.00049	0.041	0.0021	0.00033	0.0058	0.0075
Acetaldehyde	0.039	0.00030	0.000049	0.029	0.0014	0.00022	0.021	0.0010	0.00017	0.0027	0.0035
Acrolein	0.0073	0.000055	0.0000090	0.0053	0.00025	0.000040	0.0033	0.00016	0.000027	0.00047	0.00061
Greenhouse Gases											
CO_2	1,231.12	9.38	1.52	2,049.36	96.1	15.56	535.08	27.02	4.38	132.5	172
CH_4	0.026	0.00020	0.000033	0.025	0.0012	0.00019	0.014	0.00073	0.00012	0.0021	0.0027
N_2O	0.0027	0.000021	0.0000034	0.0027	0.00013	0.000021	0.0081	0.00041	0.000066	0.00056	0.00072
CO_2e [g]	---	9.4	1.52	---	96.1	15.58	---	27.16	4.40	132.7	172

a Heavy Haul trucks include septic, fuel, and water trucks

b Combo/Trailer trucks include sand trucks, cement, casing, etc

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Drill Rig Engines

Oil Well Drilling Hours of Operation	180	hours/well
Gas Well Drilling Hours of Operation	420	hours/well
Load Factor	0.43	
Drill Rig Engines Total Power	6,000	hp
Total oil wells drilled	3	oil wells
Total gas wells drilled	5	gas wells
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value for ULSD)

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

Equations:

Emission Factor (g/hp-hr) = Emission factor (lb/MMBtu) * 7000 (Btu/hp-hr) * 453.59 (g/hp-hr) / 10^6 (Btu/MMBtu)
7000 Btu/hp-hr from AP-42 Table 3.3-1 Footnote a

$$\text{Emissions (ton/well)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * \text{Load Factor} * \text{Hours per well (hr/well)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/ton)}}$$

	Drill Rig Emissions					
Species	**E. Factor (lb/hp-hr)**	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Oil Well Emissions (tons/well)**	**Gas Well Emissions (tons/well)**	**Total Emissions (tons/year)**
Criteria Pollutants & VOC						
NOx [a]	-----	4.80	27.30	2.46	5.73	35.38
CO [a]	-----	2.60	14.79	1.33	3.11	19.17
VOC [b]	0.00064	0.29	1.66	0.15	0.35	2.15
PM_{10} [a]	-----	0.15	0.85	0.077	0.18	1.11
$PM_{2.5}$ [a]	-----	0.15	0.85	0.077	0.18	1.11
SO_2 [b]	0.000012	0.0055	0.031	0.0028	0.0066	0.041
	E. Factor (lb/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Oil Well Emissions (tons/well)**	**Gas Well Emissions (tons/well)**	**Total Emissions (tons/year)**
Hazardous Air Pollutants						
Benzene [c]	7.76E-04	0.0025	0.014	0.0013	0.0029	0.018
Toluene [c]	2.81E-04	0.00089	0.0051	0.00046	0.0011	0.0066
Xylenes [c]	1.93E-04	0.00061	0.0035	0.00031	0.00073	0.0045
Formaldehyde [c]	7.89E-05	0.00025	0.0014	0.00013	0.00030	0.0018
Acetaldehyde [c]	2.52E-05	0.000080	0.00046	0.000041	0.00010	0.00059
Acrolein [c]	7.88E-06	0.000025	0.00014	0.000013	0.000030	0.00018
	E. Factor (kg/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Oil Well Emissions (tons/well)**	**Gas Well Emissions (tons/well)**	**Total Emissions (tons/year)**
Greenhouse Gases						
CO_2 [d]	73.96	517.7	2,944.8	265.03	618.40	3,816
CH_4 [d]	0.0030	0.021	0.12	0.011	0.025	0.15
N_2O [d]	0.00060	0.0042	0.024	0.0022	0.0050	0.031
CO_2e [e]	---	---	2,955	265.94	620.52	3,830

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, and PM)
NOx is conservatively assumed to be NOx + NMHC

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

c AP-42, Large Stationary Diesel Engines, Table 3.4-3

d 40 CFR Part 98 Subpart W indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an emission factor for diesel combustion of CO_2 and Table C-2 provides emission factors for diesel combustion of CH4 and N2O.

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

Drill Rig Move Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Drill Rig Move Paved Roads

Wells per Rig Move 2

Vehicle Type	Weight (lbs)	Round Trips per Move [b]
Pickup Trucks	8,000	0
Semi Trucks	80,000	0
Drill Rig Cranes	80,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-move	ton/move
PM_{10}	0.000	0.000	----	0.0
$PM_{2.5}$	0.0000	0.0000	----	0.0

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Drill Rig Move Public Unpaved Roads

Wells per Rig Move 2

Vehicle Type	Weight (lbs)	Round Trips per Move
Pickup Trucks	8,000	0
Semi Trucks	80,000	0
Drill Rig Cranes	80,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-move	ton/move
PM_{10}	0.56	0.44	----	0.0
$PM_{2.5}$	0.056	0.044	----	0.0

Drill Rig Move Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Drill Rig Move Industrial Unpaved Roads

Wells per Rig Move 2

Vehicle Type	Weight (lbs)	Round Trips per Move
Pickup Trucks	8,000	10
Semi Trucks	80,000	280
Drill Rig Cranes	80,000	1.5
Mean Vehicle Weight	77,530	---
Total Round Trips	---	292

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-move	ton/move
PM_{10}	1.10	0.86	----	0.37
$PM_{2.5}$	0.110	0.086	----	0.037

Total Drill Rig Move Fugitive Dust Emissions (tons/year)

a Rig moves are done within the project area, so no paved road travel

Total rig moves 4

	Unpaved Total ton/year	Paved Total ton/year	Total ton/year
PM_{10}	0.37	0.0	1.50
$PM_{2.5}$	0.037	0.0	0.15

Drill Rig Vehicle Tailpipe

Average Round Trip Distance	3	miles
Number of combo/trailer truck trips	282	trips/rig move
Number of heavy haul truck trips	0	trips/rig move
Number of pickup trips	10	trips/rig move
Total rig moves	4	

Equations:

$$\text{Emissions (tons/well)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-move)	Emissions (tons/move)	E. Factor [e] (gram/mile)	Emissions (lb/hr-move)	Emissions (tons/move)	E. Factor [f] (gram/mile)	Emissions (lb/hr-move)	Emissions (tons/move)	Emissions (lb/hr-move)	Emissions (tons/move)
Criteria Pollutants & VOC											
NOx	11.84	----	0.0	20.09	----	0.019	2.57	----	0.00008	----	0.08
CO	3.44	----	0.0	4.53	----	0.0042	11.57	----	0.00038	----	0.018
VOC	1.09	----	0.0	0.79	----	0.0007	0.78	----	0.000026	----	0.0030
SO_2	0.011	----	0.0	0.019	----	0.000017	0.0074	----	0.00000024	----	0.00007
PM_{10}	0.71	----	0.0	1.25	----	0.0012	0.15	----	0.0000050	----	0.005
$PM_{2.5}$	0.51	----	0.0	0.93	----	0.0009	0.076	----	0.0000025	----	0.0035
Hazardous Air Pollutants											
Benzene	0.0086	----	0.0	0.0063	----	0.000006	0.015	----	0.00000050	----	0.000025
Formaldehyde	0.088	----	0.0	0.065	----	0.00006	0.041	----	0.0000014	----	0.00025
Acetaldehyde	0.039	----	0.0	0.029	----	0.000027	0.021	----	0.0000007	----	0.00011
Acrolein	0.0073	----	0.0	0.0053	----	0.0000049	0.0033	----	0.0000001	----	0.000020
Greenhouse Gases											
CO_2	1,231.12	----	0.0	2049.36	----	1.91	535.08	----	0.018	----	7.7
CH_4	0.026	----	0.0	0.025	----	0.000024	0.014	----	0.00000048	----	0.00010
N_2O	0.0027	----	0.0	0.0027	----	0.0000025	0.0081	----	0.00000027	----	0.000011
CO_2e [g]	---	----	0.0	---	----	1.91	---	----	0.018	----	7.7

a No heavy haul trucks for drill rig moves

b Combo/Trailer trucks include semi trucks and cranes

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Completion Traffic Fugitive Dust Emissions

Industrial Unpaved	$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$		Annual
	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Completion Traffic Dust Emissions

Hours per day	24	hour/day
Days per well	17	days/well
Number of wells	8	wells/year

Vehicle Type	Weight (lbs)	Round Trips per Well
Semi Trucks - Sand [a]	56,000	561
Water Trucks-unpaved[a,b]	50,000	1,122
Water Trucks-paved[a,b]	50,000	0
Haul Trucks [a]	50,000	34
Pickup Trucks	8,000	153
Mean Vehicle Weight-paved	45,909	---
Mean Vehicle Weight-unpaved	48,364	---
Total Round Trips-paved	---	748
Total Round Trips-unpaved	---	1870

	Emission Factor		Emissions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-well	ton/well
Paved Road PM_{10}	0.034	0.032	6.56	1.27
Paved Road $PM_{2.5}$	0.0083	0.0078	1.61	0.31
Unpaved Public Road PM_{10}	0.56	0.44	0.00	0.00
Unpaved Public Road $PM_{2.5}$	0.056	0.044	0.00	0.00
Unpaved Industrial PM_{10}	0.89	0.69	12.21	1.94
Unpaved Industrial $PM_{2.5}$	0.089	0.069	1.22	0.19

	PM_{10}		$PM_{2.5}$	
Total per well	3.21	tons/well	0.51	tons/well
Total all wells	25.68	tons/year	4.04	tons/year

a Truck weight is average of full load and empty weight assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area, so there won't be any water trucks on paved roads coming into the Project Area
Additionally, 50% of the water needed in drilling will be piped through temporary surface pipes and not trucked.

Completion Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	3	miles
Hours of Operation	408	hours per well
Number of combo/trailer truck trips	561	trips/well
Number of heavy haul truck trips	34	trips/well
Number of heavy haul water trucks	1,122	trips/well
Number of pickup trips	153	trips/well
Number of wells	8	wells/year

Equations:

$$\text{Emissions (tons/well)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-well)	Emissions (tons/well)	E. Factor [e] (gram/mile)	Emissions (lb/hr-well)	Emissions (tons/well)	E. Factor [f] (gram/mile)	Emissions (lb/hr-well)	Emissions (tons/well)	Emissions (lb/hr-well)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.45	0.09	20.09	6.46	1.32	2.57	0.22	0.046	7.13	11.63
CO	3.44	0.13	0.026	4.53	1.46	0.30	11.57	1.01	0.21	2.60	4.24
VOC	1.09	0.041	0.008	0.79	0.25	0.052	0.78	0.069	0.014	0.36	0.59
SO_2	0.011	0.00042	0.00009	0.019	0.0060	0.0012	0.0074	0.00064	0.00013	0.0070	0.011
PM_{10}	0.71	0.027	0.0055	1.25	0.40	0.082	0.15	0.013	0.0027	0.44	0.72
$PM_{2.5}$	0.51	0.019	0.0039	0.93	0.30	0.061	0.076	0.0067	0.0014	0.33	0.53
Hazardous Air Pollutants											
Benzene	0.0086	0.00033	0.000066	0.0063	0.0020	0.00041	0.015	0.0013	0.00027	0.0037	0.0060
Formaldehyde	0.088	0.0033	0.00068	0.065	0.021	0.0042	0.041	0.0036	0.00073	0.028	0.045
Acetaldehyde	0.039	0.0015	0.00030	0.029	0.0093	0.0019	0.021	0.0018	0.00037	0.013	0.020
Acrolein	0.0073	0.00027	0.000056	0.0053	0.0017	0.00035	0.0033	0.00029	0.000058	0.0023	0.0037
Greenhouse Gases											
CO_2	1,231.12	46.37	9.46	2,049.36	658.51	134.34	535.08	46.89	9.57	751.8	1,227
CH_4	0.026	0.0010	0.00020	0.025	0.0081	0.0017	0.014	0.0013	0.00026	0.010	0.017
N_2O	0.0027	0.00010	0.000021	0.0027	0.00088	0.00018	0.0081	0.00071	0.00014	0.0017	0.0028
CO_2e [g]	---	46.4	9.47	---	658.98	134.43	---	47.13	9.62	752.5	1,228

a Heavy Haul trucks include water trucks and other completion haul trucks

b Combo/Trailer trucks include sand trucks, and rigs

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Well Fracturing Engines

Fracturing Hours of Operation	168	hours/well
Load Factor	0.43	
Completion Engines Total Power	18,000	hp
Number of wells	8	wells/year
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value for ULSD)

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

Equations:

Emission Factor (g/hp-hr) = Emission factor (lb/MMBtu) * 7000 (Btu/hp-hr) * 453.59 (g/hp-hr) / 10^6 (Btu/MMBtu)
7000 Btu/hp-hr from AP-42 Table 3.3-1 Footnote a

$$\text{Emissions (ton/well)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * \text{Load Factor} * \text{Hours per well (hr/well)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/ton)}}$$

	Fracturing Engine Emissions				
Species	**E. Factor (lb/hp-hr)**	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Engine Emissions (tons/well)**	**Total Emissions (tons/year)**
Criteria Pollutants & VOC					
NOx [a]	-----	4.80	81.91	6.88	55.04
CO [a]	-----	2.60	44.37	3.73	29.81
VOC [b]	0.00064	0.29	4.97	0.42	3.34
PM_{10} [a]	-----	0.15	2.56	0.22	1.72
$PM_{2.5}$ [a]	-----	0.15	2.56	0.22	1.72
SO_2 [b]	0.000012	0.0055	0.094	0.0079	0.063
	E. Factor (lb/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Engine Emissions (tons/well)**	**Total Emissions (tons/year)**
Hazardous Air Pollutants					
Benzene [c]	7.76E-04	0.0025	0.042	0.0035	0.028
Toluene [c]	2.81E-04	0.00089	0.015	0.0013	0.010
Xylenes [c]	1.93E-04	0.00061	0.010	0.00088	0.0070
Formaldehyde [c]	7.89E-05	0.00025	0.0043	0.00036	0.0029
Acetaldehyde [c]	2.52E-05	0.000080	0.0014	0.00011	0.00092
Acrolein [c]	7.88E-06	0.000025	0.00043	0.000036	0.00029
	E. Factor (kg/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Engine Emissions (tons/well)**	**Total Emissions (tons/year)**
Greenhouse Gases					
CO_2 [d]	73.96	517.7	8,834	742.08	5,937
CH_4 [d]	0.003	0.021	0.36	0.030	0.24
N_2O [d]	0.0006	0.0042	0.072	0.0060	0.048
CO_2e [e]	---	---	8,865	744.63	5,957

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, and PM)
NOx is conservatively assumed to be NOx + NMHC

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

c AP-42, Large Stationary Diesel Engines, Table 3.4-3

d 40 CFR Part 98 Subpart W indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an emission factor for diesel combustion of CO_2 and Table C-2 provides emission factors for diesel combustion of CH4 and N2O.

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

Average Produced Gas Characteristics

Gas Heat Value (wet): 1,601.3 Btu/scf

C1-C2 Wt. Fraction: 0.48
VOC Wt. Fraction: 0.49
Non-HC Wt. Fraction: 0.035
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction
Methane	62.41	16.04	10.01	0.36
Ethane	11.05	30.07	3.32	0.12
Propane	11.62	44.10	5.12	0.18
i-Butane	2.96	58.12	1.72	0.062
n-Butane	4.09	58.12	2.38	0.085
i-Pentane	1.52	72.15	1.09	0.039
n-Pentane	1.36	72.15	0.98	0.035
Hexanes	0.76	86.18	0.65	0.023
Heptanes	0.96	100.20	0.96	0.035
Octanes	0.12	114.23	0.13	0.0048
Nonanes	0.033	128.26	0.043	0.0015
Decanes	0.0067	142.29	0.0095	0.00034
Benzene	0.018	78.12	0.014	0.00052
Toluene	0.046	92.13	0.042	0.0015
Ethylbenzene	0.0015	106.16	0.0016	0.000056
Xylenes	0.021	106.16	0.022	0.00079
n-Hexane	0.41	86.18	0.35	0.013
Nitrogen	1.16	28.01	0.33	0.012
Carbon Dioxide	1.46	44.01	0.64	0.023
Hydrogen Sulfide	0.00	34.08	0.000	0.000
Total	**100**	**-**	**27.8**	**1.00**

Data from laboratory analyses

Oil Well Liquid Analysis and Resulting Tank Vent Gas Analysis

Component	Liquid Analysis mole%	Calculated Tank Vent Gas mol %	Calculated Tank Vent Gas weight %
Methane	1.2142	16.81	5.47
Ethane	1.1078	9.22	5.63
Propane	3.7015	25.75	23.06
i-Butane	1.5048	8.02	9.46
n-Butane	4.0331	18.33	21.64
i-Pentane	2.7325	6.50	9.52
n-Pentane	3.4389	6.85	10.04
Hexanes	2.6314	2.04	3.56
Heptanes	6.4499	2.12	4.30
Octanes	6.2770	0.83	1.92
Nonanes	2.3741	0.14	0.35
Decanes	57.7788	0.00020	0.0012
Benzene	0.0997	0.077	0.12
Toluene	1.4491	0.41	0.78
Ethylbenzene	0.2926	0.035	0.075
Xylenes	2.0417	0.22	0.47
n-Hexane	2.2103	1.44	2.52
2,2,4-Trimethylpentane	0.5831	0.15	0.34
Nitrogen	0.0457	0.71	0.40
Carbon Dioxide	0.0341	0.36	0.33
VOC Subtotal	**97.60**	**72.90**	**88.17**
Total	**100**	**100**	**100**

Liquid analysis is from an average of two laboratory analyses
Tank vent gas analysis is from an E&P Tank simulation

Gas Well Liquid Analysis and Resulting Tank Flash Gas Analysis

Component	Liquid Analysis mole%	Calculated Tank Vent Gas mole %	Calculated Tank Vent Gas weight %
Methane	2.74	13.62	4.72
Ethane	2.76	13.71	8.91
Propane	5.81	28.68	27.34
i-Butane	2.66	10.96	13.78
n-Butane	6.68	21.21	26.65
i-Pentane	5.21	4.69	7.32
n-Pentane	5.27	3.33	5.19
Hexanes	5.28	0.93	1.74
Heptanes	10.50	0.57	1.23
Octanes	9.92	0.16	0.39
Nonanes	3.37	0.018	0.050
Decanes	26.57	0.00050	0.0023
Benzene	0.97	0.14	0.24
Toluene	3.65	0.14	0.28
Ethylbenzene	0.30	0.0036	0.0083
Xylenes	3.76	0.039	0.089
n-Hexane	3.76	0.51	0.95
2,2,4-Trimethylpentane	0.53	0.022	0.054
Nitrogen	0.089	0.44	0.27
Carbon Dioxide	0.17	0.83	0.79
VOC Subtotal	**94.24**	**71.40**	**85.31**
Total	**100**	**100**	**100**

Liquid analysis is from an average of two laboratory analyses
Tank vent gas analysis is from an E&P Tank simulation

Operation Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		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	3	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Operation Traffic Dust Emissions

Days per year 365

Vehicle Type	Weight (lbs)	Round Trips per Day
Fresh Water Trucks-paved [a,b]	50,000	0
Fresh Water Trucks-unpaved [a,b]	50,000	0.25
Oil Tanker Trucks [a]	37,000	23
Produced Water Trucks [a]	50,000	10
Pickup Trucks	8,000	1
Mean Vehicle Weight-paved	39,971	---
Mean Vehicle Weight-unpaved	40,044	---
Total Round Trips-paved	---	34
Total Round Trips-unpaved	---	34.25

	Emission Factor		Emissions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/day	ton/year
Paved Road PM_{10}	0.029	0.028	105.69	18.23
Paved Road $PM_{2.5}$	0.0072	0.0068	25.94	4.47
Unpaved Public Road PM_{10}	0.56	0.44	0.00	0.00
Unpaved Public Road $PM_{2.5}$	0.056	0.044	0.00	0.00
Unpaved Industrial PM_{10}	0.82	0.64	83.8	11.94
Unpaved Industrial $PM_{2.5}$	0.082	0.064	8.38	1.19

	PM_{10}		$PM_{2.5}$	
Total	30.17	tons/year	5.67	tons/year

a Truck weight is average of full load and empty weight assuming it will be full on one leg and empty of the other leg of the round trip.
b Water will come from the water wells internal to the Project Area, so there won't be any water trucks on paved roads coming into the Project Area

Operation Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	3	miles
Hours of Operation	365	days/year
Number of combo/trailer truck trips	0	trips/all wells/day
Number of heavy haul truck trips	33	trips/all wells/day
Number of water truck trips	0.25	trips/all wells/day
Number of pickup trips	1	trips/all wells/day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/all wells/day)} * \text{Trip Distance (miles/trip)} * 365 \text{ days/yr}}{2000 \text{ (lb/ton)} * 453.59 \text{ (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total
	E. Factor [d] (gram/mile)	Emissions (lb/day)	Emissions (tons/year)	E. Factor [e] (gram/mile)	Emissions (lb/day)	Emissions (tons/year)	E. Factor [f] (gram/mile)	Emissions (lb/day)	Emissions (tons/year)	Emissions (tons/year)
Criteria Pollutants & VOC										
NOx	11.84	91.33	16.67	20.09	0.0	0.0	2.57	0.60	0.11	16.78
CO	3.44	26.52	4.84	4.53	0.0	0.0	11.57	2.70	0.49	5.33
VOC	1.09	8.39	1.53	0.79	0.0	0.0	0.78	0.18	0.033	1.56
SO_2	0.011	0.09	0.02	0.019	0.0	0.0	0.0074	0.0017	0.00031	0.016
PM_{10}	0.71	5.48	1.00	1.25	0.0	0.0	0.15	0.035	0.0064	1.01
$PM_{2.5}$	0.51	3.93	0.72	0.93	0.0	0.0	0.076	0.018	0.0033	0.72
Hazardous Air Pollutants										
Benzene	0.0086	0.07	0.012	0.0063	0.0	0.0	0.015	0.0035	0.00064	0.013
Formaldehyde	0.088	0.68	0.12	0.065	0.0	0.0	0.041	0.010	0.0017	0.13
Acetaldehyde	0.039	0.30	0.06	0.029	0.0	0.0	0.021	0.0048	0.00088	0.056
Acrolein	0.0073	0.06	0.010	0.0053	0.0	0.0	0.0033	0.00076	0.00014	0.010
Greenhouse Gases										
CO_2	1,231.12	9496	1,733	2,049.36	0.0	0.0	535.08	125.04	22.82	1,756
CH_4	0.026	0.20	0.04	0.025	0.0	0.0	0.014	0.0034	0.00061	0.038
N_2O	0.0027	0.02	0.004	0.0027	0.0	0.0	0.0081	0.0019	0.00034	0.0042
CO_2e [g]	---	9,508	1,735	---	0.0	0.0	---	125.69	22.94	1,758

a Heavy haul trucks inlude oil tanker trucks and water trucks
b No Combo/Trailer trucks for daily operations
c Pickup trucks include a mix of gasoline and diesel passenger trucks
d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.
e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.
f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.
g Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Oil Well Storage Tank Flashing, Working, and Breathing Emissions

Production Rate :	508.5	bbls oil/day/well
Number of oil wells:	3	wells
Control Efficiency of tanks:	98	%

COMPONENT	Per Well Uncontrolled Emissions (lb/hr)	Per Well Uncontrolled Emissions (ton/yr)	Per Well Controlled Emissions (lb/hr)	Per Well Controlled Emissions (ton/yr)	Total Oil Well Controlled Emissions (lb/hr)	Total Oil Well Controlled Emissions (ton/yr)
Carbon Dioxide	0.28	1.20	0.28	1.20	0.83	3.61
Nitrogen	0.34	1.50	0.34	1.50	1.03	4.49
Methane	4.63	20.28	0.093	0.41	0.28	1.22
Ethane	4.76	20.86	0.095	0.42	0.29	1.25
Propane	19.51	85.43	0.39	1.71	1.17	5.13
i-Butane	8.00	35.05	0.16	0.70	0.48	2.10
n-Butane	18.30	80.17	0.37	1.60	1.10	4.81
i- Pentane	8.05	35.26	0.16	0.71	0.48	2.12
n-Pentane	8.50	37.21	0.17	0.74	0.51	2.23
Hexanes	2.94	12.87	0.059	0.26	0.18	0.77
Heptanes	3.52	15.44	0.070	0.31	0.21	0.93
Octanes	1.57	6.89	0.031	0.14	0.094	0.41
Nonanes	0.29	1.25	0.0057	0.025	0.017	0.075
Decanes +	0.0010	0.0044	0.000020	0.000088	0.000060	0.00026
Benzene	0.10	0.45	0.0021	0.0090	0.0062	0.027
Toluene	0.66	2.87	0.013	0.057	0.039	0.17
Ethylbenzene	0.063	0.28	0.0013	0.0055	0.0038	0.017
Xylenes	0.40	1.74	0.0079	0.035	0.024	0.10
n-Hexane	2.13	9.35	0.043	0.19	0.13	0.56
2,2,4-Trimethylpentane	0.29	1.25	0.0057	0.025	0.017	0.075
VOC Subtotal	**74.32**	**325.52**	**1.49**	**6.51**	**4.46**	**19.53**
HAP Subtotal	**3.64**	**15.94**	**0.073**	**0.32**	**0.22**	**0.96**
TOTAL	**84.33**	**369.36**	**2.29**	**10.04**	**6.87**	**30.11**

a Emissions calculated using E&P Tanks 2.0 for flashing, working and breathing

b Uncontrolled emissions are the tank emissions prior to the combustor

c Controlled emissions are the tank emissions going to the combustor

Gas Well Storage Tank Flashing, Working, and Breathing Emissions

Production Rate :	255.7	bbls oil/day/well
Number of gas wells:	5	wells
Control Efficiency of tanks:	98	%

COMPONENT	Per Well Uncontrolled Emissions (lb/hr)	Per Well Uncontrolled Emissions (ton/yr)	Per Well Controlled Emissions (lb/hr)	Per Well Controlled Emissions (ton/yr)	Total Gas Well Controlled Emissions (lb/hr)	Total GasWell Controlled Emissions (ton/yr)
Carbon Dioxide	1.93	8.45	1.93	8.45	9.65	42.27
Nitrogen	0.65	2.86	0.65	2.86	3.27	14.32
Methane	11.56	50.62	0.23	1.01	1.16	5.06
Ethane	21.80	95.49	0.44	1.91	2.18	9.55
Propane	66.90	293.00	1.34	5.86	6.69	29.30
i-Butane	33.71	147.65	0.67	2.95	3.37	14.76
n-Butane	65.21	285.60	1.30	5.71	6.52	28.56
i- Pentane	17.91	78.45	0.36	1.57	1.79	7.85
n-Pentane	12.70	55.61	0.25	1.11	1.27	5.56
Hexanes	4.14	18.13	0.083	0.36	0.41	1.81
Heptanes	2.92	12.79	0.058	0.26	0.29	1.28
Octanes	0.93	4.06	0.019	0.081	0.093	0.41
Nonanes	0.12	0.52	0.0024	0.010	0.012	0.052
Decanes +	0.0060	0.026	0.00012	0.00053	0.00060	0.0026
Benzene	0.60	2.62	0.012	0.052	0.060	0.26
Toluene	0.69	3.00	0.014	0.060	0.069	0.30
Ethylbenzene	0.020	0.088	0.00040	0.0018	0.0020	0.0088
Xylenes	0.22	0.95	0.0043	0.019	0.022	0.10
n-Hexane	2.32	10.16	0.046	0.20	0.23	1.02
2,2,4-Trimethylpentane	0.13	0.57	0.0026	0.011	0.013	0.057
VOC Subtotal	**208.50**	**913.24**	**4.17**	**18.26**	**20.85**	**91.32**
HAP Subtotal	**3.97**	**17.40**	**0.079**	**0.35**	**0.40**	**1.74**
TOTAL	**244.44**	**1070.67**	**7.42**	**32.50**	**37.11**	**162.52**

a Emissions calculated using E&P Tanks 2.0 for flashing, working and breathing
b Uncontrolled emissions are the tank emissions prior to the combustor
c Controlled emissions are the tank emissions going to the combustor

Truck Loadout

Oil Loading - Oil well	508.5	barrels/day/oil well
Oil Loading - Gas well	255.7	barrels/day/gas well
Number of oil wells	3	oil wells
Number of gas wells	5	gas 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	VOC tpy-well	VOC tpy total
Oil - oil wells [a]	0.6	2.05	49	505	1.49	508	5.81	17.43
Oil - gas wells [b]	0.6	2.05	46	505	1.40	256	2.75	13.75

	Oil well loading tpy-well [c]	Gas well loading tpy-well [c]	Loading tpy-field [c]
Hazardous Air Pollutants			
Benzene	0.0080	0.0079	0.063
Toluene	0.051	0.0090	0.20
Ethylbenzene	0.0049	0.00027	0.016
Xylenes	0.031	0.0029	0.11
n-Hexane	0.17	0.031	0.65
2,2,4-TMP	0.022	0.0017	0.075
Greenhouse Gases			
CO2	0.021	0.025	0.19
CH4	0.36	0.15	1.84
CO2e	9.0	3.8	46.29

Notes:
a Vapor molecular weight based on E&P tank report for oil wells and pressure based on AP-42 Table 7.1-2 for RVP 5
b Vapor molecular weight based on E&P tank report for gas wells and pressure based on AP-42 Table 7.1-2 for RVP 5
c Emissions estimated based on weight fractions calculated from tank vent gas emissions

Pneumatic Controller Emissions

Pneumatic Device Emissions [a] 1.39 scf/hr Number of wells 8
Number of pneumatic controllers per well 4 controllers/well

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr-well)	Mass Flow Rate (lb/hr-well)	Mass Flow Rate (tons/yr-well)	Mass Flow Rate (tons/year)
Methane	16.04	62.41	10.01	35.97	3.47	0.15	0.64	5.14
Ethane	30.07	11.05	3.32	11.93	0.61	0.049	0.21	1.71
Propane	44.10	11.62	5.12	18.41	0.65	0.075	0.33	2.63
i-Butane	58.12	2.96	1.72	6.17	0.16	0.025	0.11	0.88
n-Butane	58.12	4.09	2.38	8.54	0.23	0.035	0.15	1.22
i-Pentane	72.15	1.52	1.09	3.93	0.084	0.016	0.070	0.56
n-Pentane	72.15	1.36	0.98	3.53	0.076	0.014	0.063	0.50
Hexanes	86.18	0.76	0.65	2.34	0.042	0.010	0.042	0.33
Heptanes	100.20	0.96	0.96	3.46	0.053	0.014	0.062	0.49
Octanes	114.23	0.12	0.13	0.48	0.0065	0.0020	0.0086	0.068
Nonanes	128.26	0.033	0.043	0.15	0.0019	0.00063	0.0027	0.022
Decanes +	142.29	0.0067	0.0095	0.034	0.00037	0.00014	0.00061	0.0049
Benzene	78.12	0.018	0.014	0.052	0.0010	0.00021	0.00092	0.0074
Toluene	92.13	0.046	0.042	0.15	0.0025	0.00062	0.0027	0.022
Ethylbenzene	106.16	0.0015	0.0016	0.0056	0.000081	0.000023	0.00010	0.00080
Xylenes	106.16	0.021	0.022	0.079	0.0012	0.00032	0.0014	0.011
n-Hexane	86.18	0.41	0.35	1.27	0.023	0.0052	0.023	0.18
Nitrogen	28.01	1.16	0.33	1.17	0.065	0.0048	0.021	0.17
Carbon Dioxide	44.01	1.46	0.64	2.31	0.081	0.0094	0.041	0.33
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000	0.00
VOC Subtotal		23.91	13.53	48.61	1.33	0.20	0.87	6.95
HAP Subtotal		0.50	0.43	1.56	0.028	0.0063	0.028	0.22
CO2e Subtotal		---	---	---	---	3.68	16.10	128.84
Total		100.00	27.83	100.00	5.56	0.41	1.79	14.29

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

Production Heater Emissions

Assumptions

Heater Treater Size	0.75	MMBtu/hr
Indirect Heater Size	0.5	MMBtu/hr
Glycol Heater Size	0.85	MMBtu/hr
Fuel Gas Heat Value	1,601	Btu/scf
Heater treaters per well	1	heater treaters
Indirect heaters per well	1	indirect heaters
Glycol heaters per well	1	glycol heaters
Number of wells	8	wells

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Heater Rating (MMBtu/hr)} * 8760 \text{ (hours/year)} * \text{Fuel Gas Heat Value (Btu/scf)}}{2{,}000 \text{ (lbs/ton)} * 1{,}020 \text{ (Btu/scf - AP -42 Standard Fuel Heating Value)} * 1{,}020 \text{ (Btu/scf - Standard Fuel Heating Value)}}$$

	Heater Treaters			Indirect Heaters			Glycol Heaters			Total Heaters	
	Emission Factor (lb/MMscf)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (lb/MMscf)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (lb/MMscf)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC											
NOx [a]	100	0.12	0.51	100	0.077	0.34	100	0.13	0.57	2.59	11.33
CO [a]	84	0.097	0.42	84	0.065	0.28	84	0.11	0.48	2.17	9.51
VOC [b]	5.5	0.0063	0.028	5.5	0.0042	0.019	5.5	0.0072	0.032	0.14	0.62
SO_2 [b]	0.6	0.00069	0.0030	0.6	0.00046	0.0020	0.6	0.00078	0.0034	0.016	0.068
PM_{10} [b]	7.6	0.0088	0.038	7.6	0.0058	0.026	7.6	0.0099	0.044	0.20	0.86
$PM_{2.5}$ [b]	7.6	0.0088	0.038	7.6	0.0058	0.026	7.6	0.0099	0.044	0.20	0.86
Hazardous Air Pollutants											
Benzene [c]	2.10E-03	2.42E-06	1.06E-05	2.10E-03	1.62E-06	7.08E-06	2.10E-03	2.75E-06	1.20E-05	0.000054	0.00024
Toluene [c]	3.40E-03	3.92E-06	1.72E-05	3.40E-03	2.62E-06	1.15E-05	3.40E-03	4.45E-06	1.95E-05	0.000088	0.00039
Hexane [c]	1.80E+00	2.08E-03	9.10E-03	1.80E+00	1.39E-03	6.07E-03	1.80E+00	2.35E-03	1.03E-02	0.047	0.20
Formaldehyde [c]	7.50E-02	8.66E-05	3.79E-04	7.50E-02	5.77E-05	2.53E-04	7.50E-02	9.81E-05	4.30E-04	0.0019	0.0085
Greenhouse Gases	Emission Factor (kg/MMBtu)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (kg/MMBtu)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (kg/MMBtu)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emissions (lb/hr)	Emissions (tons/yr)
CO_2 [d]	53.06	87.73	384.27	53.06	58.49	256.18	53.06	99.43	435.50	1,965	8,608
CH_4 [d]	0.001	0.0017	0.0072	0.001	0.0011	0.0048	0.001	0.0019	0.0082	0.037	0.16
N_2O [d]	0.0001	0.00017	0.00072	0.0001	0.00011	0.00048	0.0001	0.00019	0.00082	0.0037	0.016
CO_2e [e]	---	87.82	384.66	---	58.55	256.44	---	99.53	435.95	1,967	8,616

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 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 emission factor for CO_2, and Table C-2 provides emission factors for CH_4 and N_2O.

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

Dehydrator Emissions

Assumptions

Number of Dehydrators per well:	1	dehydrators/well
Number of producing wells:	8	wells
Production Rate:	2.44	MMscfd/field

Average Gas Analysis 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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

98 % Control Efficiency

	Uncontrolled Emissions		**Controlled Emissions**			
Species	Dehydrator Emissions (lb/hr-dehy)	Dehydrator Emissions (tons/year-dehy)	Dehydrator Emissions (lb/hr-dehy)	Dehydrator Emissions (tons/year-dehy)	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)
VOC	12.42	54.41	0.25	1.09	1.99	8.71
Hazardous Air Pollutants						
Benzene	1.00	4.40	0.020	0.088	0.16	0.70
Toluene	4.52	19.81	0.090	0.40	0.72	3.17
Ethylbenzene	0.15	0.64	0.0029	0.013	0.023	0.10
Xylenes	3.85	16.88	0.077	0.34	0.62	2.70
n-Hexane	0.08	0.34	0.002	0.007	0.012	0.054
Greenhouse Gases						
CO_2	0.75	3.28	0.75	3.28	5.98	26.2
CH_4	3.20	14.00	0.064	0.28	0.51	2.24
CO_2e	80.6	353.2	2.3	10.3	18.8	82.2

Oil and Gas Well Fugitives Number of wells 8

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-well)
Valves - Gas	54	8,760	0.49	4.50E-03	9.92E-03	1.14
Valves - Light Oil	15	8,760	0.85	2.50E-03	5.51E-03	0.31
Valves - Heavy Oil	0	8,760	---	8.40E-06	1.85E-05	----
Valves - Water/Lt. Oil	8	8,760	0.85	9.80E-05	2.16E-04	0.0065
Connectors - Gas	186	8,760	0.49	2.00E-04	4.41E-04	0.17
Connectors - Light Oil	53	8,760	0.85	2.10E-04	4.63E-04	0.092
Connectors - Heavy Oil	0	8,760	---	7.50E-06	1.65E-05	----
Connectors - Water/ Lt. Oil	27	8,760	0.85	1.10E-04	2.43E-04	0.024
Open-Ended Lines - Gas	6	8,760	0.49	2.00E-03	4.41E-03	0.056
Open-Ended Lines - Light Oil	2	8,760	0.85	1.40E-03	3.09E-03	0.023
Open-Ended Lines - Heavy Oil	0	8,760	---	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.85	2.50E-04	5.51E-04	0.0021
Flanges - Gas	0	8,760	0.49	3.90E-04	8.60E-04	----
Flanges - Light Oil	12	8,760	0.85	1.10E-04	2.43E-04	0.011
Flanges - Heavy Oil	0	8,760	---	3.90E-07	8.60E-07	----
Flanges - Water/Lt. Oil	4	8,760	0.85	2.90E-06	6.39E-06	0.00010
Other - Gas	4	8,760	0.49	8.80E-03	1.94E-02	0.17
Other - Light Oil	1	8,760	0.85	7.50E-03	1.65E-02	0.062
Other - Heavy Oil	0	8,760	---	3.20E-05	7.05E-05	----
Other - Water/Lt. Oil	1	8,760	0.85	1.40E-02	3.09E-02	0.12
VOC EMISSIONS (tons/yr)					17.45	

VOC Emissions (tons/yr) = Emission Factor (lb/hr-unit) * 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-1B and Table W-1C.

b VOC and HAP weight fractions from gas analysis and tank emissions.

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

	Gas Weight Fraction of VOC	Oil Weight Fraction of VOC	Total Emissions (tpy-well)	Total Emissions (tpy)
Benzene Emissions	0.0011	0.0029	0.0035	0.028
Toluene Emissions	0.0031	0.0033	0.0065	0.052
Ethylbenzene Emissions	0.00011	0.000097	0.00023	0.0018
Xylene Emissions	0.0016	0.0010	0.0031	0.024
n-Hexane Emissions	0.026	0.011	0.046	0.37

Oil and Gas 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-well)	CO_2 Emissions (tons/yr-well)	CO_2e Emissions (tons/yr)
Valves - Gas	54	8,760	0.62	0.015	0.121	0.76	0.049	151.55
Valves - Light Liquid	23	8,760	0.14	0.0083	0.050	0.029	0.0048	5.84
Connectors - Gas	186	8,760	0.62	0.015	0.017	0.37	0.023	73.34
Connectors - Light Liquid	80	8,760	0.14	0.0083	0.007	0.014	0.0024	2.85
Open-Ended Lines - Gas	6	8,760	0.62	0.015	0.031	0.022	0.0014	4.31
Open-Ended Lines - Light Liquid	3	8,760	0.14	0.0083	0.050	0.0038	0.00063	0.76
Flanges - Light Liquid	16	8,760	0.14	0.0083	0.003	0.0012	0.00020	0.24
Other - Gas (PRV)	4	8,760	0.62	0.015	0.193	0.089	0.0057	17.91
Other - Light Liquid	2	8,760	0.14	0.0083	0.3	0.015	0.0025	3.05
EMISSIONS (tons/yr-well)					1.30	0.090	259.9	

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 and tank emissions

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

Flare Emissions

Assumptions:

Maximum Heat Rating per Flare	2.4	MMBtu/hr
Pilot Gas used per Flare	16.4	scf/hr
Heating Value of Pilot Gas	1,601	Btu/scf
Total Heat Rating per Flare with Pilot	2.43	MMBtu/hr
Number of flares per well	1	flares/well
Number of wells	8	wells

	Emission Factor (kg/MMBtu)	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions (lb/hr)	Total Emissions (tons/yr)
Criteria Pollutants						
NOx [a]	----	0.14	0.34	1.49	2.72	11.90
CO [a]	----	0.035	0.085	0.37	0.68	2.98
Greenhouse Gases						
CO2 [b]	53.06	----	283.8	1,243.1	2,271	9,945
CH4 [b]	0.001	----	0.0053	0.023	0.043	0.19
N2O [b]	0.0001	----	0.00053	0.0023	0.004	0.019
CO2e	---	---	284.1	1,244.4	2,273	9,955

a Emission factors from Wyoming DEQ C6 S2 O&G Production Facilities Permitting Guidance September 2013
b 40 CFR Part 98 Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment.

Generator Engines

Assumptions:

Number of Wellpads	4	facilities
Number of Generator Engines per wellpad	1	engine
Generator Engine Rating	300	hp

Pollutant	Emission Factor (g/hp-hr)	Emissions per engine (lb/hr-generator)	Emissions per engine (tons/yr-generator)	Emissions [g] Total (tons/yr)
Criteria Pollutants & VOC				
NOx [b]	1.0	0.66	2.90	11.59
CO [b]	2.0	1.32	5.79	23.18
VOC [b]	0.7	0.46	2.03	8.11
PM_{10} [c]	7.22E-02	0.048	0.21	0.84
$PM_{2.5}$ [c]	7.22E-02	0.048	0.21	0.84
SO_2 [c]	2.19E-03	0.0014	0.0063	0.025
Hazardous Air Pollutants [c]				
Acetaldehyde	1.04E-02	0.0069	0.030	0.12
Acrolein	9.78E-03	0.0065	0.028	0.11
Benzene	5.88E-03	0.0039	0.017	0.068
Ethylbenzene	9.22E-05	0.000061	0.00027	0.0011
Formaldehyde	7.62E-02	0.050	0.22	0.88
Methanol	1.14E-02	0.0075	0.033	0.13
Toluene	2.08E-03	0.0014	0.0060	0.024
Xylene	7.25E-04	0.00048	0.0021	0.0084
Greenhouse Gases				
CO_2 [d]	436.2	288	1,263	5,054
CH_4 [e]	8.22E-03	0.0054	0.024	0.10
N_2O [e]	8.22E-04	0.00054	0.0024	0.010
CO_2e [f]	---	289	1,265	5,059

a Assumes maximum development scenario
b Emission factors compliant with 40 CFR Part 60 Subpart JJJJ for engines > 100 hp with applicable manufacture dates
c AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, converted to lb/hp-hr using 8200 Btu/hp-hr.
d 40 CFR Part 98 Subpart C, Table C-1
e 40 CFR Part 98 Subpart C, Table C-2
f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.
g Assumes maximum development scenario

APPENDIX E – AIR EMISSIONS INVENTORY FOR THE PROPOSED ACTION ALTERNATIVE

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Pollutant	Construction Emissions (tons/year) [a,b]					Construction Total (tons/year)	**Overall Total (tons/year)**
	Wind Erosion	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC							
NO_X	----	7.1	217.8	394.5	0.1	619.5	**903.4**
CO	----	2.5	119.1	200.9	0.1	322.6	**518.5**
VOC	----	0.4	13.3	23.3	0.01	37.0	**1,099.5**
SO_2	----	0.01	0.25	0.4	0.0002	0.7	**1.3**
PM_{10}	11.9	16.3	51.7	287.2	0.3	367.4	**609.6**
$PM_{2.5}$	1.8	2.8	12.5	49.3	0.04	66.4	**117.9**
Hazardous Air Pollutants							
Benzene	----	0.0032	0.12	0.2	0.00010	0.32	**7.03**
Toluene	----	----	0.039	0.1	----	0.10	**23.25**
Ethylbenzene	----	----	----	----	----	----	**0.88**
Xylene	----	----	0.027	0.0	----	0.068	**18.04**
n-Hexane	----	----	----	----	----	----	**18.00**
Formaldehyde	----	0.025	0.059	0.3	0.00027	0.39	**4.73**
Acetaldehyde	----	0.011	0.026	0.1	0.00013	0.17	**0.99**
Acrolein	----	0.0021	0.0050	0.0	0.000022	0.032	**0.55**
Methanol	----	----	----	----	----	----	**0.53**
2,2,4-Trimethylpentane	----	----	----	----	----	----	**1.27**
Greenhouse Gases							
CO_2	----	818	23,543	42,372	25.9	66,759	**206,916**
CH_4	----	0.010	0.93	1.52	0.00009	2.46	**156.5**
N_2O	----	0.0015	0.19	0.30	0.00005	0.49	**0.8**
CO_2e	----	819	23,622	42,499	25.9	66,966	**211,055**

a Assumes scenario of an average of 47 producing wells and 47 wells drilled. b
Emissions in summary tables may vary slightly due to rounding differences.
c Workovers do not occur in Year 1 of the Project as workovers occur on average every 1.5 years on each well.

Pollutant	Operations Emissions (tons/year) [a,b]										Production Total (tons/year)
	Truck Loading	Workovers [c]	Generator Engines	Fugitive Emissions	Pneumatics	Flares	Heaters	Storage Tanks	Dehydrators	Production Traffic	
Criteria Pollutants & VOC											
NO_X	----	----	46.4	----	----	69.9	66.5	----	----	101.1	283.9
CO	----	----	92.7	----	----	17.5	55.9	----	----	29.8	195.9
VOC	187.4	----	32.4	102.5	40.8	----	3.7	635.1	51.1	9.3	1,062.4
SO_2	----	----	0.10	----	----	----	0.4	----	----	0.095	0.6
PM_{10}	----	----	3.3	----	----	----	5.1	----	----	233.8	242.2
$PM_{2.5}$	----	----	3.3	----	----	----	5.1	----	----	43.1	51.5
Hazardous Air Pollutants											
Benzene	0.37	----	0.27	0.16	0.043	----	0.0014	1.64	4.14	0.074	6.7
Toluene	1.22	----	0.10	0.31	0.13	----	0.0023	2.77	18.62	----	23.1
Ethylbenzene	0.10	----	0.0043	0.011	0.0047	----	----	0.15	0.60	----	0.9
Xylene	0.67	----	0.034	0.14	0.066	----	----	1.19	15.87	----	18.0
n-Hexane	4.02	----	----	2.16	1.07	----	1.20	9.24	0.32	----	18.0
Formaldehyde	----	----	3.5	----	----	----	0.050	----	----	0.75	4.3
Acetaldehyde	----	----	0.48	----	----	----	----	----	----	0.34	0.8
Acrolein	----	----	0.45	----	----	----	----	----	----	0.062	0.5
Methanol	----	----	0.53	----	----	----	----	----	----	----	0.53
2,2,4-Trimethylpentane	0.47	----	----	----	----	----	----	0.80	----	----	1.3
Greenhouse Gases											
CO_2	1.1	----	20,216	4.2	1.9	58,426	50,569	259.6	154.0	10,525	140,157
CH_4	11.1	----	0.38	60.9	30.2	1.10	0.95	36.1	13.2	0.23	154.1
N_2O	----	----	0.038	----	----	0.110	0.10	----	----	0.024	0.3
CO_2e	279	----	20,237	1,527	757	58,486	50,622	1,161	483	10,538	144,089

a Assumes scenario of an average of 47 producing wells and 47 wells drilled. b
Emissions in summary tables may vary slightly due to rounding differences.
c Workovers do not occur in Year 1 of the Project as workovers occur on average every 1.5 years on each well.

Road Construction Emissions - Equipment Fugitive Dust

Dozer, Backhoe Hours of Road Construction	4.0	days per road mile
	32.0	hours per road mile
Scraper, Grader Hours of Road Construction	4.0	days per road mile
	32.0	hours per road mile
Total road mileage	1.81	miles
	8	hours per day
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 (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

	Dozer Emissions		Backhoe Emissions	
	lbs/hr/mile	**tons/mile**	**lbs/hr/mile**	**tons/mile**
TSP	1.97	0.032	1.97	0.032
PM_{15}	0.50	0.0080	0.50	0.0080
PM_{10}	0.38	0.0060	0.38	0.0060
$PM_{2.5}$	0.21	0.0033	0.21	0.0033

Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance graded and scraped	9.1	miles graded/mile road
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 grading

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 Emissions			Scraper Emissions		
	lbs/mile	**lbs/hr/mile**	**tons/mile**	**lbs/mile**	**lbs/hr/mile**	**tons/mile**
TSP	24.31	0.76	0.012	24.31	0.76	0.012
PM_{15}	11.63	0.36	0.0058	11.63	0.36	0.0058
PM_{10}	6.98	0.22	0.0035	6.98	0.22	0.0035
$PM_{2.5}$	0.75	0.024	0.00038	0.75	0.024	0.00038

	PM_{10}		$PM_{2.5}$	
Emissions for total road mileage	0.034	tons/year	0.013	tons/year

Road Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Road Construction Paved Roads

Hours per day	8	hour/day
Days per mile of road constructed	4.0	days/road mile

Vehicle Type	Weight (lbs)	Round Trips per Road Mile
Trucks - Water [a,b]	50,000	0
Trucks - Semi [a]	56,000	194
Trucks - Fuel [a]	23,500	12
Pickup Trucks	8,000	7
Mean Vehicle Weight	52,592	---
Total Round Trips	---	213

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-road mile	ton/road mile
PM_{10}	0.039	0.037	27.38	0.41
$PM_{2.5}$	0.0095	0.0090	6.72	0.10

Road Construction Public Unpaved Roads

Hours per day	8	hour/day
Days per mile of road constructed	4.0	days/road mile

Vehicle Type	Weight (lbs)	Round Trips per Road Mile
Trucks - Water [a]	50,000	0
Trucks - Semi [a]	56,000	0
Trucks - Fuel [a]	23,500	0
Pickup Trucks	8,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-road mile	ton/road mile
PM_{10}	0.56	0.44	0.00	0.00
$PM_{2.5}$	0.056	0.044	0.00	0.00

Road Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Road Construction Industrial Unpaved Roads

Hours per day	8	hour/day
Days per mile of road constructed	4.0	days/road mile

Vehicle Type	Weight (lbs)	Round Trips per Road Mile
Trucks - Water [a]	50,000	31
Trucks - Semi [a]	56,000	194
Trucks - Fuel [a]	23,500	12
Pickup Trucks	8,000	7
Mean Vehicle Weight	52,262	---
Total Round Trips	---	244

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-road mile	ton/road mile
PM_{10}	0.92	0.72	49.09	0.61
$PM_{2.5}$	0.092	0.072	4.91	0.06

Total Road Construction Fugitive Dust Emissions (tons/year)

a Truck weight is average of full load and empty weight
assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area,
so there won't be any water trucks on paved roads coming into the Project Area

	Unpaved Total	Paved Total	Total
	ton/year	ton/year	ton/year
PM_{10}	1.11	0.75	1.86
$PM_{2.5}$	0.111	0.18	0.29

Total road mileage 1.81 miles

Road Construction Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	7	miles
Hours of Operation	32	hours per mile
Number of combo/trailer truck trips	194	trips/mile of road
Number of heavy haul truck trips	12	trips/mile of road
Number of heavy haul water trucks	31	trips/mile of road
Number of pickup trips	7	trips/mile of road
Total road mileage	1.81	miles

Equations:

$$\text{Emissions (tons/road mile)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/mile of road)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-road mile)	Emissions (tons/road mile)	E. Factor [e] (gram/mile)	Emissions (lb/hr-road mile)	Emissions (tons/road mile)	E. Factor [f] (gram/mile)	Emissions (lb/hr-road mile)	Emissions (tons/road mile)	Emissions (lb/hr-road mile)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	1.21	0.019	20.09	28.47	0.46	2.57	0.13	0.0021	29.81	0.86
CO	3.44	0.35	0.0056	4.53	6.42	0.103	11.57	0.59	0.0095	7.36	0.21
VOC	1.09	0.11	0.0018	0.79	1.12	0.018	0.78	0.040	0.00064	1.27	0.037
SO_2	0.011	0.0011	0.000018	0.019	0.026	0.00042	0.0074	0.00038	0.0000060	0.028	0.00080
PM_{10}	0.71	0.07	0.00117	1.25	1.76	0.028	0.15	0.0077	0.00012	1.85	0.053
$PM_{2.5}$	0.51	0.05	0.00084	0.93	1.32	0.021	0.076	0.0039	0.000062	1.38	0.040
Hazardous Air Pollutants											
Benzene	0.0086	0.0009	0.000014	0.0063	0.0089	0.00014	0.015	0.00077	0.000012	0.0106	0.00031
Formaldehyde	0.088	0.009	0.00014	0.065	0.092	0.0015	0.041	0.0021	0.000033	0.103	0.0030
Acetaldehyde	0.039	0.004	0.000065	0.029	0.041	0.00065	0.021	0.00105	0.000017	0.046	0.0013
Acrolein	0.0073	0.0007	0.000012	0.0053	0.0075	0.00012	0.0033	0.00017	0.0000027	0.0084	0.00024
Greenhouse Gases											
CO_2	1,231.12	126.3	2.02	2,049.36	2,903	46.45	535.08	27.35	0.44	3,057	88.5
CH_4	0.026	0.0027	0.000043	0.025	0.036	0.00057	0.014	0.00074	0.000012	0.039	0.00114
N_2O	0.0027	0.00028	0.0000045	0.0027	0.0039	0.000062	0.0081	0.00041	0.0000066	0.0046	0.00013
CO_2e [g]	---	126.4	2.02	---	2,905	46.49	---	27.49	0.44	3,059	88.6

a Heavy Haul trucks include water and fuel trucks

b Combo/Trailer trucks include semi trucks

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Road Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Total road mileage 1.81 miles

Scraper Hours	32.0	hours per mile	Grader Hours	32.0	hours per mile
Scraper HP [a]	422.5		Grader HP [a]	231.2	
Load Factor [b]	0.43		Load Factor [b]	0.43	
Dozer Hours	32.0	hours per mile	Backhoe Hours	32.0	hours per mile
Dozer HP [a]	136.1		Backhoe HP [a]	137.6	
Load Factor [b]	0.43		Load Factor [b]	0.43	

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

Heavy Const. Vehicles	Scraper			Dozer			Grader		
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)
Criteria Pollutants & VOC									
NOx	2.27	0.91	0.015	1.70	0.22	0.0035	1.52	0.33	0.0053
CO	0.91	0.36	0.0058	0.74	0.095	0.0015	0.51	0.11	0.0018
VOC [d]	0.17	0.069	0.0011	0.18	0.023	0.00038	0.17	0.037	0.00059
PM_{10}	0.13	0.052	0.00083	0.18	0.023	0.00036	0.096	0.021	0.00034
$PM_{2.5}$	0.13	0.050	0.00081	0.17	0.022	0.00035	0.093	0.020	0.00033
SO_2	0.0031	0.0013	0.000020	0.0030	0.00039	0.0000063	0.0029	0.00064	0.000010
Greenhouse Gases									
CO_2	536.3	214.80	3.44	536.3	69.19	1.11	536.3	117.55	1.88
CO_2e [e]	---	214.80	3.44	---	69.19	1.11	---	117.55	1.88

Heavy Const. Vehicles	Backhoe			Total	
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/mile)	Emissions (tons/mile)	Emissions (lb/hr/mile)	Emissions (tons/year)
Criteria Pollutants & VOC					
NOx	1.49	0.19	0.0031	1.66	0.048
CO	0.65	0.085	0.0014	0.66	0.019
VOC [d]	0.17	0.022	0.00036	0.15	0.0044
PM_{10}	0.15	0.020	0.00032	0.12	0.0033
$PM_{2.5}$	0.15	0.019	0.00031	0.11	0.0032
SO_2	0.0030	0.00039	0.0000062	0.0027	0.000078
Greenhouse Gases					
CO_2	536.3	69.96	1.12	471.5	13.65
CO_2e [e]	---	69.96	1.12	471.5	13.65

a Load factors from Table 9 of "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling", EPA-420-R-10-016, July 2010. Load factor as 7-cycle average.

b Horsepower from base year 2000 population counts from EPA-420-R-10-017, July 2010.

c Emission factors developed using NONROAD model, assuming Diesel Construction Equipment in Converse and Campbell County for calendar year 2016.

d Emission Factor represents total Hydrocarbon Emissions multiplied by the VOC factor of 1.053 referenced from EPA-420-R-10-015, July 2010.

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

Pad Construction Emissions - Equipment Fugitive Dust

Total acreage for all new and expanded well pads	59.09	acres
Total acreage for all facility pads	25.90	acres
Total acreage for all frac pads	0.00	acres
Dozer, Backhoe Hours of Well Pad Construction	0.31	days per acre
	2.5	hours per acre
Scraper, Grader Hours of Well Pad Construction	0.77	days per acre
	6.2	hours per acre
	8	hours per day
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 (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

	Dozer Emissions		Backhoe Emissions	
	lbs/hr	**tons/acre**	**lbs/hr**	**tons/acre**
TSP	1.97	0.0024	1.97	0.0024
PM_{15}	0.50	0.00062	0.50	0.00062
PM_{10}	0.38	0.00046	0.38	0.00046
$PM_{2.5}$	0.21	0.00025	0.21	0.00025

Distance graded and scraped	0.61	miles/acre
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 grading

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 Emissions			Scraper Emissions		
	lbs/acre	**lbs/hr/acre**	**tons/acre**	**lbs/acre**	**lbs/hr/acre**	**tons/acre**
TSP	1.63	0.26	0.00081	1.63	0.26	0.00081
PM_{15}	0.78	0.13	0.00039	0.78	0.13	0.00039
PM_{10}	0.47	0.076	0.00023	0.47	0.076	0.00023
$PM_{2.5}$	0.050	0.0082	0.000025	0.050	0.0082	0.000025

	PM_{10}		$PM_{2.5}$	
Total for all Well Pads	0.12	tons/yr	0.048	tons/yr

Pad Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Pad Construction Paved Roads

Hours per day	8	hour/day
Days per acre	0.9	days/acre
Total acreage for all pads	85.0	acres

Vehicle Type	Weight (lbs)	Round Trips per Acre
Trucks - Water [a,b]	50,000	0
Trucks - Semi [a]	56,000	27
Trucks - Fuel [a]	23,500	2
Pickup Trucks	8,000	7
Scraper	88,000	0
Grader	45,000	0
Backhoe	24,000	0
Dozer	30,000	0
Mean Vehicle Weight	44,861	---
Total Round Trips	---	36

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.033	0.031	17.54	0.059
$PM_{2.5}$	0.0081	0.0077	4.30	0.015

Pad Construction Public Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.9	days/acre
Total acreage for all pads	85.0	acres

Vehicle Type	Weight (lbs)	Round Trips per Acre
Trucks - Water [a]	50,000	0
Trucks - Semi [a]	56,000	0
Trucks - Fuel [a]	23,500	0
Pickup Trucks	8,000	0
Scraper	88,000	0
Grader	45,000	0
Backhoe	24,000	0
Dozer	30,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.56	0.44	0.00	0.00
$PM_{2.5}$	0.056	0.044	0.00	0.00

Pad Construction Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Pad Construction Industrial Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.9	days/acre
Total acreage for all pads	85.0	acres

Vehicle Type	Weight (lbs)	Round Trips per Acre
Trucks - Water [a]	50,000	4
Trucks - Semi [a]	56,000	27
Trucks - Fuel [a]	23,500	2
Pickup Trucks	8,000	7
Scraper	88,000	1
Grader	45,000	1
Backhoe	24,000	1
Dozer	30,000	1
Mean Vehicle Weight	45,500	---
Total Round Trips	---	44

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.86	0.67	37.07	0.104
$PM_{2.5}$	0.086	0.067	3.71	0.0104

Total Well Pad Construction Fugitive Dust Emissions (tons/year)

	Unpaved Total	Paved Total	Total
	ton/year	ton/year	ton/year
PM_{10}	8.83	5.06	13.88
$PM_{2.5}$	0.88	1.24	2.12

a Truck weight is average of full load and empty weight
assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area,
so there won't be any water trucks on paved roads coming into the Project Area

Pad Construction Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	7	miles
Hours of Operation	7.2	hours per acre
Number of combo/trailer truck trips	27	trips/acre
Number of heavy haul truck trips	2	trips/acre Number
of heavy haul water trucks	4	trips/acre
Number of pickup trips	7	trips/acre
Total acreage for all pads	85.0	acres

Equations:

$$\text{Emissions (tons/pad)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/pad)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-acre)	Emissions (tons/acre)	E. Factor [e] (gram/mile)	Emissions (lb/hr-acre)	Emissions (tons/acre)	E. Factor [f] (gram/mile)	Emissions (lb/hr-acre)	Emissions (tons/acre)	Emissions (lb/hr-acre)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.87	0.0031	20.09	17.66	0.063	2.57	0.58	0.0021	19.12	5.83
CO	3.44	0.25	0.00091	4.53	3.98	0.014	11.57	2.64	0.0095	6.87	2.10
VOC	1.09	0.080	0.00029	0.79	0.69	0.0025	0.78	0.18	0.00064	0.95	0.29
SO_2	0.011	0.00082	0.0000029	0.019	0.016	0.000058	0.0074	0.0017	0.0000060	0.019	0.0057
PM_{10}	0.71	0.052	0.00019	1.25	1.09	0.0039	0.15	0.034	0.00012	1.18	0.36
$PM_{2.5}$	0.51	0.038	0.00013	0.93	0.82	0.0029	0.076	0.017	0.000062	0.87	0.27
Hazardous Air Pollutants											
Benzene	0.0086	0.00064	0.0000023	0.0063	0.0055	0.000020	0.015	0.0034	0.000012	0.0096	0.0029
Formaldehyde	0.088	0.0065	0.000023	0.065	0.057	0.00020	0.041	0.0093	0.000033	0.073	0.022
Acetaldehyde	0.039	0.0029	0.000010	0.029	0.025	0.000091	0.021	0.0047	0.000017	0.033	0.010
Acrolein	0.0073	0.00054	0.0000019	0.0053	0.0047	0.000017	0.0033	0.00074	0.0000027	0.0059	0.0018
Greenhouse Gases											
CO_2	1,231.1	90.7	0.33	2,049.4	1,801	6.5	535.08	121.92	0.44	2,014	614
CH_4	0.026	0.0019	0.0000070	0.025	0.022	0.000080	0.014	0.0033	0.000012	0.027	0.0084
N_2O	0.0027	0.00020	0.00000072	0.0027	0.0024	0.0000086	0.0081	0.0018	0.0000066	0.0045	0.0014
CO_2e [g]	---	90.8	0.33	---	1,802	6.47	---	122.55	0.44	2,016	615

a Heavy Haul trucks include water and fuel trucks

b Combo/Trailer trucks include semi trucks

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Pad Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Total acreage for all pads 85.0 acres

Scraper Hours	6.2	hours per acre	Grader Hours	6.2	hours per acre
Scraper HP [a]	422.5		Grader HP [a]	231.2	
Load Factor [b]	0.43		Load Factor [b]	0.43	
Dozer Hours	2.5	hours per acre	Backhoe Hours	2.5	hours per acre
Dozer HP [a]	136.1		Backhoe HP [a]	137.6	
Load Factor [b]	0.43		Load Factor [b]	0.43	

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

Heavy Const. Vehicles	Scraper			Dozer			Grader		
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)
Criteria Pollutants & VOC									
NOx	2.27	0.91	0.0028	1.70	0.22	0.00027	1.52	0.33	0.0010
CO	0.91	0.36	0.0011	0.74	0.095	0.00012	0.51	0.11	0.00034
VOC [d]	0.17	0.069	0.00021	0.18	0.023	0.000029	0.17	0.037	0.00011
PM_{10}	0.13	0.052	0.00016	0.18	0.023	0.000028	0.096	0.021	0.000064
$PM_{2.5}$	0.13	0.050	0.00016	0.17	0.022	0.000027	0.093	0.020	0.000063
SO_2	0.0031	0.0013	0.0000039	0.0030	0.00039	0.00000048	0.0029	0.00064	0.0000020
Greenhouse Gases									
CO_2	536.3	214.8	0.66	536.3	69.2	0.085	536.3	117.5	0.36
CO_2e [e]	---	214.8	0.66	---	69.2	0.085	---	117.5	0.36

Heavy Const. Vehicles	Backhoe			Total	
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	Emissions (lb/hr/acre)	Emissions (tons/year)
Criteria Pollutants & VOC					
NOx	1.49	0.19	0.00024	1.66	0.37
CO	0.65	0.085	0.00010	0.66	0.14
VOC [d]	0.17	0.022	0.000027	0.15	0.032
PM_{10}	0.15	0.020	0.000025	0.12	0.024
$PM_{2.5}$	0.15	0.019	0.000024	0.11	0.023
SO_2	0.0030	0.00039	0.00000048	0.0027	0.00058
Greenhouse Gases					
CO_2	536.3	70.0	0.086	471.5	101.5
CO_2e [e]	---	70.0	0.086	471.5	101.5

a Load factors from Table 9 of "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling", EPA-420-R-10-016, July 2010. Load factor as 7-cycle average.

b Horsepower from base year 2000 population counts from EPA-420-R-10-017, July 2010.

c Emission factors developed using NONROAD model, assuming Diesel Construction Equipment in Converse and Campbell County for calendar year 2016.

d Emission Factor represents total Hydrocarbon Emissions multiplied by the VOC factor of 1.053 referenced from EPA-420-R-10-015, July 2010.

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

Interim Reclamation Emissions - Equipment Fugitive Dust

Dozer Hours of Interim Reclamation	0.50	days per acre
	4.00	hours per acre
Scraper, Grader Hours of Interim Reclamation	0.83	days per acre
	6.67	hours per acre
Total acres reclaimed	17.94	acres
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 (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

	Dozer Emissions	
	lbs/hr	**tons/acre**
TSP	1.97	0.0039
PM_{15}	0.50	0.0010
PM_{10}	0.38	0.00075
$PM_{2.5}$	0.21	0.00041

Distance graded and scraped	0.60	miles/acre
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 grading

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 Emissions			Scraper Emissions		
	lbs/acre	**lbs/hr/acre**	**tons/acre**	**lbs/acre**	**lbs/hr/acre**	**tons/acre**
TSP	1.60	0.24	0.00080	1.60	0.24	0.00080
PM_{15}	0.77	0.12	0.00038	0.77	0.12	0.00038
PM_{10}	0.46	0.069	0.00023	0.46	0.069	0.00023
$PM_{2.5}$	0.050	0.0075	0.000025	0.050	0.0075	0.000025

	PM_{10}		$PM_{2.5}$	
Total for all reclaimed acres	0.022	tons/year	0.0083	tons/year

Interim Reclamation Traffic Fugitive Dust Emissions

Industrial Unpaved	E (PM_{10}) / VMT = $1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	E (PM_{10}) / VMT = $(1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	E ($PM_{2.5}$) / VMT = $(0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	E (PM_{10}) / VMT = $(1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	E ($PM_{2.5}$) / VMT = $(0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	E (PM_{10}) / VMT = $0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Interim Reclamation Paved Roads

Hours per day	8	hour/day
Days per acre	0.83	days/acre
Total reclaimed acreage	17.94	acres

Vehicle Type	Weight (lbs)	Round Trips per acre
Trucks - Water [a,b]	50,000	0
Pickup Trucks	8,000	3
Scraper	88,000	0
Grader	45,000	0
Dozer	30,000	0
Mean Vehicle Weight	8,000	---
Total Round Trips	---	3

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.0057	0.0054	0.27	0.00085
$PM_{2.5}$	0.0014	0.0013	0.067	0.00021

Interim Reclamation Public Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.83	days/acre

Vehicle Type	Weight (lbs)	Round Trips per acre
Trucks - Water [a]	50,000	0
Pickup Trucks	8,000	0
Scraper	88,000	0
Grader	45,000	0
Dozer	30,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.56	0.44	0.0	0.00
$PM_{2.5}$	0.056	0.044	0.0	0.00

Interim Reclamation Traffic Fugitive Dust Emissions

Industrial Unpaved	$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %
Public Road Unpaved	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %
Paved Calculation AP-42, Chapter 13.2.1	$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Interim Reclamation Industrial Unpaved Roads

Hours per day	8	hour/day
Days per acre	0.83	days/acre

Vehicle Type	Weight (lbs)	Round Trips per acre
Trucks - Water [a]	50,000	1
Pickup Trucks	8,000	3
Scraper	88,000	1
Grader	45,000	1
Dozer	30,000	1
Mean Vehicle Weight	33,857	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-acre	ton/acre
PM_{10}	0.76	0.59	5.56	0.014
$PM_{2.5}$	0.076	0.059	0.56	0.0014

Total Interim Reclamation Fugitive Dust Emissions (tons/year)

a Truck weight is average of full load and empty weight
assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area,
so there won't be any water trucks on paved roads coming into the Project Area

	Unpaved Total	Paved Total	Total
	ton/year	ton/year	ton/year
PM_{10}	0.26	0.015	0.27
$PM_{2.5}$	0.026	0.0038	0.030

Interim Reclamation Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	7	miles
Hours of Operation	0.83	days per acre
Number of combo/trailer truck trips	0	trips/acre
Number of heavy haul water truck trips	1	trips/acre
Number of pickup trips	3	trips/acre
Total reclaimed acreage	17.94	acres

Equations:

$$\text{Emissions (tons/acre)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/acre)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/day-acre)	Emissions (tons/acre)	E. Factor [e] (gram/mile)	Emissions (lb/day-acre)	Emissions (tons/acre)	E. Factor [f] (gram/mile)	Emissions (lb/day-acre)	Emissions (tons/acre)	Emissions (lb/day-acre)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.22	0.000091	20.09	0.0	0.0	2.57	2.16	0.00090	2.38	0.018
CO	3.44	0.064	0.000027	4.53	0.0	0.0	11.57	9.74	0.0041	9.80	0.073
VOC	1.09	0.020	0.0000084	0.79	0.0	0.0	0.78	0.66	0.00027	0.68	0.0051
SO_2	0.011	0.00021	0.00000009	0.019	0.0	0.0	0.0074	0.0062	0.0000026	0.0064	0.000048
PM_{10}	0.71	0.0132	0.0000055	1.25	0.0	0.0	0.15	0.13	0.000053	0.14	0.00104
$PM_{2.5}$	0.51	0.0094	0.0000039	0.93	0.0	0.0	0.076	0.064	0.000027	0.074	0.00055
Hazardous Air Pollutants											
Benzene	0.0086	0.00016	0.00000007	0.0063	0.0	0.0	0.015	0.013	0.0000053	0.013	0.000096
Formaldehyde	0.088	0.0016	0.00000068	0.065	0.0	0.0	0.041	0.034	0.000014	0.036	0.00027
Acetaldehyde	0.039	0.00073	0.00000030	0.029	0.0	0.0	0.021	0.017	0.0000072	0.018	0.00013
Acrolein	0.0073	0.00013	0.00000006	0.0053	0.0	0.0	0.0033	0.0027	0.0000011	0.0029	0.000022
Greenhouse Gases											
CO_2	1,231.12	22.8	0.01	2,049.36	0.0	0.0	535.08	450.2	0.19	473.0	3.54
CH_4	0.026	0.00049	0.00000020	0.025	0.0	0.0	0.014	0.012	0.0000051	0.013	0.000094
N_2O	0.0027	0.000051	0.00000002	0.0027	0.0	0.0	0.0081	0.0068	0.0000028	0.0068	0.000051
CO_2e [g]	---	22.8	0.01	---	0.0	0.0	---	452.5	0.19	475.3	3.55

a Heavy Haul trucks include water trucks

b No Combo/Trailer trucks used in interim reclamation

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Interim Reclamation Heavy Equipment Tailpipe Emissions

Assumptions:

Total reclaimed acreage	17.94	acres			
Scraper Hours	6.67	hours per acre	Grader Hours	6.67	hours per acre
Scraper HP [a]	422.5		Scraper HP [a]	231.2	
Load Factor [b]	0.43		Load Factor [b]	0.43	
Dozer Hours	4.00	hours per acre	Backhoe Hours	0.0	hours per acre
Scraper HP [a]	136.1		Scraper HP [a]	137.6	
Load Factor [b]	0.43		Load Factor [b]	0.43	

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

Heavy Const. Vehicles	Scraper			Dozer			Grader		
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)
Criteria Pollutants & VOC									
NOx	2.27	0.91	0.0030	1.70	0.22	0.00044	1.52	0.33	0.0011
CO	0.91	0.36	0.0012	0.74	0.095	0.00019	0.51	0.11	0.00037
VOC [d]	0.17	0.069	0.00023	0.18	0.023	0.000047	0.17	0.037	0.00012
PM_{10}	0.13	0.052	0.00017	0.18	0.023	0.000045	0.10	0.021	0.000070
$PM_{2.5}$	0.13	0.050	0.00017	0.17	0.022	0.000044	0.093	0.020	0.000068
SO_2	0.0031	0.0013	0.0000042	0.0030	0.00039	0.0000008	0.0029	0.00064	0.0000021
Greenhouse Gases									
CO_2	536.3	214.80	0.72	536.3	69.19	0.14	536.3	117.55	0.39
CO_2e [e]	---	214.80	0.72	---	69.19	0.14	---	117.55	0.39

Heavy Const. Vehicles	Backhoe			Total	
	E. Factor [c] (g/hp-hr)	Emissions (lb/hr/acre)	Emissions (tons/acre)	Emissions (lb/hr/acre)	Emissions (tons/year)
Criteria Pollutants & VOC					
NOx	1.49	0.0	0.0	1.46	0.082
CO	0.65	0.0	0.0	0.57	0.032
VOC [d]	0.17	0.0	0.0	0.13	0.0072
PM_{10}	0.15	0.0	0.0	0.096	0.0052
$PM_{2.5}$	0.15	0.0	0.0	0.093	0.0050
SO_2	0.0030	0.0	0.0	0.0023	0.00013
Greenhouse Gases					
CO_2	536.3	0.0	0.0	401.54	22.36
CO_2e [e]	---	0.0	0.0	401.54	22.36

a Load factors from Table 9 of "Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling", EPA-420-R-10-016, July 2010. Load factor as 7-cycle average.
b Horsepower from base year 2000 population counts from EPA-420-R-10-017, July 2010.

c Emission factors developed using NONROAD model, assuming Diesel Construction Equipment in Converse and Campbell County for calendar year 2016.
d Emission Factor represents total Hydrocarbon Emissions multiplied by the VOC factor of 1.053 referenced from EPA-420-R-10-015, July 2010.
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Wind Erosion Fugitive Dust Emissions - Construction

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for 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)
Disturbance Area	13.2	acres short term disturbance for roads
	53,305	square meters disturbance for roads
	85.0	acres short term disturbance for pads
	343,922	square meters disturbance for pads
Number of days above threshold	13.7	Number of days per year 2 minute wind is >= 40 mph (disturbances/year)
Meteorological Data	July 1999 - Dec 2008 Douglas Converse County Airport, WY	
Fastest Mile Wind Speed ($U_{10}^{+)}$)	23.7	meters/sec (53 mph) reported as average 2-minute wind speed for Douglas Airport, WY
Control for Watering	50	% control

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	Pad U_t^* Threshold Velocity m/s	Pad Erosion Potential g/m^2	Road U_t^* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
23.70	1.26	1.02	9.14	1.33	0.00

Wind Erosion Emissions

Particulate Species	Pads (tons/year)	Roads (tons/year)
PM_{10}	11.86	0.00
$PM_{2.5}$	1.78	0.00

Drilling Traffic Fugitive Dust Emissions

Industrial Unpaved	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %
Public Road Unpaved	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$		Annual
AP-42 Chapter 13.2.2, November 2006	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$		Annual
	$E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E (PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %
Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Drilling Traffic Dust Emissions

Hours per day	24	hour/day
Days per well	13.5	days/well (average)
Number of wells drilled	47	wells/year

Vehicle Type	Weight (lbs)	Round Trips per Well
Semi Trucks - Mud [a]	56,000	18
Water Trucks-unpaved[a,b]	50,000	20
Water Trucks-paved[a,b]	50,000	0
Semi Trucks - Casing [a]	56,000	12
Semi Trucks - Cement [a]	56,000	8
Septic Trucks [a]	31,000	6
Fuel Trucks [a]	23,500	4
Semis-cuttings, etc Trucks [a]	56,000	27
Pickup Trucks	8,000	70
Mean Vehicle Weight-paved	30,897	---
Mean Vehicle Weight-unpaved	33,212	---
Total Round Trips-paved	---	145
Total Round Trips-unpaved	---	165

	Emission Factor		Emissions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-well	ton/well
Paved Road PM_{10}	0.023	0.021	1.07	0.16
Paved Road $PM_{2.5}$	0.0055	0.0052	0.26	0.040
Unpaved Public Road PM_{10}	0.56	0.44	0.00	0.00
Unpaved Public Road $PM_{2.5}$	0.056	0.044	0.00	0.00
Unpaved Industrial PM_{10}	0.75	0.59	2.67	0.34
Unpaved Industrial $PM_{2.5}$	0.075	0.059	0.27	0.034

	PM_{10}		$PM_{2.5}$	
Total per well	0.50	tons/well	0.074	tons/well
Total all wells	23.59	tons/year	3.48	tons/year

a Truck weight is average of full load and empty weight assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area, so there won't be any water trucks on paved roads coming into the Project Area
Additionally, 50% of the water needed in drilling will be piped through temporary surface pipes and not trucked.

Drilling Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	7	miles
Hours of Operation	324	hours per well (average)
Number of combo/trailer truck trips	65	trips/well
Number of heavy haul truck trips	10	trips/well
Number of heavy haul water trucks	20	trips/well
Number of pickup trips	70	trips/well
Number of wells	47	wells/year

Equations:

$$\text{Emissions (tons/well)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d]	Emissions	Emissions	E. Factor [e]	Emissions	Emissions	E. Factor [f]	Emissions	Emissions	Emissions	Emissions
	(gram/mile)	(lb/hr-well)	(tons/well)	(gram/mile)	(lb/hr-well)	(tons/well)	(gram/mile)	(lb/hr-well)	(tons/well)	(lb/hr-well)	(tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.097	0.016	20.09	0.94	0.15	2.57	0.13	0.021	1.17	8.90
CO	3.44	0.028	0.0045	4.53	0.21	0.034	11.57	0.58	0.09	0.82	6.28
VOC	1.09	0.0089	0.0014	0.79	0.037	0.0060	0.78	0.040	0.0064	0.085	0.65
SO_2	0.011	0.000091	0.000015	0.019	0.00087	0.00014	0.0074	0.00037	0.000060	0.0013	0.010
PM_{10}	0.71	0.0058	0.00094	1.25	0.058	0.009	0.15	0.0076	0.0012	0.072	0.55
$PM_{2.5}$	0.51	0.0042	0.00067	0.93	0.044	0.0071	0.076	0.0039	0.00062	0.052	0.39
Hazardous Air Pollutants											
Benzene	0.0086	0.000070	0.000011	0.0063	0.00030	0.000048	0.015	0.00076	0.00012	0.0011	0.0086
Formaldehyde	0.088	0.00072	0.00012	0.065	0.0030	0.00049	0.041	0.0021	0.00033	0.0058	0.044
Acetaldehyde	0.039	0.00032	0.000052	0.029	0.0014	0.00022	0.021	0.0010	0.00017	0.0027	0.021
Acrolein	0.0073	0.000059	0.0000096	0.0053	0.00025	0.000040	0.0033	0.00016	0.000027	0.00047	0.0036
Greenhouse Gases											
CO_2	1,231.12	10.05	1.63	2,049.36	96.1	15.56	535.08	27.02	4.38	133.1	1,014
CH_4	0.026	0.00022	0.000035	0.025	0.0012	0.00019	0.014	0.00073	0.00012	0.0021	0.016
N_2O	0.0027	0.000022	0.0000036	0.0027	0.00013	0.000021	0.0081	0.00041	0.000066	0.00056	0.0043
CO_2e [g]	---	10.1	1.63	---	96.1	15.58	---	27.16	4.40	133.4	1,015

a Heavy Haul trucks include septic, fuel, and water trucks

b Combo/Trailer trucks include sand trucks, cement, casing, etc

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Drill Rig Engines

Oil Well Drilling Hours of Operation	180	hours/well
Gas Well Drilling Hours of Operation	420	hours/well
Load Factor	0.43	
Drill Rig Engines Total Power	6,000	hp
Total oil wells drilled	19	oil wells
Total gas wells drilled	28	gas wells
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value for ULSD)

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

Equations:

Emission Factor (g/hp-hr) = Emission factor (lb/MMBtu) * 7000 (Btu/hp-hr) * 453.59 (g/hp-hr) / 10^6 (Btu/MMBtu)
7000 Btu/hp-hr from AP-42 Table 3.3-1 Footnote a

$$\text{Emissions (ton/well)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * \text{Load Factor} * \text{Hours per well (hr/well)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/ton)}}$$

	Drill Rig Emissions					
Species	**E. Factor (lb/hp-hr)**	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Oil Well Emissions (tons/well)**	**Gas Well Emissions (tons/well)**	**Total Emissions (tons/year)**
Criteria Pollutants & VOC						
NOx [a]	-----	4.80	27.30	2.46	5.73	207.88
CO [a]	-----	2.60	14.79	1.33	3.11	112.60
VOC [b]	0.00064	0.29	1.66	0.15	0.35	12.60
PM_{10} [a]	-----	0.15	0.85	0.077	0.18	6.50
$PM_{2.5}$ [a]	-----	0.15	0.85	0.077	0.18	6.50
SO_2 [b]	0.000012	0.0055	0.031	0.0028	0.0066	0.24
	E. Factor (lb/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Oil Well Emissions (tons/well)**	**Gas Well Emissions (tons/well)**	**Total Emissions (tons/year)**
Hazardous Air Pollutants						
Benzene [c]	7.76E-04	0.0025	0.014	0.0013	0.0029	0.11
Toluene [c]	2.81E-04	0.00089	0.0051	0.00046	0.0011	0.039
Xylenes [c]	1.93E-04	0.00061	0.0035	0.00031	0.00073	0.027
Formaldehyde [c]	7.89E-05	0.00025	0.0014	0.00013	0.00030	0.011
Acetaldehyde [c]	2.52E-05	0.000080	0.00046	0.000041	0.00010	0.0035
Acrolein [c]	7.88E-06	0.000025	0.00014	0.000013	0.000030	0.0011
	E. Factor (kg/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Oil Well Emissions (tons/well)**	**Gas Well Emissions (tons/well)**	**Total Emissions (tons/year)**
Greenhouse Gases						
CO_2 [d]	73.96	517.7	2,944.8	265.03	618.40	22,421
CH_4 [d]	0.0030	0.021	0.12	0.011	0.025	0.91
N_2O [d]	0.00060	0.0042	0.024	0.0022	0.0050	0.18
CO_2e [e]	---	---	2,955	265.94	620.52	22,498

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, and PM)
NOx is conservatively assumed to be NOx + NMHC

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

c AP-42, Large Stationary Diesel Engines, Table 3.4-3

d 40 CFR Part 98 Subpart W indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an emission factor for diesel combustion of CO_2 and Table C-2 provides emission factors for diesel combustion of CH4 and N2O.

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

Drill Rig Move Traffic Fugitive Dust Emissions

Industrial Unpaved	E (PM_{10}) / VMT = 1.5 * $(S/12)^{0.9}$ * $(W/3)^{0.45}$ * (365-p)/365)		Annual
AP-42 Chapter 13.2.2, November 2006	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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	E (PM_{10}) / VMT = (1.8 * (s/12) * $(S/30)^{0.5}$)/$(M/0.5)^{0.2}$ * (365-p)/365)		Annual
AP-42 Chapter 13.2.2, November 2006	E ($PM_{2.5}$) / VMT = (0.18 * (s/12) * $(S/30)^{0.5}$)/$(M/0.5)^{0.2}$ * (365-p)/365)		Annual
	E (PM_{10}) / VMT = (1.8 * (s/12) * $(S/30)^{0.5}$)/$(M/0.5)^{0.2}$		Daily
	E ($PM_{2.5}$) / VMT = (0.18 * (s/12) * $(S/30)^{0.5}$)/$(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	E (PM_{10}) / VMT = 0.0022 * $(sL)^{0.91}$ * $(W)^{1.02}$ * (1-(p/(365*4))		Annual
January 2011	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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Drill Rig Move Paved Roads

Wells per Rig Move 2

Vehicle Type	Weight (lbs)	Round Trips per Move [b]
Pickup Trucks	8,000	0
Semi Trucks	80,000	0
Drill Rig Cranes	80,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Paved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-move	ton/move
PM_{10}	0.000	0.000	----	0.0
$PM_{2.5}$	0.0000	0.0000	----	0.0

`

Drill Rig Move Public Unpaved Roads

Wells per Rig Move 2

Vehicle Type	Weight (lbs)	Round Trips per Move
Pickup Trucks	8,000	0
Semi Trucks	80,000	0
Drill Rig Cranes	80,000	0
Mean Vehicle Weight	0	---
Total Round Trips	---	0

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-move	ton/move
PM_{10}	0.56	0.44	----	0.0
$PM_{2.5}$	0.056	0.044	----	0.0

Drill Rig Move Traffic Fugitive Dust Emissions

Industrial Unpaved	E (PM_{10}) / VMT = 1.5 * (S/12)$^{0.9}$ * (W/3)$^{0.45}$ * (365-p)/365)		Annual
AP-42 Chapter 13.2.2, November 2006	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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$ * (365-p)/365)		Annual
AP-42 Chapter 13.2.2, November 2006	E ($PM_{2.5}$) / VMT = (0.18 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$ * (365-p)/365)		Annual
	E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$		Daily
	E ($PM_{2.5}$) / VMT = (0.18 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	E (PM_{10}) / VMT = 0.0022 * (sL)$^{0.91}$ * (W)$^{1.02}$ * (1-(p/(365*4))		Annual
January 2011	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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Drill Rig Move Industrial Unpaved Roads

Wells per Rig Move 2

Vehicle Type	Weight (lbs)	Round Trips per Move
Pickup Trucks	8,000	10
Semi Trucks	80,000	280
Drill Rig Cranes	80,000	1.5
Mean Vehicle Weight	77,530	---
Total Round Trips	---	292

	Emission Factor		Unpaved Road Emisions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-move	ton/move
PM_{10}	1.10	0.86	----	0.87
$PM_{2.5}$	0.110	0.086	----	0.087

Total Drill Rig Move Fugitive Dust Emissions (tons/year)

a Rig moves are done within the project area, so no paved road travel

Total rig moves 24

	Unpaved Total	Paved Total	Total
	ton/year	ton/year	ton/year
PM_{10}	0.87	0.0	20.99
$PM_{2.5}$	0.087	0.0	2.10

Drill Rig Vehicle Tailpipe

Average Round Trip Distance	7	miles
Number of combo/trailer truck trips	282	trips/rig move
Number of heavy haul truck trips	0	trips/rig move
Number of pickup trips	10	trips/rig move
Total rig moves	24	

Equations:

$$\text{Emissions (tons/well)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-move)	Emissions (tons/move)	E. Factor [e] (gram/mile)	Emissions (lb/hr-move)	Emissions (tons/move)	E. Factor [f] (gram/mile)	Emissions (lb/hr-move)	Emissions (tons/move)	Emissions (lb/hr-move)	Emissions (tons/move)
Criteria Pollutants & VOC											
NOx	11.84	----	0.0	20.09	----	0.044	2.57	----	0.00020	----	1.05
CO	3.44	----	0.0	4.53	----	0.0098	11.57	----	0.00089	----	0.26
VOC	1.09	----	0.0	0.79	----	0.0017	0.78	----	0.000060	----	0.043
SO_2	0.011	----	0.0	0.019	----	0.000040	0.0074	----	0.00000057	----	0.00098
PM_{10}	0.71	----	0.0	1.25	----	0.0027	0.15	----	0.0000116	----	0.065
$PM_{2.5}$	0.51	----	0.0	0.93	----	0.0020	0.076	----	0.0000059	----	0.049
Hazardous Air Pollutants											
Benzene	0.0086	----	0.0	0.0063	----	0.000014	0.015	----	0.00000117	----	0.00036
Formaldehyde	0.088	----	0.0	0.065	----	0.00014	0.041	----	0.0000032	----	0.0035
Acetaldehyde	0.039	----	0.0	0.029	----	0.000063	0.021	----	0.0000016	----	0.0015
Acrolein	0.0073	----	0.0	0.0053	----	0.0000115	0.0033	----	0.0000003	----	0.00028
Greenhouse Gases											
CO_2	1,231.12	----	0.0	2049.36	----	4.45	535.08	----	0.041	----	107.8
CH_4	0.026	----	0.0	0.025	----	0.000055	0.014	----	0.00000111	----	0.00134
N_2O	0.0027	----	0.0	0.0027	----	0.0000059	0.0081	----	0.00000062	----	0.00016
CO_2e [g]	---	----	0.0	---	----	4.45	---	----	0.042	----	107.9

a No heavy haul trucks for drill rig moves

b Combo/Trailer trucks include semi trucks and cranes

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Completion Traffic Fugitive Dust Emissions

Industrial Unpaved	$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		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	7	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365$		Annual
AP-42 Chapter 13.2.2, November 2006	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2} * (365-p)/365)$		Annual
	$E(PM_{10}) / VMT = (1.8 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	$E(PM_{2.5}) / VMT = (0.18 * (s/12) * (S/30)^{0.5})/(M/0.5)^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Completion Traffic Dust Emissions

Hours per day	24	hour/day
Days per well	17	days/well
Number of wells	47	wells/year

Vehicle Type	Weight (lbs)	Round Trips per Well
Semi Trucks - Sand [a]	56,000	561
Water Trucks-unpaved[a,b]	50,000	1,122
Water Trucks-paved[a,b]	50,000	0
Haul Trucks [a]	50,000	34
Pickup Trucks	8,000	153
Mean Vehicle Weight-paved	45,909	---
Mean Vehicle Weight-unpaved	48,364	---
Total Round Trips-paved	---	748
Total Round Trips-unpaved	---	1870

	Emission Factor		Emissions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/hr-well	ton/well
Paved Road PM_{10}	0.034	0.032	6.56	1.27
Paved Road $PM_{2.5}$	0.0083	0.0078	1.61	0.31
Unpaved Public Road PM_{10}	0.56	0.44	0.00	0.00
Unpaved Public Road $PM_{2.5}$	0.056	0.044	0.00	0.00
Unpaved Industrial PM_{10}	0.89	0.69	28.49	4.54
Unpaved Industrial $PM_{2.5}$	0.089	0.069	2.85	0.45

	PM_{10}		$PM_{2.5}$	
Total per well	5.80	tons/well	0.76	tons/well
Total all wells	272.73	tons/year	35.93	tons/year

a Truck weight is average of full load and empty weight assuming it will be full on one leg and empty of the other leg of the round trip
b Water will come from the water wells internal to the Project Area, so there won't be any water trucks on paved roads coming into the Project Area
Additionally, 50% of the water needed in drilling will be piped through temporary surface pipes and not trucked.

Completion Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	7	miles
Hours of Operation	408	hours per well
Number of combo/trailer truck trips	561	trips/well
Number of heavy haul truck trips	34	trips/well
Number of heavy haul water trucks	1,122	trips/well
Number of pickup trips	153	trips/well
Number of wells	47	wells/year

Equations:

$$\text{Emissions (tons/well)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)} * \text{453.59 (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total	
	E. Factor [d] (gram/mile)	Emissions (lb/hr-well)	Emissions (tons/well)	E. Factor [e] (gram/mile)	Emissions (lb/hr-well)	Emissions (tons/well)	E. Factor [f] (gram/mile)	Emissions (lb/hr-well)	Emissions (tons/well)	Emissions (lb/hr-well)	Emissions (tons/year)
Criteria Pollutants & VOC											
NOx	11.84	0.73	0.15	20.09	6.46	1.32	2.57	0.22	0.046	7.41	71.09
CO	3.44	0.21	0.043	4.53	1.46	0.30	11.57	1.01	0.21	2.68	25.73
VOC	1.09	0.067	0.014	0.79	0.25	0.052	0.78	0.069	0.014	0.39	3.74
SO_2	0.011	0.00069	0.00014	0.019	0.0060	0.0012	0.0074	0.00064	0.00013	0.0073	0.070
PM_{10}	0.71	0.044	0.0090	1.25	0.40	0.082	0.15	0.013	0.0027	0.46	4.39
$PM_{2.5}$	0.51	0.032	0.0064	0.93	0.30	0.061	0.076	0.0067	0.0014	0.34	3.24
Hazardous Air Pollutants											
Benzene	0.0086	0.00053	0.000109	0.0063	0.0020	0.00041	0.015	0.0013	0.00027	0.0039	0.037
Formaldehyde	0.088	0.0055	0.00111	0.065	0.021	0.0042	0.041	0.0036	0.00073	0.030	0.29
Acetaldehyde	0.039	0.0024	0.00050	0.029	0.0093	0.0019	0.021	0.0018	0.00037	0.013	0.13
Acrolein	0.0073	0.00045	0.000092	0.0053	0.0017	0.00035	0.0033	0.00029	0.000058	0.0024	0.023
Greenhouse Gases											
CO_2	1,231.12	76.22	15.55	2,049.36	658.51	134.34	535.08	46.89	9.57	781.6	7,494
CH_4	0.026	0.0016	0.00033	0.025	0.0081	0.0017	0.014	0.0013	0.00026	0.011	0.11
N_2O	0.0027	0.00017	0.000035	0.0027	0.00088	0.00018	0.0081	0.00071	0.00014	0.0018	0.017
CO_2e [g]	---	76.3	15.57	---	658.98	134.43	---	47.13	9.62	782.4	7,502

a Heavy Haul trucks include water trucks and other completion haul trucks

b Combo/Trailer trucks include sand trucks, and rigs

c Pickup trucks include a mix of gasoline and diesel passenger trucks

d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.

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

Well Fracturing Engines

Fracturing Hours of Operation	168	hours/well
Load Factor	0.43	
Completion Engines Total Power	18,000	hp
Number of wells	47	wells/year
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value for ULSD)

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

Equations:

Emission Factor (g/hp-hr) = Emission factor (lb/MMBtu) * 7000 (Btu/hp-hr) * 453.59 (g/hp-hr) / 10^6 (Btu/MMBtu)
7000 Btu/hp-hr from AP-42 Table 3.3-1 Footnote a

$$\text{Emissions (ton/well)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * \text{Load Factor} * \text{Hours per well (hr/well)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/ton)}}$$

	Fracturing Engine Emissions				
Species	**E. Factor (lb/hp-hr)**	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Engine Emissions (tons/well)**	**Total Emissions (tons/year)**
Criteria Pollutants & VOC					
NOx [a]	-----	4.80	81.91	6.88	323.37
CO [a]	-----	2.60	44.37	3.73	175.16
VOC [b]	0.00064	0.29	4.97	0.42	19.60
PM_{10} [a]	-----	0.15	2.56	0.22	10.11
$PM_{2.5}$ [a]	-----	0.15	2.56	0.22	10.11
SO_2 [b]	0.000012	0.0055	0.094	0.0079	0.37
	E. Factor (lb/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Engine Emissions (tons/well)**	**Total Emissions (tons/year)**
Hazardous Air Pollutants					
Benzene [c]	7.76E-04	0.0025	0.042	0.0035	0.17
Toluene [c]	2.81E-04	0.00089	0.015	0.0013	0.060
Xylenes [c]	1.93E-04	0.00061	0.010	0.00088	0.041
Formaldehyde [c]	7.89E-05	0.00025	0.0043	0.00036	0.017
Acetaldehyde [c]	2.52E-05	0.000080	0.0014	0.00011	0.0054
Acrolein [c]	7.88E-06	0.000025	0.00043	0.000036	0.0017
	E. Factor (kg/MMBtu)	**E. Factor (g/hp-hr)**	**Engine Emissions (lb/hr-well)**	**Engine Emissions (tons/well)**	**Total Emissions (tons/year)**
Greenhouse Gases					
CO_2 [d]	73.96	517.7	8,834	742.08	34,878
CH_4 [d]	0.003	0.021	0.36	0.030	1.41
N_2O [d]	0.0006	0.0042	0.072	0.0060	0.28
CO_2e [e]	---	---	8,865	744.63	34,998

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, and PM)
NOx is conservatively assumed to be NOx + NMHC

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

c AP-42, Large Stationary Diesel Engines, Table 3.4-3

d 40 CFR Part 98 Subpart W indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an emission factor for diesel combustion of CO_2 and Table C-2 provides emission factors for diesel combustion of CH4 and N2O.

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

Average Produced Gas Characteristics

Gas Heat Value (wet): 1,601.3 Btu/scf

C1-C2 Wt. Fraction: 0.48
VOC Wt. Fraction: 0.49
Non-HC Wt. Fraction: 0.035
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction
Methane	62.41	16.04	10.01	0.36
Ethane	11.05	30.07	3.32	0.12
Propane	11.62	44.10	5.12	0.18
i-Butane	2.96	58.12	1.72	0.062
n-Butane	4.09	58.12	2.38	0.085
i-Pentane	1.52	72.15	1.09	0.039
n-Pentane	1.36	72.15	0.98	0.035
Hexanes	0.76	86.18	0.65	0.023
Heptanes	0.96	100.20	0.96	0.035
Octanes	0.12	114.23	0.13	0.0048
Nonanes	0.033	128.26	0.043	0.0015
Decanes	0.0067	142.29	0.0095	0.00034
Benzene	0.018	78.12	0.014	0.00052
Toluene	0.046	92.13	0.042	0.0015
Ethylbenzene	0.0015	106.16	0.0016	0.000056
Xylenes	0.021	106.16	0.022	0.00079
n-Hexane	0.41	86.18	0.35	0.013
Nitrogen	1.16	28.01	0.33	0.012
Carbon Dioxide	1.46	44.01	0.64	0.023
Hydrogen Sulfide	0.00	34.08	0.000	0.000
Total	**100**	**-**	**27.8**	**1.00**

Data from laboratory analyses

Oil Well Liquid Analysis and Resulting Tank Vent Gas Analysis

Component	Liquid Analysis mole%	Calculated Tank Vent Gas mol %	Calculated Tank Vent Gas weight %
Methane	1.2142	16.81	5.47
Ethane	1.1078	9.22	5.63
Propane	3.7015	25.75	23.06
i-Butane	1.5048	8.02	9.46
n-Butane	4.0331	18.33	21.64
i-Pentane	2.7325	6.50	9.52
n-Pentane	3.4389	6.85	10.04
Hexanes	2.6314	2.04	3.56
Heptanes	6.4499	2.12	4.30
Octanes	6.2770	0.83	1.92
Nonanes	2.3741	0.14	0.35
Decanes	57.7788	0.00020	0.0012
Benzene	0.0997	0.077	0.12
Toluene	1.4491	0.41	0.78
Ethylbenzene	0.2926	0.035	0.075
Xylenes	2.0417	0.22	0.47
n-Hexane	2.2103	1.44	2.52
2,2,4-Trimethylpentane	0.5831	0.15	0.34
Nitrogen	0.0457	0.71	0.40
Carbon Dioxide	0.0341	0.36	0.33
VOC Subtotal	**97.60**	**72.90**	**88.17**
Total	**100**	**100**	**100**

Liquid analysis is from an average of two laboratory analyses
Tank vent gas analysis is from an E&P Tank simulation

Gas Well Liquid Analysis and Resulting Tank Flash Gas Analysis

Component	Liquid Analysis mole%	Calculated Tank Vent Gas mole %	Calculated Tank Vent Gas weight %
Methane	2.74	13.62	4.72
Ethane	2.76	13.71	8.91
Propane	5.81	28.68	27.34
i-Butane	2.66	10.96	13.78
n-Butane	6.68	21.21	26.65
i-Pentane	5.21	4.69	7.32
n-Pentane	5.27	3.33	5.19
Hexanes	5.28	0.93	1.74
Heptanes	10.50	0.57	1.23
Octanes	9.92	0.16	0.39
Nonanes	3.37	0.018	0.050
Decanes	26.57	0.00050	0.0023
Benzene	0.97	0.14	0.24
Toluene	3.65	0.14	0.28
Ethylbenzene	0.30	0.0036	0.0083
Xylenes	3.76	0.039	0.089
n-Hexane	3.76	0.51	0.95
2,2,4-Trimethylpentane	0.53	0.022	0.054
Nitrogen	0.089	0.44	0.27
Carbon Dioxide	0.17	0.83	0.79
VOC Subtotal	**94.24**	**71.40**	**85.31**
Total	**100**	**100**	**100**

Liquid analysis is from an average of two laboratory analyses
Tank vent gas analysis is from an E&P Tank simulation

Operation Traffic Fugitive Dust Emissions

Industrial Unpaved	E (PM_{10}) / VMT = 1.5 * (S/12)$^{0.9}$ * (W/3)$^{0.45}$ * (365-p)/365)		Annual
AP-42 Chapter 13.2.2, November 2006	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	5	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		
	Control efficiency for water on unpaved roads		50 %

Public Road Unpaved	E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$ * (365-p)/365)		Annual
AP-42 Chapter 13.2.2, November 2006	E ($PM_{2.5}$) / VMT = (0.18 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$ * (365-p)/365)		Annual
	E (PM_{10}) / VMT = (1.8 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$		Daily
	E ($PM_{2.5}$) / VMT = (0.18 * (s/12) * (S/30)$^{0.5}$)/(M/0.5)$^{0.2}$		Daily
	Silt Content (s)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Moisture Content (M)	2.4	% - AP-42 11.9-3 Haul Truck average moisture
	Average Speed (S)	30	mph
	Round Trip Miles	0	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	Control efficiency for water on unpaved roads		0 %

Paved Calculation AP-42, Chapter 13.2.1	E (PM_{10}) / VMT = 0.0022 * (sL)$^{0.91}$ * (W)$^{1.02}$ * (1-(p/(365*4))		Annual
January 2011	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 13.2.1-2 baseline low volume roads
	Round Trip Miles	106	miles
	Precipitation Days (P)	80	days per year (Douglas Converse Airport data)
	W = average weight in tons of vehicles traveling the road		

Operation Traffic Dust Emissions

Days per year 365

Vehicle Type	Weight (lbs)	Round Trips per Day
Fresh Water Trucks-paved [a,b]	50,000	0
Fresh Water Trucks-unpaved [a,b]	50,000	0.25
Oil Tanker Trucks [a]	37,000	140
Produced Water Trucks [a]	50,000	60
Pickup Trucks	8,000	1
Mean Vehicle Weight-paved	40,736	---
Mean Vehicle Weight-unpaved	40,748	---
Total Round Trips-paved	---	201
Total Round Trips-unpaved	---	201.25

	Emission Factor		Emissions	
	Daily	Annual		
	lb/VMT	lb/VMT	lb/day	ton/year
Paved Road PM_{10}	0.030	0.028	637.05	109.88
Paved Road $PM_{2.5}$	0.0073	0.0069	156.37	26.97
Unpaved Public Road PM_{10}	0.56	0.44	0.00	0.00
Unpaved Public Road $PM_{2.5}$	0.056	0.044	0.00	0.00
Unpaved Industrial PM_{10}	0.82	0.64	827.4	117.86
Unpaved Industrial $PM_{2.5}$	0.082	0.064	82.74	11.79

	PM_{10}		$PM_{2.5}$	
Total	227.74	tons/year	38.76	tons/year

a Truck weight is average of full load and empty weight assuming it will be full on one leg and empty of the other leg of the round trip.
b Water will come from the water wells internal to the Project Area, so there won't be any water trucks on paved roads coming into the Project Area

Operation Vehicle Tailpipe

Average Round Trip Distance	106	miles
Avg Round Trip for Water Trucks	7	miles
Hours of Operation	365	days/year
Number of combo/trailer truck trips	0	trips/all wells/day
Number of heavy haul truck trips	200	trips/all wells/day
Number of water truck trips	0.25	trips/all wells/day
Number of pickup trips	1	trips/all wells/day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Trips (trip/all wells/day)} * \text{Trip Distance (miles/trip)} * 365 \text{ days/yr}}{2000 \text{ (lb/ton)} * 453.59 \text{ (gram/lb)}}$$

Development Vehicles	Heavy Haul Trucks [a]			Combo/Trailer Trucks [b]			Pickup Trucks [c]			Total
	E. Factor [d] (gram/mile)	Emissions (lb/day)	Emissions (tons/year)	E. Factor [e] (gram/mile)	Emissions (lb/day)	Emissions (tons/year)	E. Factor [f] (gram/mile)	Emissions (lb/day)	Emissions (tons/year)	Emissions (tons/year)
Criteria Pollutants & VOC										
NOx	11.84	553.45	101.00	20.09	0.0	0.0	2.57	0.60	0.11	101.11
CO	3.44	160.70	29.33	4.53	0.0	0.0	11.57	2.70	0.49	29.82
VOC	1.09	50.82	9.27	0.79	0.0	0.0	0.78	0.18	0.033	9.31
SO_2	0.011	0.52	0.10	0.019	0.0	0.0	0.0074	0.0017	0.00031	0.10
PM_{10}	0.71	33.20	6.06	1.25	0.0	0.0	0.15	0.035	0.0064	6.07
$PM_{2.5}$	0.51	23.80	4.34	0.93	0.0	0.0	0.076	0.018	0.0033	4.35
Hazardous Air Pollutants										
Benzene	0.0086	0.40	0.074	0.0063	0.0	0.0	0.015	0.0035	0.00064	0.074
Formaldehyde	0.088	4.12	0.75	0.065	0.0	0.0	0.041	0.010	0.0017	0.75
Acetaldehyde	0.039	1.84	0.34	0.029	0.0	0.0	0.021	0.0048	0.00088	0.34
Acrolein	0.0073	0.34	0.062	0.0053	0.0	0.0	0.0033	0.00076	0.00014	0.062
Greenhouse Gases										
CO_2	1,231.12	57545	10,502	2,049.36	0.0	0.0	535.08	125.04	22.82	10,525
CH_4	0.026	1.24	0.23	0.025	0.0	0.0	0.014	0.0034	0.00061	0.23
N_2O	0.0027	0.13	0.023	0.0027	0.0	0.0	0.0081	0.0019	0.00034	0.024
CO_2e [g]	---	57,614	10,515	---	0.0	0.0	---	125.69	22.94	10,538

a Heavy haul trucks inlude oil tanker trucks and water trucks
b No Combo/Trailer trucks for daily operations
c Pickup trucks include a mix of gasoline and diesel passenger trucks
d Emission factors developed using EPA MOVES2014 model, assuming Diesel Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.
e Emission factors developed using EPA MOVES2014 model, assuming Diesel Combination Short Haul Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.
f Emission factors developed using EPA MOVES2014 model, assuming Passenger Gasoline and Diesel Trucks, traveling an average of 30 mph in Converse and Campbell County, for calendar year 2016.
g Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Oil Well Storage Tank Flashing, Working, and Breathing Emissions

Production Rate :	508.5	bbls oil/day/well
Number of oil wells:	19	wells
Control Efficiency of tanks:	98	%

COMPONENT	Per Well Uncontrolled Emissions (lb/hr)	Per Well Uncontrolled Emissions (ton/yr)	Per Well Controlled Emissions (lb/hr)	Per Well Controlled Emissions (ton/yr)	Total Oil Well Controlled Emissions (lb/hr)	Total Oil Well Controlled Emissions (ton/yr)
Carbon Dioxide	0.28	1.20	0.28	1.20	5.23	22.89
Nitrogen	0.34	1.50	0.34	1.50	6.50	28.46
Methane	4.63	20.28	0.093	0.41	1.76	7.71
Ethane	4.76	20.86	0.095	0.42	1.81	7.93
Propane	19.51	85.43	0.39	1.71	7.41	32.46
i-Butane	8.00	35.05	0.16	0.70	3.04	13.32
n-Butane	18.30	80.17	0.37	1.60	6.96	30.46
i- Pentane	8.05	35.26	0.16	0.71	3.06	13.40
n-Pentane	8.50	37.21	0.17	0.74	3.23	14.14
Hexanes	2.94	12.87	0.059	0.26	1.12	4.89
Heptanes	3.52	15.44	0.070	0.31	1.34	5.87
Octanes	1.57	6.89	0.031	0.14	0.60	2.62
Nonanes	0.29	1.25	0.0057	0.025	0.11	0.48
Decanes +	0.0010	0.0044	0.000020	0.000088	0.00038	0.0017
Benzene	0.10	0.45	0.0021	0.0090	0.039	0.17
Toluene	0.66	2.87	0.013	0.057	0.25	1.09
Ethylbenzene	0.063	0.28	0.0013	0.0055	0.024	0.10
Xylenes	0.40	1.74	0.0079	0.035	0.15	0.66
n-Hexane	2.13	9.35	0.043	0.19	0.81	3.55
2,2,4-Trimethylpentane	0.29	1.25	0.0057	0.025	0.11	0.48
VOC Subtotal	**74.32**	**325.52**	**1.49**	**6.51**	**28.24**	**123.70**
HAP Subtotal	**3.64**	**15.94**	**0.073**	**0.32**	**1.38**	**6.06**
TOTAL	**84.33**	**369.36**	**2.29**	**10.04**	**43.53**	**190.68**

a Emissions calculated using E&P Tanks 2.0 for flashing, working and breathing

b Uncontrolled emissions are the tank emissions prior to the combustor

c Controlled emissions are the tank emissions going to the combustor

Gas Well Storage Tank Flashing, Working, and Breathing Emissions

Production Rate :	255.7	bbls oil/day/well
Number of gas wells:	28	wells
Control Efficiency of tanks:	98	%

COMPONENT	Per Well Uncontrolled Emissions (lb/hr)	Per Well Uncontrolled Emissions (ton/yr)	Per Well Controlled Emissions (lb/hr)	Per Well Controlled Emissions (ton/yr)	Total Gas Well Controlled Emissions (lb/hr)	Total GasWell Controlled Emissions (ton/yr)
Carbon Dioxide	1.93	8.45	1.93	8.45	54.04	236.70
Nitrogen	0.65	2.86	0.65	2.86	18.31	80.21
Methane	11.56	50.62	0.23	1.01	6.47	28.35
Ethane	21.80	95.49	0.44	1.91	12.21	53.47
Propane	66.90	293.00	1.34	5.86	37.46	164.08
i-Butane	33.71	147.65	0.67	2.95	18.88	82.68
n-Butane	65.21	285.60	1.30	5.71	36.52	159.94
i- Pentane	17.91	78.45	0.36	1.57	10.03	43.93
n-Pentane	12.70	55.61	0.25	1.11	7.11	31.14
Hexanes	4.14	18.13	0.083	0.36	2.32	10.15
Heptanes	2.92	12.79	0.058	0.26	1.64	7.16
Octanes	0.93	4.06	0.019	0.081	0.52	2.27
Nonanes	0.12	0.52	0.0024	0.010	0.067	0.29
Decanes +	0.0060	0.026	0.00012	0.00053	0.0034	0.015
Benzene	0.60	2.62	0.012	0.052	0.33	1.47
Toluene	0.69	3.00	0.014	0.060	0.38	1.68
Ethylbenzene	0.020	0.088	0.00040	0.0018	0.011	0.049
Xylenes	0.22	0.95	0.0043	0.019	0.12	0.53
n-Hexane	2.32	10.16	0.046	0.20	1.30	5.69
2,2,4-Trimethylpentane	0.13	0.57	0.0026	0.011	0.073	0.32
VOC Subtotal	**208.50**	**913.24**	**4.17**	**18.26**	**116.76**	**511.41**
HAP Subtotal	**3.97**	**17.40**	**0.079**	**0.35**	**2.22**	**9.74**
TOTAL	**244.44**	**1070.67**	**7.42**	**32.50**	**207.79**	**910.14**

a Emissions calculated using E&P Tanks 2.0 for flashing, working and breathing
b Uncontrolled emissions are the tank emissions prior to the combustor
c Controlled emissions are the tank emissions going to the combustor

Truck Loadout

Oil Loading - Oil well	508.5	barrels/day/oil well
Oil Loading - Gas well	255.7	barrels/day/gas well
Number of oil wells	19	oil wells
Number of gas wells	28	gas 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	VOC tpy-well	VOC tpy total
Oil - oil wells [a]	0.6	2.05	49	505	1.49	508	5.81	110.42
Oil - gas wells [b]	0.6	2.05	46	505	1.40	256	2.75	77.02

	Oil well loading tpy-well [c]	Gas well loading tpy-well [c]	Loading tpy-field [c]
Hazardous Air Pollutants			
Benzene	0.0080	0.0079	0.37
Toluene	0.051	0.0090	1.22
Ethylbenzene	0.0049	0.00027	0.10
Xylenes	0.031	0.0029	0.67
n-Hexane	0.17	0.031	4.02
2,2,4-TMP	0.022	0.0017	0.47
Greenhouse Gases			
CO2	0.021	0.025	1.12
CH4	0.36	0.15	11.12
CO2e	9.0	3.8	279.11

Notes:
a Vapor molecular weight based on E&P tank report for oil wells and pressure based on AP-42 Table 7.1-2 for RVP 5
b Vapor molecular weight based on E&P tank report for gas wells and pressure based on AP-42 Table 7.1-2 for RVP 5
c Emissions estimated based on weight fractions calculated from tank vent gas emissions

Pneumatic Controller Emissions

Pneumatic Device Emissions [a] 1.39 scf/hr Number of wells 47
Number of pneumatic controllers per well 4 controllers/well

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr-well)	Mass Flow Rate (lb/hr-well)	Mass Flow Rate (tons/yr-well)	Mass Flow Rate (tons/year)
Methane	16.04	62.41	10.01	35.97	3.47	0.15	0.64	30.20
Ethane	30.07	11.05	3.32	11.93	0.61	0.049	0.21	10.02
Propane	44.10	11.62	5.12	18.41	0.65	0.075	0.33	15.45
i-Butane	58.12	2.96	1.72	6.17	0.16	0.025	0.11	5.18
n-Butane	58.12	4.09	2.38	8.54	0.23	0.035	0.15	7.17
i-Pentane	72.15	1.52	1.09	3.93	0.084	0.016	0.070	3.30
n-Pentane	72.15	1.36	0.98	3.53	0.076	0.014	0.063	2.96
Hexanes	86.18	0.76	0.65	2.34	0.042	0.010	0.042	1.97
Heptanes	100.20	0.96	0.96	3.46	0.053	0.014	0.062	2.90
Octanes	114.23	0.12	0.13	0.48	0.0065	0.0020	0.0086	0.40
Nonanes	128.26	0.033	0.043	0.15	0.0019	0.00063	0.0027	0.13
Decanes +	142.29	0.0067	0.0095	0.034	0.00037	0.00014	0.00061	0.029
Benzene	78.12	0.018	0.014	0.052	0.0010	0.00021	0.00092	0.043
Toluene	92.13	0.046	0.042	0.15	0.0025	0.00062	0.0027	0.13
Ethylbenzene	106.16	0.0015	0.0016	0.0056	0.000081	0.000023	0.00010	0.0047
Xylenes	106.16	0.021	0.022	0.079	0.0012	0.00032	0.0014	0.066
n-Hexane	86.18	0.41	0.35	1.27	0.023	0.0052	0.023	1.07
Nitrogen	28.01	1.16	0.33	1.17	0.065	0.0048	0.021	0.98
Carbon Dioxide	44.01	1.46	0.64	2.31	0.081	0.0094	0.041	1.94
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000	0.00
VOC Subtotal		23.91	13.53	48.61	1.33	0.20	0.87	40.80
HAP Subtotal		0.50	0.43	1.56	0.028	0.0063	0.028	1.31
CO2e Subtotal		---	---	---	---	3.68	16.10	756.91
Total		100.00	27.83	100.00	5.56	0.41	1.79	83.95

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

Production Heater Emissions

Assumptions

Heater Treater Size	0.75	MMBtu/hr
Indirect Heater Size	0.5	MMBtu/hr
Glycol Heater Size	0.85	MMBtu/hr
Fuel Gas Heat Value	1,601	Btu/scf
Heater treaters per well	1	heater treaters
Indirect heaters per well	1	indirect heaters
Glycol heaters per well	1	glycol heaters
Number of wells	47	wells

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Heater Rating (MMBtu/hr)} * 8760 \text{ (hours/year)} * \text{Fuel Gas Heat Value (Btu/scf)}}{2{,}000 \text{ (lbs/ton)} * 1{,}020 \text{ (Btu/scf - AP -42 Standard Fuel Heating Value)} * 1{,}020 \text{ (Btu/scf - Standard Fuel Heating Value)}}$$

	Heater Treaters			Indirect Heaters			Glycol Heaters			Total Heaters	
	Emission Factor (lb/MMscf)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (lb/MMscf)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (lb/MMscf)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC											
NOx [a]	100	0.12	0.51	100	0.077	0.34	100	0.13	0.57	15.19	66.54
CO [a]	84	0.097	0.42	84	0.065	0.28	84	0.11	0.48	12.76	55.89
VOC [b]	5.5	0.0063	0.028	5.5	0.0042	0.019	5.5	0.0072	0.032	0.84	3.66
SO_2 [b]	0.6	0.00069	0.0030	0.6	0.00046	0.0020	0.6	0.00078	0.0034	0.091	0.40
PM_{10} [b]	7.6	0.0088	0.038	7.6	0.0058	0.026	7.6	0.0099	0.044	1.15	5.06
$PM_{2.5}$ [b]	7.6	0.0088	0.038	7.6	0.0058	0.026	7.6	0.0099	0.044	1.15	5.06
Hazardous Air Pollutants											
Benzene [c]	2.10E-03	2.42E-06	1.06E-05	2.10E-03	1.62E-06	7.08E-06	2.10E-03	2.75E-06	1.20E-05	0.00032	0.0014
Toluene [c]	3.40E-03	3.92E-06	1.72E-05	3.40E-03	2.62E-06	1.15E-05	3.40E-03	4.45E-06	1.95E-05	0.00052	0.0023
Hexane [c]	1.80E+00	2.08E-03	9.10E-03	1.80E+00	1.39E-03	6.07E-03	1.80E+00	2.35E-03	1.03E-02	0.27	1.20
Formaldehyde [c]	7.50E-02	8.66E-05	3.79E-04	7.50E-02	5.77E-05	2.53E-04	7.50E-02	9.81E-05	4.30E-04	0.011	0.050
Greenhouse Gases	Emission Factor (kg/MMBtu)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (kg/MMBtu)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emission Factor (kg/MMBtu)	Emissions (lb/hr/unit)	Emissions (tons/yr/unit)	Emissions (lb/hr)	Emissions (tons/yr)
CO_2 [d]	53.06	87.73	384.27	53.06	58.49	256.18	53.06	99.43	435.50	11,546	50,569
CH_4 [d]	0.001	0.0017	0.0072	0.001	0.0011	0.0048	0.001	0.0019	0.0082	0.22	0.95
N_2O [d]	0.0001	0.00017	0.00072	0.0001	0.00011	0.00048	0.0001	0.00019	0.00082	0.022	0.10
CO_2e [e]	---	87.82	384.66	---	58.55	256.44	---	99.53	435.95	11,557	50,622

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 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 emission factor for CO_2, and Table C-2 provides emission factors for CH_4 and N_2O.

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

Dehydrator Emissions

Assumptions

Number of Dehydrators per well:	1	dehydrators/well
Number of producing wells:	47	wells
Production Rate:	2.44	MMscfd/field

Average Gas Analysis 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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

98 % Control Efficiency

	Uncontrolled Emissions		**Controlled Emissions**			
Species	Dehydrator Emissions (lb/hr-dehy)	Dehydrator Emissions (tons/year-dehy)	Dehydrator Emissions (lb/hr-dehy)	Dehydrator Emissions (tons/year-dehy)	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)
VOC	12.42	54.41	0.25	1.09	11.68	51.15
Hazardous Air Pollutants						
Benzene	1.00	4.40	0.020	0.088	0.94	4.14
Toluene	4.52	19.81	0.090	0.40	4.25	18.62
Ethylbenzene	0.15	0.64	0.0029	0.013	0.14	0.60
Xylenes	3.85	16.88	0.077	0.34	3.62	15.87
n-Hexane	0.08	0.34	0.002	0.007	0.072	0.32
Greenhouse Gases						
CO_2	0.75	3.28	0.75	3.28	35.16	154.0
CH_4	3.20	14.00	0.064	0.28	3.00	13.16
CO_2e	80.6	353.2	2.3	10.3	110.2	482.9

Oil and Gas Well Fugitives Number of wells 47

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-well)
Valves - Gas	54	8,760	0.49	4.50E-03	9.92E-03	1.14
Valves - Light Oil	15	8,760	0.85	2.50E-03	5.51E-03	0.31
Valves - Heavy Oil	0	8,760	---	8.40E-06	1.85E-05	----
Valves - Water/Lt. Oil	8	8,760	0.85	9.80E-05	2.16E-04	0.0065
Connectors - Gas	186	8,760	0.49	2.00E-04	4.41E-04	0.17
Connectors - Light Oil	53	8,760	0.85	2.10E-04	4.63E-04	0.092
Connectors - Heavy Oil	0	8,760	---	7.50E-06	1.65E-05	----
Connectors - Water/ Lt. Oil	27	8,760	0.85	1.10E-04	2.43E-04	0.024
Open-Ended Lines - Gas	6	8,760	0.49	2.00E-03	4.41E-03	0.056
Open-Ended Lines - Light Oil	2	8,760	0.85	1.40E-03	3.09E-03	0.023
Open-Ended Lines - Heavy Oil	0	8,760	---	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.85	2.50E-04	5.51E-04	0.0021
Flanges - Gas	0	8,760	0.49	3.90E-04	8.60E-04	----
Flanges - Light Oil	12	8,760	0.85	1.10E-04	2.43E-04	0.011
Flanges - Heavy Oil	0	8,760	---	3.90E-07	8.60E-07	----
Flanges - Water/Lt. Oil	4	8,760	0.85	2.90E-06	6.39E-06	0.00010
Other - Gas	4	8,760	0.49	8.80E-03	1.94E-02	0.17
Other - Light Oil	1	8,760	0.85	7.50E-03	1.65E-02	0.062
Other - Heavy Oil	0	8,760	---	3.20E-05	7.05E-05	----
Other - Water/Lt. Oil	1	8,760	0.85	1.40E-02	3.09E-02	0.12
VOC EMISSIONS (tons/yr)					102.52	

VOC Emissions (tons/yr) = Emission Factor (lb/hr-unit) * 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-1B and Table W-1C.

b VOC and HAP weight fractions from gas analysis and tank emissions.

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

	Gas Weight Fraction of VOC	Oil Weight Fraction of VOC	Total Emissions (tpy-well)	Total Emissions (tpy)
Benzene Emissions	0.0011	0.0029	0.0035	0.16
Toluene Emissions	0.0031	0.0033	0.0065	0.31
Ethylbenzene Emissions	0.00011	0.000097	0.00023	0.011
Xylene Emissions	0.0016	0.0010	0.0031	0.14
n-Hexane Emissions	0.026	0.011	0.046	2.16

Oil and Gas 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-well)	CO_2 Emissions (tons/yr-well)	CO_2e Emissions (tons/yr)
Valves - Gas	54	8,760	0.62	0.015	0.121	0.76	0.049	890.37
Valves - Light Liquid	23	8,760	0.14	0.0083	0.050	0.029	0.0048	34.34
Connectors - Gas	186	8,760	0.62	0.015	0.017	0.37	0.023	430.88
Connectors - Light Liquid	80	8,760	0.14	0.0083	0.007	0.014	0.0024	16.72
Open-Ended Lines - Gas	6	8,760	0.62	0.015	0.031	0.022	0.0014	25.35
Open-Ended Lines - Light Liquid	3	8,760	0.14	0.0083	0.050	0.0038	0.00063	4.48
Flanges - Light Liquid	16	8,760	0.14	0.0083	0.003	0.0012	0.00020	1.43
Other - Gas (PRV)	4	8,760	0.62	0.015	0.193	0.089	0.0057	105.20
Other - Light Liquid	2	8,760	0.14	0.0083	0.3	0.015	0.0025	17.92
EMISSIONS (tons/yr-well)					1.30	0.090	1,526.7	

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 and tank emissions

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

Flare Emissions

Assumptions:

Maximum Heat Rating per Flare	2.4	MMBtu/hr
Pilot Gas used per Flare	16.4	scf/hr
Heating Value of Pilot Gas	1,601	Btu/scf
Total Heat Rating per Flare with Pilot	2.43	MMBtu/hr
Number of flares per well	1	flares/well
Number of wells	47	wells

	Emission Factor (kg/MMBtu)	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions (lb/hr)	Total Emissions (tons/yr)
Criteria Pollutants						
NOx [a]	----	0.14	0.34	1.49	15.96	69.93
CO [a]	----	0.035	0.085	0.37	3.99	17.48
Greenhouse Gases						
CO2 [b]	53.06	----	283.8	1,243.1	13,339	58,426
CH4 [b]	0.001	----	0.0053	0.023	0.251	1.10
N2O [b]	0.0001	----	0.00053	0.0023	0.025	0.11
CO2e	---	---	284.1	1,244.4	13,353	58,486

a Emission factors from Wyoming DEQ C6 S2 O&G Production Facilities Permitting Guidance September 2013
b 40 CFR Part 98 Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment.

Generator Engines

Assumptions:

Number of Wellpads	16	facilities
Number of Generator Engines per wellpad	1	engine
Generator Engine Rating	300	hp

Pollutant	Emission Factor (g/hp-hr)	Emissions per engine (lb/hr-generator)	Emissions per engine (tons/yr-generator)	Emissions [g] Total (tons/yr)
Criteria Pollutants & VOC				
NOx [b]	1.0	0.66	2.90	46.35
CO [b]	2.0	1.32	5.79	92.70
VOC [b]	0.7	0.46	2.03	32.45
PM_{10} [c]	7.22E-02	0.048	0.21	3.35
$PM_{2.5}$ [c]	7.22E-02	0.048	0.21	3.35
SO_2 [c]	2.19E-03	0.0014	0.0063	0.10
Hazardous Air Pollutants [c]				
Acetaldehyde	1.04E-02	0.0069	0.030	0.48
Acrolein	9.78E-03	0.0065	0.028	0.45
Benzene	5.88E-03	0.0039	0.017	0.27
Ethylbenzene	9.22E-05	0.000061	0.00027	0.0043
Formaldehyde	7.62E-02	0.050	0.22	3.53
Methanol	1.14E-02	0.0075	0.033	0.53
Toluene	2.08E-03	0.0014	0.0060	0.096
Xylene	7.25E-04	0.00048	0.0021	0.034
Greenhouse Gases				
CO_2 [d]	436.2	288	1,263	20,216
CH_4 [e]	8.22E-03	0.0054	0.024	0.38
N_2O [e]	8.22E-04	0.00054	0.0024	0.038
CO_2e [f]	---	289	1,265	20,237

a Assumes maximum development scenario
b Emission factors compliant with 40 CFR Part 60 Subpart JJJJ for engines > 100 hp with applicable manufacture dates
c AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, converted to lb/hp-hr using 8200 Btu/hp-hr.
d 40 CFR Part 98 Subpart C, Table C-1
e 40 CFR Part 98 Subpart C, Table C-2
f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.
g Assumes maximum development scenario