APPENDICIES

APPENDIX A

Interdisciplinary Team Analysis Record Checklist & Resources Considered and Dismissed from Further Analysis

INTERDISCIPLINARY TEAM CHECKLIST

Project Title: Dominion River Bend Unit Infill Project

NEPA Log Number: UT-080-07-772

File/Serial Number:

Project Leader:

DETERMINATION OF STAFF: ***(Choose one of the following abbreviated options for the left column)***

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

NC = (DNAs only) actions and impacts not changed from those disclosed in the existing NEPA documents cited in Section D of the DNA form. The Rationale column may include NI and NP discussions.

Determi-nation	Resource	Rationale for Determination*	Signature	Date
RESOURCES AND ISSUES CONSIDERED (INCLUDES SUPPLEMENTAL AUTHORITIES APPENDIX 1 H-1790-1)				
PI	Air Quality	Additional compression proposed. Also air quality impacts from equipment associated with the construction, drilling, completion, and production of new wells.	Stephanie Howard	01/06/2012
NP	Areas of Critical Environmental Concern	A review of the GIS layers for the Vernal Record of Decision and Resource Management Plan found that this resource was not present within the proposed project area.	Jason R. West	1-05-2012
NP	BLM Natural Areas	No BLM natural areas exist in the project area.	Jason R. West	1-05-2012
PI	BLM Sensitive Plant Species	Sandy soils in the vicinity of the proposed project may provide suitable habitat for the UT BLM sensitive plant species *Yucca sterilis*.	Aaron Roe	1/9/12
PI	Cultural Resources	Cultural resources occur in the project area. Portions of the project area have not been covered by cultural resource inventories. Class III cultural resource inventories as well as consultation and coordination with the Utah SHPO will be conducted prior to any surface disturbing activities. Cultural resources that are determined to be eligible for inclusion into the National Register of Historic Places will avoided by the project or have potential adverse impacts mitigated.	Cameron Cox	8/17/2012
PI	Environmental Justice	No minority or economically disadvantaged communities or populations would not be disproportionately affected	Stephanie Howard	01/06/2012

Determi-nation	Resource	Rationale for Determination*	Signature	Date
		by the proposed action or alternatives. However, the project will generate financial support for the Ute Tribe.		
NP	Farmlands (Prime or Unique)	There are no designated prime or unique farmlands in the Vernal Field Office area.	Stephanie Howard	01/06/2012
PI	Fish and Wildlife Excluding USFWS Designated Species	Roundtail chub, bluehead sucker, and flannel mouth sucker habitat within ½ mile of the project area. There are at least 15 bald eagle roosts within ½ mile of the project area along the Green River. Also golden eagle, red-tailed hawk and American kestrel nests found within or within ½ mile of the project area. The proposed area contains white-tailed prairie dog habitat as well as burrowing owl habitat. The proposed area contains UDWR-designated crucial value and year-long fawning habitat for pronghorn antelope; crucial value and year-long fawning habitat for mule deer.	Daniel Emmett	8/16/2012
PI	Floodplains	Floodplains will be avoided wherever possible. However, when they can't be, mitigation or avoidance measures will be implemented by applying appropriate Best Management Practices (BMPs), Applicant Committed Measures, or as part of Conditions of Approval (COAs). HUD inventoried floodplains are rare within the project area however numerous ephemeral drainages with non-HUD inventoried floodplains are present.	Stan Olmstead	1/31/2012
PI	Fuels/Fire Management	No planned fuel treatments in the area. The proposed disturbances may increase the chance of invasive species, primarily *Bromus tectorum.,* An increase of *Bromus tectorum* may raise the frequency and rate of spreads of wildfires in the area. The proposed reclamation standards should minimize the potential for invasive species.	Blaine Tarbell	01/09/12
NI	Geology / Mineral Resources/Energy Production	Compliance with existing BLM construction restrictions on slopes and construction design will cause the possibility of the project initiating landslides, other mass movements, or flooding to be unlikely. Natural gas, oil, Gilsonite, oil shale, and tar sand are the only mineral resources that could be impacted by the project. Production of natural gas or oil would deplete reserves, but the proposed project allows for the recovery of natural gas and oil per 43 CFR 3162.1(a), under the existing Federal lease. Compliance with "Onshore Oil and Gas Order No. 2, Drilling Operations" will assure that the project will not adversely affect gilsonite, oil shale, or tar sand deposits. Due to the state-of-the-art drilling and well completion techniques, the possibility of adverse	Elizabeth Gamber	1/9/2012

Determi-nation	Resource	Rationale for Determination*	Signature	Date
		degradation of tar sand or oil shale deposits by the proposed action will be negligible. Well completion must be accomplished in compliance with "Onshore Oil and Gas Order No. 2, Drilling Operations". These guidelines specify the following: *"Proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use."*		
PI	Greenhouse Gas Emissions	Emissions of Greenhouse Gases are anticipated to occur.	Stephanie Howard	1/9/2012
PI	Hydrologic Conditions (stormwater)	Analyze each of the alternatives for surface water flow pattern changes due to the project to understand how water flow patterns impact erosion. Stormwater analysis for Section 402 of the Clean Water Act also needs to be performed however the Energy Policy Act of 2005 exempted much of the stormwater requirements for energy exploration and this should be explained.	Stan Olmstead	1/31/2012
PI	Invasive Plants/Noxious Weeds, Soils, and Vegetation	The proposed project will result in disturbance to the native plant community. Surface disturbance associated with the proposed project will provide suitable habitat for the establishment and spread of non-native plant species. Measures that meet at least the requirements of the Vernal Surface Disturbance Weed Policy need to be incorporated. Potential for increased soil erosion and/or sedimentation from increased surface disturbance.	Aaron Roe	1/9/12
NI	Lands/Access	The surface ownership in the RBU Project Area consists of BLM land administered by the Vernal Field Office (17,301 acres, Uintah and Ouray Indian Reservation administered by the Bureau of Indian Affairs (BIA) (3,847 acres), and State land administered by the School and Institutional Trust Lands Administration (SITLA) (640 acres). The proposed area is located within the Vernal Field Office Resource Management Plan, which allows for oil and gas development with associated road	Margo Roberts	01/10/2012

Determi-nation	Resource	Rationale for Determination*	Signature	Date
		and pipeline rights-of-way. Current land uses, within the area identified in the proposed action and adjacent lands, consist of existing oil and gas development, Gilsonite mining, wildlife habitat, recreational use, and sheep and cattle ranching. No existing land uses would be changed or modified by the implementation of the proposed action; therefore, there would be no impact. If the proposed new construction for roads or pipelines is located outside of the RBU Unit Boundaries, rights-of-way would be required.		
NP	Lands with Wilderness Characteristics (LWC)	Inventories found no wilderness character existed within the proposed project area.	Jason R. West	8/15/2012
PI	Livestock Grazing	The loss of vegetation due to the surface disturbances would likely be irretrievable due to the low precipitation and shallow soils. This loss of vegetation would reduce livestock and wildlife forage. The proposed project does lie within a sheep allotment; therefore additional fragmentation from roads and pipelines could also impact the sheep grazing operation.	Dusty Carpenter	1-20-12
PI	Migratory Birds	Migratory birds/habitat will be impacted by the Proposed Action. Part of the analysis area is encompassed by a designated Bird Habitat Conservation Area (BHCA-BCR #10).	Daniel Emmett	8/16/2012
NP	Native American Religious Concerns	Consultations with Native American Tribes were initiated on September 2, 2010. No concerns were brought forth during the process.	Cameron Cox	8/17/2012
PI	Paleontology	Potential impact due to high presence for paleontologic resources in the project area. At the site specific level, a paleontologic survey must be completed for each well site in this project area before any construction on the associated well pad, access road, or pipeline can begin. The recommended mitigation included in each paleo survey must be followed to protect existing paleo resources.	Elizabeth Gamber	1/9/2012
PI	Rangeland Health Standards	Rangeland Health was analyzed in 2006 for the area; however, since then there has been a large increase in oil and gas mineral extraction development. Rangeland Health has not been reevaluated since the oil and gas boom, therefore, it cannot be assumed that the area is still meeting rangeland health for the following two standards. Utah Rangeland Health Standard #1 requires that "upland soils exhibit permeability and infiltration rates that sustain	Dusty Carpenter	1/20/2012

Determi-nation	Resource	Rationale for Determination*	Signature	Date
		or improve site productivity, considering the soil type, climate and landform". Increased soil erosion and soil compaction could potentially result in a failure to achieve Rangeland Health Standard #1. See soils section for analysis. Further increase in surface disturbance could cause the allotment to not meet Utah Rangeland Health standards #3 (due to increased invasive species due to disturbance which decreases the desired species). See weeds section for analysis.		
NI	Recreation	The proposed project is part of the VFO Extensive Recreation Management Area (ERMA). The area is a heavily developed extraction field, and currently limited recreation takes place, with occasional hunters visiting the area, Occasional 4x4 truck use and occasional ATV/Motorcycle use.	Jason West	8/15/2012
PI	Socio-Economics	The Proposed Action would affect the socio-economics of local cities and towns surrounding the project area. Project area work crews would likely increase local revenue through expenditures on lodging, meals, and supplies.	Stephanie Howard	01/06/2012
PI	Threatened, Endangered or Candidate Animal Species	Razorback sucker, Colorado pikeminnow, Humpback chub, and bonytail habitat within ½ mile of the project area within the Green River. Potential yellow-billed cuckoo habitat within ½ mile of the project area along cottonwood stands along the Green River. Water depletion will occur. There is no occupied, brooding, or winter habitat for sage grouse.	Daniel Emmett	8/16/2012
PI	Threatened, Endangered, Proposed or Candidate Plant Species	Suitable clay reed-mustard habitat appears to be located within 300 feet of the southwest portion of the Proposed Project area Much of the proposed project area is located within potential habitat for Uinta Basin hookless cactus. Known occupied habitat for the species is located in the northwest and southeast portions of the project area.	Aaron Roe	1/9/12
PI	Visual Resources	VRM Class II and Class IV identified.	Jason R. West	1-9-2012
NI	Wastes (hazardous or solid)	*Hazardous Waste:* No chemicals subject to reporting under SARA Title III in an amount equal to or greater than 10,000 pounds will be used, produced, stored, transported, or disposed of annually in association with the drilling, testing, or completing of this project. Furthermore, no extremely hazardous substances, as defined in 40 CFR 355, in threshold planning quantities, will be used, produced, stored, transported, or disposed of in association with the drilling, testing, or completing of	Stephanie Howard	01/06/2012

Determi-nation	Resource	Rationale for Determination*	Signature	Date
		this project. *Solid Wastes:* Trash would be confined in a covered container and hauled to an approved landfill. Burning of waste or oil would not be done. Human waste would be contained and be disposed of at an approved sewage treatment facility.		
PI	Waters of the U.S.	Willow Creek and a number of unnamed ephemeral drainages occur within the project area. New surface disturbance is minimized by directional drilling; however, construction of new roads and pipelines may impact surface waters. Unavoidable impacts or road maintenance upgrades to surface waters should be coordinated with the U.S. Army Corps of Engineers and Utah Division of Water Rights for possible permitting. See the water resources section for analysis.	Stan Olmstead	1/31/2012
PI Surface PI Ground	Water Resources/Quality (surface/ground)	*Surface:* Potential impacts to surface waters from sedimentation and contamination (chemical spills) may occur to degrade surface water quality. Analysis of water quality should include acres disturbed within each of the alternatives as well as acres disturbed prior to the project proposal. Types of disturbance will have different impacts so analysis for roads, pads and other proposed projects will need independent analysis to show impact to surface water quality and the potential from chemical spills. A spill prevention plan is necessary. *Ground*: Compliance with State Rule R649-3-8, Casing Program, should assure that the project will not adversely affect groundwater quality. Due to the standard for casing design and state-of-the-art drilling techniques, the possibility of adverse degradation of groundwater quality by the proposed action will likely be negligible. The well casing design standard specifies the following: "*The casing program adopted must be planned to protect any potential oil or gas horizons penetrated during drilling from infiltration of waters from other sources and to prevent the migration of oil, gas, or water from one horizon to another.*" However, there is always the potential for various types of leaks or spills over the life of an oil and gas field. Upgradient and downgradient groundwater monitoring may be beneficial.	Sur: Stan Olmstead Gr: Elizabeth Gamber	Sur: 2/9/2012 Gr: 3/09/2012

Determi-nation	Resource	Rationale for Determination*	Signature	Date
PI	Wetlands/Riparian Zones	There are no riparian areas on BLM managed lands within the proposed project area (see Vernal Field Office GIS database). Riparian habitat is located along Willow Creek on Tribal lands. Also there is riparian habitat outside the project area.	Stan Olmstead	1/31/2012
NI	Wild and Scenic Rivers	The Lower Green River suitable WSR section boundary seems to conflict with the proposed project boundary. However, no new surface disturbance will occur in those areas.	Jason R. West	11-05-2012
NI	Wild Horses and Burros	The project area lays ~1.5 to 2 miles outside of the designated Hill Creek HA boundary; however, the boundary is not fenced nor is there a divisive topographic feature to serve as a physical barrier. Therefore, horses within the HA utilize the area within the project area as habitat. There is no AML for horses within the Hill Creek HA; therefore this resource does not need further analysis within the document.	Dusty Carpenter	08.15.2012
NP	Wilderness/WSA	A review of the GIS layers for the Vernal Record of Decision and Resource Management Plan found that this resource was not present within the proposed project area.	Jason R. West	1-05-2012
NP	Woodland / Forestry	None present. Per review of GIS data.	David Palmer	01/10/2012

APPENDIX B

Conservation Measures for Special Status Plant Species

Clay reed-mustard (*Schoencrambe argillacea*)

In order to minimize effects to the federally threatened clay reed-mustard, the BLM in coordination with the U.S. Fish and Wildlife Service (USFWS) developed the following avoidance and minimization measures. Integration of and adherence to these measures will help ensure the activities carried out during oil and gas development (including but not limited to drilling, production, and maintenance) are in compliance with the Endangered Species Act (ESA). The following avoidance and minimization measures should be included in the Plan of Development (POD):

1. Pre-project habitat assessments will be completed across 100 percent of the project disturbance area within potential habitat[1] prior to any ground disturbing activities to determine if suitable clay reed-mustard habitat is present.

2. Site inventories will be conducted within suitable habitat[2] to determine occupancy. Where standard surveys are technically infeasible and otherwise hazardous due to topography, slope, etc., suitable habitat will be assessed and mapped for avoidance (hereafter, "avoidance areas"); in such cases, in general, 300-foot buffers will be maintained between surface disturbance and avoidance areas. However, site-specific distances will need to be approved by FWS and BLM when disturbance will occur upslope of habitat. Where conditions allow, inventories:
    a. Must be conducted by qualified individual(s) and according to BLM and USFWS accepted survey protocols,
    b. Will be conducted in suitable and occupied[3] habitat for all areas proposed for surface disturbance prior to initiation of project activities and within the same growing season, at a time when the plant can be detected (usually May 1st to June 5th, in the Uintah Basin; however, surveyors should verify that the plant is flowering by contacting a BLM or a USFWS botanist or demonstrating that the nearest known population is in flower),
    c. Will occur within 300 feet from the centerline of the proposed right-of-way (ROW) for surface pipelines or roads; and within 300 feet from the perimeter of disturbance for the proposed well pad including the well pad,
    d. Will include, but not be limited to, plant species lists and habitat characteristics, and
    e. Will be valid until May 1st the following year.

[1] *Potential habitat* comprises areas that satisfy the broad criteria of the species habitat description; usually determined by preliminary, in-house assessment.

[2] *Suitable habitat* comprises areas that contain or exhibit the specific components or constituents necessary for plant persistence; determined by field inspection and/or surveys; may or may not contain clay reed-mustard; habitat descriptions can be found in Federal Register Notice and species recovery plan links at <http://www.fws.gov/endangered/wildlife.html>.

[3] *Occupied habitat* is defined as any area within 300 feet of a listed plant individual.

3. Design project infrastructure to minimize impacts within suitable habitat[2]:

    a. Where standard surveys are technically infeasible, infrastructure and activities will avoid all suitable habitat (avoidance areas) and incorporate 300-foot buffers, in general; however, site specific distances will need to be approved by USFWS and BLM when disturbance will occur upslope of habitat,
    b. Reduce well pad size to the minimum needed, without compromising safety,
    c. Limit new access routes created by the project,
    d. Roads and utilities should share common right-of-ways where possible,
    e. Reduce the width of right-of-ways and minimize the depth of excavation needed for the road bed; where feasible, use the natural ground surface for the road within habitat,
    f. Place signing to limit off-road travel in sensitive areas, and
    g. Stay on designated routes and other cleared/approved areas.

4. Within occupied habitat[3], project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants:
    a. Where standard surveys are technically infeasible, infrastructure and activities will avoid all suitable habitat (avoidance areas) and incorporate 300-foot buffers, in general; however, site-specific distances will need to be approved by USFWS and BLM when disturbance will occur upslope of habitat,
    b. Follow the above recommendations (#3) for project design within suitable habitats,
    c. To avoid water flow and/or sedimentation into occupied habitat and avoidance areas, silt fences, hay bales, and similar structures or practices will be incorporated into the project design; appropriate placement of fill is encouraged,
    d. Construction of roads will occur such that the edge of the right-of-way is at least 300 feet from any plant and 300 feet from avoidance areas,
    e. Roads will be graveled within occupied habitat; the operator is encouraged to apply water for dust abatement to such areas from May 1st to June 5th (flowering period), dust abatement applications will be comprised of water only.
    f. The edge of the well pad should be located at least 300 feet away from plants and avoidance areas, in general; however, site-specific distances will need to be approved by USFWS and BLM when disturbance will occur upslope of habitat,
    g. Surface pipelines will be laid such that a 300-foot buffer exists between the edge of the right-of-way and plants and 300 feet between the edge of ROW and avoidance areas; use stabilizing and anchoring techniques when the pipeline crosses suitable habitat to ensure pipelines don't move towards the population; site-specific distances will need to be approved by USFWS and BLM when disturbance will occur upslope of habitat,
    h. Construction activities will not occur from May 1st through June 5th within occupied habitat,
    i. Before and during construction, areas for avoidance should be visually identifiable in the field, e.g., flagging, temporary fencing, rebar, etc.,
    j. Where technically and economically feasible, use directional drilling or multiple wells from the same pad,
    k. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, and
    l. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible.

5. Occupied clay reed-mustard habitats within 300 feet of the edge of the surface pipelines' ROWs, 300 feet of the edge of the roads' ROWs, and 300 feet from the edge of the well pad shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Annual reports shall be provided to the BLM and the USFWS. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the USFWS.

6. Reinitiation of section 7 consultation with the USFWS will be sought immediately if any loss of plants or occupied habitat for the shrubby reed-mustard is anticipated as a result of project activities.

Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the USFWS to ensure continued compliance with the ESA.

Uinta Basin hookless cactus (*Sclerocactus wetlandicus*)

In order to minimize effects to the federally threatened Uinta Basin hookless cactus, the BLM in coordination with the USFWS, developed avoidance and minimization measures. Integration of and adherence to these measures will help ensure the activities carried out during oil and gas development (including but not limited to drilling, production, and maintenance) are in compliance with the ESA. The following avoidance and minimization measures would be included in the POD:

1. Pre-project habitat assessments will be completed across 100 percent of the project disturbance area within potential habitat[4] prior to any ground disturbing activities to determine if suitable Uinta Basin hookless cactus habitat is present.

2. Within suitable habitat[5], site inventories will be conducted to determine occupancy.

Inventories:

   a. Must be conducted by qualified individual(s) and according to BLM and USFWS accepted survey protocols,

   b. Will be conducted in suitable and occupied[6] habitat for all areas proposed for surface disturbance prior to initiation of project activities and within the same growing season, at a time when the plant can be detected, and during appropriate flowering periods. For this species, surveys can be done any time of the year, provided there is no snow cover,

   c. Will occur within 300 feet from the edge of the proposed ROW for surface pipelines or roads; and within 300 feet from the perimeter of disturbance for the proposed well pad including the well pad,

   d. Will include, but not be limited to, plant species lists and habitat characteristics, and

   e. Will be valid until one year from the survey date.

3. Design project infrastructure to minimize impacts within suitable habitat[5]:

   a. Reduce well pad size to the minimum needed, without compromising safety,

   b. Limit new access routes created by the project,

   c. Roads and utilities should share common ROWs where possible,

   d. Reduce width of ROWs and minimize the depth of excavation needed for the road bed; where feasible, use the natural ground surface for the road within habitat,

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[4] *Potential habitat* is defined as areas which satisfy the broad criteria of the species habitat description; usually determined by preliminary, in-house assessment.

[5] *Suitable habitat* is defined as areas which contain or exhibit the specific components or constituents necessary for plant persistence; determined by field inspection and/or surveys; may or may not contain Uinta Basin hookless cactus. Habitat descriptions can be found in the U.S. Fish and Wildlife Service's 1990 Recovery Plan and Federal Register Notices for the Uinta Basin hookless cactus (http://www.fws.gov/endangered/wildlife.html).

[6] *Occupied habitat* is defined as areas currently or historically known to support Uinta Basin hookless cactus; synonymous with "known habitat."

e. Place signing to limit off-road travel in sensitive areas,

f. Stay on designated routes and other cleared/approved areas, and

g. All disturbed areas will be re-vegetated with native species comprised of species indigenous to the area and non-native species that are not likely to invade other areas.

4. Within occupied habitat[6], project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants when and where practicable:

   a. Follow the above (#3) recommendations for project design within suitable habitats,

   b. Buffers of 300 feet minimum between the edge of the ROW (roads and surface pipelines) or surface disturbance (well pads) and plants and populations will be incorporated,

   c. Surface pipelines will be laid such that a 300-foot buffer exists between the edge of the right-of-way and the plants, use stabilizing and anchoring techniques when the pipeline crosses the habitat to ensure the pipelines don't move towards the population,

   d. Before and during construction, areas for avoidance should be visually identifiable in the field, e.g., flagging, temporary fencing, rebar, etc.,

   e. Where technically and economically feasible, use directional drilling or multiple wells from the same pad,

   f. Designs will avoid concentrating water flows or sediments into occupied habitat,

   g. Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat, and

   h. Minimize the disturbed area of producing well locations through interim and final reclamation. Reclaim well pads following drilling to the smallest area possible.

5. Occupied Uinta Basin hookless cactus habitats within 300 feet of the edge of the surface pipelines' ROWs, 300 feet of the edge of the roads' ROWs, and 300 feet from the edge of the well pad shall be monitored for a period of three years after ground disturbing activities. Monitoring will include annual plant surveys to determine plant and habitat impacts relative to project facilities. Annual reports shall be provided to the BLM and the USFWS. To ensure desired results are being achieved, minimization measures will be evaluated and may be changed after a thorough review of the monitoring results and annual reports during annual meetings between the BLM and the USFWS.

6. Reinitiation of section 7 consultation with the Service will be sought immediately if any loss of plants or occupied habitat for the Uinta Basin hookless cactus is anticipated as a result of project activities.

Additional site-specific measures may also be employed to avoid or minimize effects to the species. These additional measures will be developed and implemented in consultation with the USFWS to ensure continued compliance with the ESA.

APPENDIX C

Soils

Appendix C. Characteristics of Soil Units in the RBU Project Area

Map Complex Name and Number	Acreage in RBU Project Area	Soil Unit Name	Soil Texture	Parent Material	Landforms	Percent of Soil Unit	Slope	Depth Class	Drainage Class	Salinity Class	Sodium Class	RSMR[1]	Runoff Speed	Water Erosion Potential (Kw)
Badland-Rock outcrop complex (12)	59	Badland	--	Shale and siltstone of the Green River and Uinta Formations	Erosional remnants, hills, and ridges	50	1 to 75%	Very shallow	Somewhat excessively drained	Strongly saline	Strongly sodic	Poor	Very high	0.1
		Rock outcrop	--	Sandstone and shale bedrock	Cliffs, escarpments, ledges, erosional remnants	35	1 to 100%	Very shallow	--	--	--	--	Very high	0.1
Cadrina extremely stony loam-Rock outcrop complex (36)	1,257	Cadrina	Extremely stony loam	Slope alluvium and colluvium over residuum derived from shale and sandstone	Hills	65	25 to 50%	Shallow	Well drained	Very slightly saline	Slightly sodic	Poor	Very high	0.05
		Rock outcrop	--	--	Cliffs, escarpments, ledges, erosional remnants	20	25 to 50%	--	--	--	--	--	Very high	0.1
Cadrina-Badland-Rock outcrop complex (37)	539	Cadrina	Extremely channery loam	Slope alluvium and colluvium over residuum derived from shale and sandstone	Hills	65	25 to 50%	Shallow	Well drained	Very slightly saline	Slightly sodic	Poor	Very high	0.05
		Badland	--	--	Erosional remnants, hills, and ridges	20	25 to 50%	Shallow	Somewhat excessively drained	Strongly saline	Strongly sodic	Poor	Very high	0.1
		Rock outcrop	--	--	Cliffs, escarpments, ledges, erosional remnants	10	25 to 50%	--	--	--	--	--	Very high	0.1
Crustown-Motto complex (62)	85	Crustown	Sand, loamy sand	Eolian deposits over residuum derived from calcareous sandstone	Hills	50	2 to 8%	Shallow	Somewhat excessively drained	Non-saline	Non-sodic	Poor	High	0.17
		Motto	Clay loam	Slope alluvium over residuum derived from shale and sandstone	Benches, hills	35	2 to 25%	Shallow	Well drained	Slightly saline	Strongly sodic	Poor	Very high	0.15
Casmos-Cadrina-Badland complex (42)	532	Casmos	Very channery loam, channery loam	Slope alluvium over residuum derived from sandstone, siltstone, and shale	Hills	35	4 to 25%	Very shallow	Well drained	Very slightly saline	Slightly sodic	Poor	Very high	0.15

Map Complex Name and Number	Acreage in RBU Project Area	Soil Unit Name	Soil Texture	Parent Material	Landforms	Percent of Soil Unit	Slope	Depth Class	Drainage Class	Salinity Class	Sodium Class	RSMR[1]	Runoff Speed	Water Erosion Potential (Kw)
		Cadrina	Extremely channery loam	Slope alluvium over residuum derived from shale and sandstone	Hills	30	4 to 25%	Shallow	Well drained	Very slightly saline	Slightly sodic	Poor	Very high	0.05
		Badland	--	--	Erosional remnants, hills, and ridges	20	4 to 25%	Very shallow	Somewhat excessively drained	Strongly saline	Strongly sodic	Poor	Very high	0.1
Motto-Casmos complex (152)	7,111	Motto	Clay loam	Slope alluvium over residuum derived from shale and sandstone	Benches, hills	55	2 to 25%	Shallow	Well drained	Slightly saline	Strongly sodic	Poor	Very high	0.15
		Casmos	Channery loam	Slope alluvium over residuum derived from sandstone, siltstone and shale	Hills	30	4 to 25%	Very shallow	Well drained	Very slightly saline	Slightly sodic	Poor	Very high	0.15
Motto-Rock outcrop complex (154)	3,105	Motto	Very flaggy clay loam, clay loam, extremely channery clay loam	Slope alluvium over residuum derived from shale and sandstone	Benches, hills	75	2 to 25%	Shallow	Well drained	Slightly saline	Strongly sodic	Poor	Very high	0.15
		Rock outcrop	--	--	Cliffs, escarpments, ledges, erosional remnants	10	2 to 25%	--	--	--	--	--	Very high	0.1
Turzo loam (242)	15	Turzo	Loam, silty clay loam	Alluvium derived from quartzite, sandstone, limestone and shale	Alluvial flats	85	0 to 4%	Deep	Well drained	Mod. saline	Mod. sodic	Fair	Medium	0.37

[1]Reclamation Source Material Rating

Sources: USDA-NRCS 2003

APPENDIX D

Cultural Resource Inventories

Appendix D. Known Archaeological Sites within the RBU Project Area.

Site Number	Site Type	NRHP Assessment	State of Utah Project Number
42UN874	Dual Component, Prehistoric Rock Art, Lithic Scatter, Historic Artifact Scatter	Eligible	U-80-UB-0465b
42UN875	Temporary Camp	Not Eligible	U-80-AF-0505bi
42UN876	Temporary Camp	Not Eligible	U-80-AF-0505bi
42UN878	Lithic Scatter	Not Eligible	U-80-AF-0505bi
42UN897	Rock Shelter	Not Eligible	U-80-AF-0507b
42UN840	Rock panel	Eligible	U-81-UT-280
42UN1093	Chipping/reshafting station	Eligible	U-81-GC-501b
42UN994	Petroglyph panels	Not Evaluated	U-81-AF-0672b
42UN881	Rock Art	Eligible	U-85-SJ-0641bi
42UN1564	Rock Shelters, Lithic Scatter	Eligible	U-85-AF-664b
42UN842	Lithic scatter and rock art panel	Eligible	U-85-AF-664b
42UN1652	Open Camp	Eligible	U-87-WK-764b
42UN1777	Lithic Scatter	Eligible	Archaeological Evaluations in the Northern Colorado Plateau Cultural Area
42UN1863	Rock shelter/lithic scatter	Eligible	U-91-AF-146i
42UN1894	Open campsite	Eligible	U-91-54937
42UN1944	Open campsite	Eligible	U-91-54937
42UN1951	Lithic scatter	Eligible	U-91-54937
42UN1952	Open Occupation	Eligible	U-91-54937
42UN1960	Lithic Scatter	Eligible	U-92-AF-54b
42UN1961	Rock Shelter Occupation	Eligible	U-92-AF-54b
42UN1974	Open Occupation	Not Eligible	U-92-AF-82bi
42UN1979	Lithic Scatter	Eligible	U-92-54937

Site Number	Site Type	NRHP Assessment	State of Utah Project Number
42UN1990	Open Occupation	Eligible	U-92-AF-192b
42UN2013	Lithic Scatter	Eligible	U-92-AF-226b
42UN2014	Lithic Scatter	Eligible	U-92-AF-226b
42UN2016	Lithic Scatter	Eligible	U-92-AF-226b
42UN2023	Cairn and low rock alignment	Not Evaluated	N/A
42UN2107	Rock Shelters and Lithic Scatter	Eligible	U-92-AF-326b
42UN2457	Dual Component, Prehistoric and Historic Rock Art	Eligible	U-97-AFO-250i
42UN1571	Campsite	Eligible	U-00-AF-00-460b
42UN3190	Stone tool/debitage scatter	Not Eligible	U-03-AY-0198b
42UN3251	Stone Circle	Not Eligible	U-03-AY-0628i
42UN4529	Temporary ranch camp	Not Eligible	U-04-AY-884b
42UN4780	Rock cairn	Not Eligible	U-04-AY-896b
42UN4754	Rock cairn	Not Eligible	U-04-AY-956b
42UN5024	Gilsonite Mine	Not Eligible	U-04-AY-972bi
42UN4847	Gilsonite Mine	Eligible	U-04-AY-976bi
42UN4568	Cairn	Not Eligible	U-04-MQ-1424bi
42UN4569	Cairn	Not Eligible	U-04-MQ-1424bi
42UN4570	Cairns	Not Eligible	U-04-MQ-1424bi
42UN4571	Historic Rock Art	Eligible	U-04-MQ-1424bi
42UN4572	Historic Rock Art	Eligible	U-04-MQ-1424bi
42UN4573	Historic Rock Art	Not Eligible	U-04-MQ-1424bi
42UN4574	Gilsonite Mine Loading Ramp	Not Eligible	U-04-MQ-1424bi
42UN4575	Cairn	Not Eligible	U-04-MQ-1424bi
42UN4576	Lithic Scatter	Eligible	U-04-MQ-1424bi

Site Number	Site Type	NRHP Assessment	State of Utah Project Number
42UN3218	Rock Art	Eligible	U-03-AY-0240i U-05-AY-536i
42UN3219	Rock Art	Eligible	U-05-AY-536i
42UN3241	Lithic scatter/campsite	Eligible	U-05-AY-0622bs
42UN3236	Lithic Scatter	Eligible	U-06-AY-1319b
42UN3240	Rock Cairn	Not Eligible	U-06-AY-1319b

APPENDIX E

Summary of Potential Special Status Species

SUMMARY OF POTENTIAL OCCURRENCE OF SPECIAL STATUS PLANT AND WILDLIFE SPECIES FOR XTO'S RIVER BEND UNIT PROJECT

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Plants				
Arabis vivariensis Park rock cress	S	Uintah: Weber Formation sandstone & limestone outcrops; mixed desert shrub or pinyon juniper communities; 5,000-6,000 feet; flowers May.	None - No potential habitat. The geological formation and soils associated with this species do not occur in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Astragalus equisolensis Horseshoe milkvetch	S	Uintah: East of Green River, Horseshoe Bend; Duchesne River Formation soils; mixed desert shrub communities; 4,790-5,185 feet.; flowers May-early June.	None - No populations, potential or suitable habitat occurs for this species in this area. Known populations occur along the upper Green River; outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Astragalus hamiltonii Hamilton milkvetch	S	Uintah: Duchesne River, Mowry, Dakota & Wasatch Formations; mixed desert shrub or pinyon juniper communities; 5,240-5,800 feet; flowers May-June.	None - No populations, potential or suitable habitat occurs for this species in this area. Known populations occur near Vernal; outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Cirsium ownbeyi Ownbey thistle	S	Daggett, north east Uintah: Uinta Mountain canyons; pinyon-juniper, mixed desert shrub or riparian communities; 5,500-6,200 feet; flowers late May-August.	None - No potetnial habitat. The geological formation and soils associated with this species do not occur in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Cleomella palmeriana var. *goodrichii* Goodrich stinkweed	S	Uintah: Morrison Formation, heavy clay; mat-salt-bush, Cicsco woody aster, salt desert shrub community; 4,000-6,000 feet; flowers May.	None - No potential habitat. The geological formation and soils associated with this species do not occur in the RBU Project Area.	Yes. otential habitat for this species does not occur within the RBU Project Area.
Cryptantha barnebyi	S	Uintah: Green River Formation; oil shale; gently sloping white shale barrens; shadscale-saltbush or Pinyon-juniper communities;	None - No populations, potential or suitable habitat occurs for this species in this area.	Yes. Potential habitat for this species does not occur within

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Barneby's catseye		5,600-7,200 feet.	Known populations occur east and outside of the RBU Project Area.	the RBU Project Area.
Cryptantha grahamii Graham's catseye	S	Uintah: Green River Shale in mixed desert shrub, sagebrush, pinyon-juniper, and mountain brush communities; 5,000-7,400 feet.	Low. Formation and associated soils may occur in the RBU Project Area. However, there is little known about the species' exact habitat requirements.	Yes. This species is not known to occur within the RBU Project Area.
Erigeron untermannii Untermann fleabane	S	Duchesne, Uintah: West Tavaputs Plateau; Green River, Uinta Formation; ridges; dry calcereaous shales and sandstones; pinyon juniper or mountain brush communities; 7,000-7,800 feet. Flowers May–June.	None - No populations, potential or suitable habitat occurs for this species in this area. Species occurs at higher elevation than the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Habenaria zothecina Alcove bog orchid	S	Uintah: unconsolidated Quaternary alluvium; seeps, hanging gardens, riparian areas in mixed desert shrub, pinyon juniper, or oak brush communities; 4,360-8,690 feet.; flowers late July-August.	Low - Potential habitat occurs for this species in hydric soils associated with the Green River. However, due to high levels of siltation in the Green River, the probability of this species to occur in the RBU Project Area is very low.	Yes. Potential habitat for this species does not occur within the RBU Project Area..
Hymenoxys lapidicola Rock bitterweed	S	Uintah: Blue Mountain; Weber Formation, sandy ledges & crevices; pinyon juniper or ponderosa-manzanita communities; 5,700-8,100 feet; flowers June.	None - No potential habitat. The geological formation and soils associated with this species do not occur in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Lepidium barnebyanum Barnaby's pepper plant	E	Tribal in Duchesne: Tavaputs Plateau; Uinta Formation; white shale ridgecrests; pinyon juniper community; 6,200-6,500 feet.; flowers May - June.	None - No potential habitat. Known populations occur outside of Uintah County; therefore outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Lepidium huberi Huber's pepperplant	S	Uintah: Uinta Mountian foothills, Book Cliffs; Chinle, Park City, Weber Formation; eroding cliffs, alluvium; black sage or mountain brush communities; 5,000-9,700 feet.; flowers June-August.	None - No potential habitat. The geological formation and soils associated with this species do not occur in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Mentzelia goodrichii Goodrich's blazingstar	S	Duchesne: Green River Formation; escarpments of Willow & Argyle Canyons; steep white calciferous shale cliffs; open mountain brush communities; 8,100-8,800 feet.; flowers July - August.	None - No potential habitat. Known populations occur outside of Uintah County; therefore outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Penstemon goodrichii Goodrich's penstemon	S	Duchesne, Uintah: near Lapoint, Tridell, Whiterocks; Duchesne River Formation; clay badlands; desert shrub, shadscale, pinyon juniper or mountain brush communities; 5,590 to 6,215 feet.; flowers late May - June.	None - No potential habitat. Known populations occur in northern Uintah County; outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Penstemon grahamii Graham's beardtongue (Graham's penstemon)	P	Uintah, Duchesne: Green River Formation; oil shale or white shale knolls & talus; semi-barren mixed desert shrub or pinyon juniper communities; 4,600-6,700 feet; flowers from late May - mid-June.	None - No potential habitat. Known populations occur south and outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Penstemon scariosus var. *albifluvis* White River beardtongue (White River) penstemon	C	Uintah: Green River Formation; se of Bonanza; shale slopes; semi-barren mixed desert shrub or pinyon juniper communities; 5,000-6,000 feet.; flowers late May-June.	None - No populations, potential or suitable habitat occurs for this species in this area. Known populations occur in the upper White River; outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Schoenocrambe argillacea Clay thelopody (clay reed-mustard)	T	Uintah: Book Cliffs; contact zone of upper Uinta and lower Green River Formations; mixed desert shrub, Indian ricegrass & pygmy sagebrush communities; 5,000-5,650 feet.; flowers May-early June.	High - Potential habitat occurs within RBU Project Area. Known populations occur in the southwestern portion of the RBU Project Area.	**No.**
Schoencrambe suffrutescens Shrubby reed-mustard	E	Duchesne, Uintah: Green River Formation; Badlands Cliffs, Gray Knolls, Little Rock Pack Mountain; calcareous shale; mixed desert shrub, pinyon juniper or mountain brush communities; 5,400-6,000 feet.; flowers late May - mid-August.	None - No potential habitat. Known populations occur south and outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Sclerocactus brevispinus Pariette cactus	T	Duchesne: Pariette Bench south of Myton; Uinta Formation (Wagonhound Member), fine alkaline clay; shadscale, mat-saltbush community; 4,700-5,400 feet.	None - No potential habitat. Known populations occur outside of Uintah County; therefore outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Sclerocactus glaucus (Sclerocactus wetlandicus) Uinta Basin hookless cactus	T	Duchesne, Uintah: alluvial benches of Green River watershed from Ouray to Carbon County line; cold desert shrub communities; 4,700-6,000 feet.	Moderate - Potential habitat occurs within RBU Project Area. Known populations occur in the vicinity of the RBU Project Area.	**No.**
Spiranthes diluvialis Ute ladies'-tresses	T	Daggett, Duchesne, Uintah: Green River tributaries, Uinta Mountains, Browns Park, Book Cliffs; unconsolidated alluvium; wetland meadow communities; 4,400-6,810 feet.; flowers late July - September	None - Potential habitat occurs west of the RBU Project Area along the Green River. Known populations occur outside of and approximately 40 miles north of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Thelesperma caespitosum Green River greenhead	S	Duchesne: Uinta Mountains, Tavaputs Plateau; Bishop Conglomerate Formation; cushion plant community on rim crests above mountain brush; 7,500-9,000 feet.; flowers May - June.	None - No potential habitat. Known populations occur outside of Uintah County; therefore outside of the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Yucca sterilis Spanish bayonet	S	Uintah: Salt and mixed desert shrub communities growing in sandy soils, 4,800-5,800 feet.	Moderate – Potential habitat occurs within the RBU Project Area.	**No.**
Birds				
Accipiter gentilis Northern goshawk	S	Mature mountain forest and riparian zone habitats. The northern goshawk is a neotropical migrant that occurs across the northern regions of North America in scattered populations primarily in mature mountain forest and valley cottonwood habitats.	None. There is no suitable habitat for this species in the project area. Populations of northern goshawk have been identified in the mid elevations of the VPA in the Uinta Mountains and the Book Cliffs.	Yes. Potential habitat for this species does not occur within the RBU Project Area.

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Aquilla chysaetos Golden eagle	BGEPA	Found in mountainous areas, canyons, shrublands, and grasslands, and in shrub-steppe habitats in the winter.	High. Nesting and foraging habitat is found throughout the area. This species is known to nest within the RBU Project Area.	**No.**
Asio flammeus Short-eared owl	S	Inhabits arid grasslands, agricultural areas, marshes, and occasionally open woodlands. In Utah, cold desert shrub and sagebrush-rabbit brush habitats also are utilized. Typically a ground nester. Typical breeding season: April 10 through June 15.	Low. The species breeds in northern Utah and occurs as a migrant potentially throughout the state. Known to occur in Uintah County, with occurrence probable in Duchesne County. Low potential for this species to occur.	Yes. Limited potential habitat for this species occurs within the RBU Project Area.
Athene cunicularia Burrowing owl	S	Inhabits desert, semi-desert shrubland, grasslands, and agricultural areas. Nesting habitat primarily consists of flat, dry, and relatively open terrain; short vegetation; and abandoned mammal burrows for nesting and shelter. Breeding season: April through July 15.	Moderate to High. Scattered prairie dog colonies are located within the RBU Project Area which this species may utilize for nesting.	**No.**
Buteo regalis Ferruginous hawk	S	In Utah, this species resides mainly in lowland open desert terrain characterized by barren cliffs and bluffs, pinyon-juniper woodlands, sagebrush-rabbit brush, and cold desert shrub. Nesting habitat includes promontory points and rocky outcrops.	Moderate to High. Suitable foraging and nesting habitat for this species does may occur in the RBU Project Area.	Yes. Limited potential habitat for this species occurs within the RBU Project Area.
Centrocercus urophasianus Greater sage-grouse	C	Inhabits upland sagebrush habitat in rolling hills and benches. Breeding occurs on open leks (or strutting grounds) and nesting and brooding occurs in upland areas and meadows in proximity to water and generally within a 1-mile radius of the lek. During winter, sagebrush habitats at sub-montane elevations commonly are used. Breeding season: March 1 through June 30.	Low. The species is widespread, but declining, in Utah, with extant populations in Uintah and Duchesne counties. No designated habitats have been identified within the RBU Project Area.	**No.**

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Charadrius montanus Mountain plover	S	One known breeding population exists in Utah, and is located on Myton Bench. The Utah population breeds in shrub-steppe habitat among white-tailed prairie dogs and near roadways or oil well pads.	Low. The breeding population on Myton Bench is suspected to have drastically declined in recent years. There have been no new breeding bird sightings since 2002.	Yes. Limited potential habitat for this species occurs within the RBU Project Area.
Coccyzus americanus occidentalis Western yellow-billed cuckoo	C	This species is considered to be a riparian obligate and usually occurs in large tracts of cottonwood/willow habitats. However, this species also has been documented in lowland deciduous woodlands, alder thickets, deserted farmlands, and orchards. Breeding season: late June through July.	Low to Moderate Potential. Small patches of potential habitat occur immediately west of the RBU Project Area.	**No.**
Cypseloides niger Black swift	S	This species requires waterfalls for nesting; typically the falls are permanent. Coniferous forests, often mixed conifer or spruce-fir forests, typically surround nesting sites, but this varies depending on elevation and aspect, and nest sites may include mountain shrub, aspen, or even alpine components. Streams that create the waterfalls are typically mountain riparian habitats.	None. Suitable habitat for this species does not exist in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Dolichonyx oryzivorus Bobolink	S	Inhabits mesic and irrigated meadows, riparian woodlands, and subalpine marshes at lower elevations (2,800–5,500 feet). Suitable breeding habitat includes tall grass, flooded meadows, prairies, and agricultural fields; forbs and perch sites also are required.	Low. The species breeds in isolated areas of Utah, primarily in the northern half of the state. No breeding by this species has been documented within the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Haliaeetus leucocephalus Bald eagle	S	In Utah, breeding occurrences are limited to eight locations within four counties (Daggett, Davis, Grand, Duchesne, Emery, Grand, and Wayne counties). Winter habitat typically includes areas of open water, adequate food sources, and sufficient diurnal perches and night roosts.	Moderate. Bald eagle winter roosting habitat occurs immediately west of the RBU Project Area within the Green River riparian corridor.	**No.**

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Melanerpes lewis Lewis' woodpecker	S	Inhabits open habitats including pine forests, riparian areas, and piñon-juniper woodlands. Breeding habitat typically includes ponderosa pines and cottonwoods in stream bottoms and farm areas. In Utah, the species inhabits agricultural lands and urban parks, montane and desert riparian woodlands, and submontane shrub habitats. Breeding season: mid-May through mid-August.	Low. In Utah, the species is widespread, but is an uncommon nester along the Green River. Breeding by this species has been observed in Ouray and Uintah counties, and along Pariette Wash.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Numenius americanus Long-billed curlew	S	Inhabits shortgrass prairies, alpine meadows, riparian woodlands, and reservoir habitats. Breeding habitat includes upland areas of shortgrass prairie or grassy meadows with bare ground components, usually near water.	Low. Widespread migrant in Utah. Breeding birds are fairly common but localized, primarily in central and northwestern Utah. Potential nesting has been reported in Uintah County, but has not been confirmed.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Pelecanus erythrorhynchos American white pelican	S	Inhabits areas of open water including large rivers, lakes, ponds, and reservoirs with surrounding habitats ranging from barren to heavily vegetated sites. Typically nests on isolated islands in lakes or reservoirs.	Low. In Utah, the species is known to nest on islands associated with Great Salt and Utah lakes.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Strix occidentalis lucida Mexican spotted owl	T	This species is found primarily in canyons with mixed conifer forests, pine-oak woodlands and riparian areas. This species nests on platforms and large cavities in trees, on ledges, and in caves. Breeding and nesting season: approximately March through August.	None. No Mexican spotted owl suitable habitat or nests have been identified within the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Fish				
Catostomus discobolus Bluehead sucker	S	Occupies a wide range of aquatic habitats ranging from cold, clear mountain streams to warm, turbid rivers. This species occurs in the lower portion of Pariette Draw and in the Green River below the Pariette Draw confluence. Fast flowing streams have been identified as important habitat for this species.	Moderate. Suitable habitat for this species occurs in the RBU Project Area.	**No.**

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Catostomus latipinnis Flannelmouth sucker	S	Adults occur in riffles, runs, and pools in streams and large rivers, with the highest densities usually in pool habitat. Young live in slow to moderately swift waters near the shoreline areas.	Moderate. This species occurs in the main-stem Colorado and its large tributaries.	**No.**
Gila cypha Humpback chub	E	Suitable habitat for this species is characterized by a wide variety of riverine habitats, especially canyon areas with fast currents, deep pools, and boulder habitat. This species originally inhabited the main stem of the Colorado River from what is now Lake Mead to the canyon areas of the Green and Yampa River Basins. Currently, it appears restricted to the Colorado River at Black Rocks and Westwater Canyon of the Green River, and Yampa Canyon of the Yampa River. Suitable habitat and critical habitat has been designated for this species in the Green River in Uintah County.	Moderate. Designated Critical Habitat for this species occurs along the segment of Green River located approximately 20 miles downstream of the Project Area.	**No.**
Gila elegans Bonytail	E	This species is endemic to the Colorado River system and currently is restricted to the Green River in Utah. They use main channels of large rivers and favor swift currents.	Moderate. Designated Critical Habitat for this species occurs at the segment of the Green River located approximately 20 miles downstream of the Project Area.	**No.**
Gila robusta Roundtail chub	S	Adults inhabit low to high flow areas in the Green River; young occur in shallow areas with minimal flow.	Moderate. Known distribution of this species includes portions of the Green River west of the RBU Project Area.	**No.**
Ptychocheilus lucius Colorado pikeminnow	E	The range of the Colorado pikeminnow is restricted to the Upper Colorado River basin, upstream of Glen Canyon Dam. Adult Colorado pikeminnow use a variety of habitat types, depending on time of year, but mainly utilize shoreline runs, eddies, backwater habitats, seasonally flooded bottoms, and side canyons. They are most abundant in the upper Green River (between the mouth of the Yampa River and head of Desolation Canyon) and lower Green River (between the Price and San Rafael Rivers). Other	Moderate. Critical habitat for this species is located along portions of the Green River that flow west of the RBU Project Area.	**No.**

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
		concentration areas include the Yampa River, the lower 21 miles of the White River, and the Ruby and Horsethief Canyon area between Westwater, Utah, and Loma, Colorado .		
Xyrauchen texanus Razorback sucker	E	This fish species is found in a variety of habitats including quiet eddies, pools, and mid-channel runs. They are usually found over sand or silt substrate, but occur over gravel and cobble bars. The largest population is known to occur in the upper Green River between the confluence of the Yampa River and the confluence of the Duchesne River. Adults also occur in the Colorado River near Grand Junction, Colorado, although numbers are very low. Critical habitat has been designated for this species in the Green River in Carbon, Duchesne, Emery, Uintah and Grand Counties.	Moderate. Critical habitat for this species is located along portions of the Green River that flow west of the RBU Project Area.	**No.**
Mammals				
Corynorhinus townsendii Townsend's big-eared bat	S	Inhabits a wide range of habitats from semi desert shrublands and piñon-juniper woodlands to open montane forests. Roosting occurs in mines and caves, in abandoned buildings, on rock cliffs, and occasionally in tree cavities. Foraging occurs well after dark over water, along margins of vegetation, and over sagebrush.	Low. The species occurs throughout much of Utah including Duchesne and Uintah counties. Relative to the project area, one individual was collected at the Ouray National Wildlife Refuge in 1980.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Cynomys leucurus White-tailed prairie dog	S	White-tailed prairie dogs are typically found in open shrublands, semi-desert grasslands, and mountain valleys, where they occur in loosely organized colonies that may occupy hundreds of acres on favorable sites. Similar to other prairie dogs, white-tailed prairie dogs spend much of their time in underground burrows, often hibernating during the winter.	Moderate. Suitable habitat for this species occurs in the project area.	**No.**

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Euderma maculatum Spotted bat	S	Inhabits desert shrub, sagebrush-rabbitbrush, Pinyon-juniper woodland, and ponderosa pine and montane forest habitats. In Utah, the species also uses lowland riparian and montane grassland habitats. Suitable cliff habitat typically appears to be necessary for roosts/hibernacula. Spotted bats typically do not migrate and use hibernacula that maintain a constant temperature above freezing from September through May. Hibernation (in caves) and winter activity have been documented in southwestern Utah.	Low. The species potentially occurs throughout Utah; however, no occurrence records exist for the extreme northern or western parts of the state. Known occurrences have been reported in northeastern Uintah County.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Lynx canadensis Canada lynx	E	Primarily occurs in Douglas-fir, spruce-fir, and subalpine forests at elevations above 7,800 feet. The lynx uses large woody debris such as downed logs and windfalls to provide denning sites for protection and thermal cover for kittens.	None. If extant in Utah, this species most likely occurs in montane forests in the Uinta Mountains.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Mustela nigripes Black-footed ferret	E	This species inhabits semi-arid grasslands and mountain basins. It is found primarily in association with active prairie dog colonies that contain suitable burrow densities and colonies that are of sufficient size.	None. Suitable habitat is not present.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Myotis thysanodes Fringed myotis	S	A small bat that occurs in most of the western United States, as well as in much of Mexico and part of southwestern Canada. The species is widely distributed throughout Utah, but is not very common in the state. The fringed myotis inhabits caves, mines, and buildings, most often in desert and woodland areas.	None. Suitable habitat for this species does not exist in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Nyctinomops macrotis Big free-tailed bat	S	The species is rare in Utah, occurring primarily in the southern half of the state, although individuals may rarely occur in northern Utah. Prefers rocky and woodland habitats, where roosting occurs in caves, mines, old buildings, and rock crevices.	None. High cliffs that bats may use for roosting do not occur in the RBU Project Area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.

Species	Status[1]	Habitat (county: location; formation; community; elevation; notes)	Potential for Occurrence Within the Proposed RBU Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Vulpes macrotis Kit fox	S	Native to much of the western United States and northern Mexico. Although the species is not overly abundant in Utah, it does occur in the western, east-central, and southeastern areas of the state. The kit fox opportunistically eats small mammals (primarily rabbits and hares), small birds, invertebrates, and plant matter. The species is primarily nocturnal, but individuals may be found outside of their dens during the day. The species most often occurs in open prairie, plains, and desert habitats.	None. Suitable habitat for this species does not exist in the project area.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Reptiles				
Elaphe guttata Cornsnake	S	An isolated population occurs in western Colorado and eastern Utah. Usually found near streams, or in rocky or forest habitats. This species is typically more active at night.	None. This species is not known in Uintah County.	Yes. Potential habitat for this species does not occur within the RBU Project Area.
Opheodrys vernalis Smooth greensnake	S	Typically inhabits meadows, grassy marshes, and moist grassy fields along forest edges. Its distribution ranges from northeastern Utah into central Colorado and northern New Mexico, and into the Northern Plains from the Canadian border south to Kansas and Missouri.	None. No moist meadows or marshes are present.	Yes. Potential habitat for this species does not occur within the RBU Project Area.

[1]Status: E = Federally-listed as endangered; T = Federally-listed as threatened; C = Federal candidate species; P = Federal proposed species; S = Special Status Species Vernal Field Office; BGEPA = Bald and Golden Eagle Protection Act

Source: adapted from BLM Vernal office Special Status Plant Species List, 2011.

Source for location information: UNHP-UDWR 2007, UNPS 2007, and Goodrich and Neese 1986.

APPENDIX F-1

Emissions Inventories for Alternative A

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.61	1.97	0.0099	0.20	0.82
PM_{15}	0.50	0.0075	0.16	0.50	0.0025	0.05	0.21
PM_{10}	0.38	0.0056	0.12	0.19	0.0009	0.02	0.14
$PM_{2.5}$	0.21	0.0031	0.06	0.10	0.0005	0.01	0.07

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	0.64	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	0.64	miles
PM_{10} Multiplier	0.6 * PM_{15} (AP-42 Table 11.9-1, 7/98)	
$PM_{2.5}$ Multiplier	0.031 * TSP (AP-42 Table 11.9-1, 7/98)	

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

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

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

Emissions = 1.71 lbs TSP/well pad

Emissions = 0.82 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	1.71	0.17	8.55E-04	1.77E-02
PM_{15}	0.82	0.08	4.09E-04	8.47E-03
PM_{10}	0.49	0.05	2.45E-04	5.08E-03
$PM_{2.5}$	0.05	0.01	2.65E-05	5.49E-04

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.61	1.97	0.0099	0.20	0.82
PM_{15}	0.50	0.0075	0.16	0.50	0.0025	0.05	0.21
PM_{10}	0.38	0.0056	0.12	0.38	0.0019	0.04	0.16
$PM_{2.5}$	0.21	0.0031	0.06	0.21	0.0010	0.02	0.09

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

b Assumes maximum development scenario

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2 10 20	day grading per well pad and road (Estimate) hours/day hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	5.54	0.28	0.0028	0.06
PM_{15}	2.65	0.13	0.0013	0.03
PM_{10}	1.59	0.08	0.0008	0.02
$PM_{2.5}$	0.17	0.01	0.0001	0.002

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	1.71	0.171	8.55E-05
PM_{15}	0.82	0.082	4.09E-05
PM_{10}	0.49	0.049	2.45E-05
$PM_{2.5}$	0.05	0.005	2.65E-06

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	0.0790
PM_{15}	0.0202
PM_{10}	0.0142
$PM_{2.5}$	0.0078

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.61	1.97	0.0099	0.20	0.82
PM_{15}	0.50	0.0075	0.16	0.50	0.0025	0.05	0.21
PM_{10}	0.38	0.0056	0.12	0.19	0.0009	0.02	0.14
$PM_{2.5}$	0.21	0.0031	0.06	0.10	0.0005	0.01	0.07

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	5.50	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	5.50	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 14.78 lbs TSP/well

Emissions = 7.07 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	14.78	0.49	0.0074	0.15
PM_{15}	7.07	0.24	0.0035	0.07
PM_{10}	4.24	0.14	0.0021	0.04
$PM_{2.5}$	0.46	0.02	0.0002	0.005

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

Hours per day 10
Days per pad 9

Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Semi: Hvy Equip Hauler	60,000	3					
Haul Trucks: Equipment/Fuel/Water	48,000	5					
Pickup Truck: Crew	7,000	10					
Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
				Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
				7.7		0.8	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.067	98.6	11.0	9.9	1.1
				Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
				1.02		0.10	

Vertical Drilling (days/well)

Hours per day 10
Days per well 14

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				73.8		7.4	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	11.8	16.5	1.2
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.18		0.12	

Directional Drilling (days/well)

Hours per day 10
Days per well 21

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				408.9		40.9	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	7.9	16.5	0.8
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				6.51		0.65	

Kleinfelder/Buys

Project: XTO RBU, Alternative A
Date: 5/3/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				200.2		20.0	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.134	195.8	19.6	19.6	2.0
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				9.11		0.91	

Interim Reclamation (days/well)

Hours per day 10
Days per pad 2

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Pickup: Crew	7,000	4					
Haul Trucks: Equipment	60,000	1					
Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.2		0.1	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.035	51.5	25.7	5.1	2.6
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				0.37		0.04	

Annual Traffic Fugitive Dust Emissions (tons/year)

Unpaved Roads PM_{10} (tons)	Unpaved Roads $PM_{2.5}$ (tons)
692	69.2
Paved Roads PM_{10} (tons)	**Paved Roads $PM_{2.5}$ (tons)**
18.18	1.82

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

9. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	acres total disturbance
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

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

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

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

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

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

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10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.228
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	1.201
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.144
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	1.11E-02
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	8.65E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	21	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/mile)} * \text{Trip Distance (miles)} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	3.44E-04
CO	1.15E-03	7.40E-04
VOC [d]	3.17E-04	2.04E-04
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

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12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	453	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.515	0.117	3.23	0.144	0.033	0.658	13.9
CO	17.5	1.107	0.251	36.8	1.64	0.372	2.75	57.9
VOC [c]	4.83	0.306	0.069	2.29	0.102	0.023	0.408	8.59
SO_2	0.321	2.03E-02	4.60E-03	0.214	9.54E-03	2.16E-03	2.99E-02	0.629
CH_4 [e,f]	0.230	1.46E-02	3.30E-03	0.180	8.02E-03	1.82E-03	2.26E-02	0.475

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	6.706
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	17.933
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	4.028
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.275
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.200

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.034
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.269
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.023
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	1.92E-03
CH_4 [e,f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.55E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	453	hours/well (Proposed Action)
Development Rate	93	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	404
CO [b]	5.50E-03	4.40	93
VOC [b]	7.05E-04	0.56	11.9
PM_{10} [b]	4.30E-04	0.34	7.24
$PM_{2.5}$ [b]	3.59E-04	0.29	6.05
SO_2 [b]	4.05E-06	3.24E-03	6.81E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	9.80E-02
Toluene [d]	2.11E-06	1.69E-03	3.55E-02
Xylenes [d]	1.45E-06	1.16E-03	2.44E-02
Formaldehyde [d]	5.92E-07	4.73E-04	9.97E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	3.18E-03
Acrolein [d]	5.91E-08	4.73E-05	9.96E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.64E-02
Total PAH [e, f]	1.59E-06	1.27E-03	2.68E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	19,541
CH_4 [b, c]	7.05E-04	0.56	11.9

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	178
CO [a]	5.70E-03	4.56	96
VOC [a]	2.20E-03	1.76	37.1
PM_{10} [a]	3.30E-04	0.26	5.56
$PM_{2.5}$ [b]	3.30E-04	0.26	5.56
SO_2 [b]	4.05E-06	3.24E-03	6.81E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	9.80E-02
Toluene [d]	2.11E-06	1.69E-03	3.55E-02
Xylenes [d]	1.45E-06	1.16E-03	2.44E-02
Formaldehyde [d]	5.92E-07	4.73E-04	9.97E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	3.18E-03
Acrolein [d]	5.91E-08	4.73E-05	9.96E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.64E-02
Total PAH [e, f]	1.59E-06	1.27E-03	2.68E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	19,541
CH_4 [b, c]	7.05E-04	0.56	11.9

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	-226	ton/yr
CO	3	ton/yr
VOC	25.2	ton/yr
PM_{10}	-1.68	ton/yr
$PM_{2.5}$	-0.49	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

[f] PAH (Polycyclic Aromatic Hydrocarbons) includes naphthalene and are a HAP because they are polycyclic organic matter (POM)

[g] Assumes maximum development scenario

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16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	93	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO_2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	102.000	18.97
CO [a]	5.50E-03	23.375	4.35
VOC [a,b]	7.05E-04	2.996	0.56
PM_{10} [a,c]	4.30E-04	1.8264	0.3397
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.2840
SO_2 [a]	4.05E-06	0.017	0.003
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	4.60E-03
Toluene [e]	2.11E-06	8.96E-03	1.67E-03
Xylenes [e]	1.45E-06	6.15E-03	1.14E-03
Formaldehyde [e]	5.92E-07	2.51E-03	4.68E-04
Acetaldehyde [e]	1.89E-07	8.03E-04	1.49E-04
Acrolein [e]	5.91E-08	2.51E-04	4.67E-05
Naphthalene [f]	9.75E-07	4.14E-03	7.71E-04
Total PAH [f]	1.59E-06	6.76E-03	1.26E-03
Greenhouse Gases			
CO_2 [a]	1.16	4,930	917
CH_4 [a]	7.05E-04	2.996	0.557

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.37
CO [g]	6.68E-03	0.43	0.08
VOC [b,g]	2.47E-03	0.16	0.03
PM_{10} [g]	2.20E-03	0.14	0.03
$PM_{2.5}$ [g]	2.20E-03	0.14	0.03
SO_2 [g]	2.05E-03	0.13	0.02
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	8.30E-05
Toluene [h]	3.07E-06	1.96E-04	3.64E-05
Xylenes [h]	2.14E-06	1.36E-04	2.53E-05
Formaldehyde [h]	8.85E-06	5.64E-04	1.05E-04
Acetaldehyde [h]	5.75E-06	3.67E-04	6.82E-05
Acrolein [h]	6.94E-07	4.42E-05	8.23E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	3.48E-06
Naphthalene [h]	6.36E-07	4.05E-05	7.54E-06
Total PAH [h]	1.26E-06	8.03E-05	1.49E-05
Greenhouse Gases			
CO_2 [g]	1.15	73.3	13.6
CH_4 [b,g]	2.47E-03	0.157	0.03

[a] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
[b] Emission Factor represents total Hydrocarbon Emissions
[c] Total particulate emission factor is 0.0007, Total PM_{10} fraction determined from Table 3.4-2
[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2
[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96
[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96
[g] AP-42 Table 3.3-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[h] AP-42 Table 3.3-2, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[i] Assumes maximum development scenario

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
Total:	1.0000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. Well Development Venting

Assumptions:		Following completion, wells are vented prior to connnection to the gathering pipeline
Venting Period	48	hours (Project Proponents)
Amount of Vented Gas:	1.0	MMscf day (Average volume estimated by proponents)
Development Rate:	93	Wells per year (Project Proponents)
Control Rate	95	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	88
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	10.51
Propane	44.1	2.17	0.957	0.052	21.7	52.5	5.86
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	1.43
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	1.88
i-Pentane	72.2	0.197	0.142	0.008	1.97	7.78	0.87
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.69
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.64
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.61
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.19
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.06
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.06
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.02
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.31
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.72
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.89
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		3.79	2.06	0.11	37.9	113	12.63
HAP Subtotal		0.09	0.07	0.00	0.86	4.07	0.45
Total		100	18.4	1.00	1,000	1,012	113

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19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	17	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	306,000	miles/year
Number of Condensate Haul Truck Round Trips:	12	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	31	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	1,632,590	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (Typical value)
Fuel density	7.08	lbs/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{453.6 (g/lb)} * \text{2000 (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * \text{453.6 (g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	3.23	0.60	1.09	8.13	8.04	14.7	8.64	15.8
CO	36.8	6.83	12.4	17.5	17.3	31.5	24.1	44.0
VOC [c]	2.11	0.39	0.71	4.60	4.55	8.30	4.94	9.01
SO_2	0.21	0.04	0.07	0.32	0.32	0.58	0.36	0.65
Greenhouse Gases								
CH_4 [d]	0.18	0.03	0.06	0.23	0.23	0.41	0.26	0.48

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)

[c] Emission factor is for total Hydrocarbons - Methane Offset

[d] AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

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20. Operations Pneumatic Emissions

Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas flow Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (Mscf/day)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
	VOC Subtotal	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	484	2196	8634.1

Liquid Level Controller Specifications

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

Trace Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Methanol Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
2	Trace pump	0.45	1.98
2	Chemical injection pump	0.45	1.98
	Totals (per well) =	1.04	4.54

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
2	Trace pump	3.16	6.93
2	Chemical injection pump	3.16	6.93
	Totals (per well) =	7.24	17.84

Kleinfelder/Buys

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
W = average weight in tons of vehicles traveling the road		
Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	17.0						
Haul Truck: Oil	48,000	7.0						
Haul Truck: Water	48,000	31.0	Paved	2.14	2,591	7.10	259	0.71
Mean Weight	35,327	55.0	Unpaved	0.101	122	0.33	12.2	0.03
					PM_{10}		$PM_{2.5}$	
Annual Traffic Fugitive Dust Emissions (tons/year)			Paved		1.30		0.130	
			Unpaved		0.061		0.006	
			Total		1.36		0.136	

Assume 3 barrels per day condensate per well (484 wells = 60,984 gallons/day for transport)
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 484 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:
Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	961
Hazardous Air Pollutants			
Benzene		0.015	7.3
Toluene		0.012	5.8
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.97
n-Hexane		0.045	21.8
Total HAPS		0.080	38.7
Greenhouse Gases			
CO_2		0.017	8.23
CH_4		0.77	374

a Assumes maximum development scenario

23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 484 wells at Peak Production
Wells Requiring Dehydrators: 484 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Tons per year per well are calculated with the conservative estimate that the wellsite dehys could theoretically run 8,760 hours out of the year

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	1,489
Hazardous Air Pollutants				
Benzene		0.074	0.32	156
Toluene		0.165	0.72	351
Ethylbenzene		0.010	0.04	20.8
Xylenes		0.146	0.64	309
n-Hexane		0.006	0.03	12.7
Greenhouse Gases				
CH_4		0.069	0.30	147

25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	484	new wells

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} \cdot 1{,}000\ \text{(Btu/MBtu)} \cdot \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} \cdot 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} \cdot \text{VOC wt. fraction}$$

	Wellpad Separator Emissions			Wellpad Deby-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [1] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	159	100	0.025	53	0.100	212
CO [a]	84.0	0.063	134	84.0	0.021	44.5	0.084	178
TOC [c]	11.0	0.008	17.5	11.0	0.003	5.8	0.011	23.3
VOC	-	0.001	1.96	-	0.000	0.65	0.001	2.61
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	12.1	7.60	0.002	0.008	0.008	12.1
PM_{10} [c]	7.60	0.006	12.1	7.60	0.002	4.028	0.008	16.1
$PM_{2.5}$ [c]	7.60	0.006	12.1	7.60	0.002	4.028	0.008	16.1
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	3.34E-03	2.10E-03	5.25E-07	1.11E-03	2.10E-06	4.45E-03
Toluene [d]	3.40E-03	2.55E-06	5.41E-03	3.40E-03	8.50E-07	1.80E-03	3.40E-06	7.21E-03
Hexane [d]	1.80E+00	1.35E-03	2.86E+00	1.80E+00	4.50E-04	9.54E-01	1.80E-03	3.82E+00
Formaldehyde [d]	7.50E-02	5.63E-05	1.19E-01	7.50E-02	1.88E-05	3.97E-02	7.50E-05	1.59E-01
Dichlorobenzene [d]	1.20E-03	9.00E-07	1.91E-03	1.20E-03	3.00E-07	6.36E-04	1.20E-06	2.54E-03
Naphthalene [d]	6.10E-04	4.58E-07	9.70E-04	6.10E-04	1.53E-07	3.23E-04	6.10E-07	1.29E-03
POM 2[d,e,f]	5.90E-05	4.43E-08	9.38E-05	5.90E-05	1.48E-08	3.13E-05	5.90E-08	1.25E-04
POM 3[d,g]	1.60E-05	1.20E-08	2.54E-05	1.60E-05	4.00E-09	8.48E-06	1.60E-08	3.39E-05
POM 4[d,h]	1.80E-06	1.35E-09	2.86E-06	1.80E-06	4.50E-10	9.54E-07	1.80E-09	3.82E-06
POM 5[d,i]	2.40E-06	1.80E-09	3.82E-06	2.40E-06	6.00E-10	1.27E-06	2.40E-09	5.09E-06
POM 6[d,j]	7.20E-06	5.40E-09	1.14E-05	7.20E-06	1.80E-09	3.82E-06	7.20E-09	1.53E-05
POM 7[d,k]	1.8E-06	1.35E-09	2.86E-06	1.8E-06	4.50E-10	9.54E-07	1.80E-09	3.82E-06
Greenhouse Gases								
CO_2 [c]	120,000	90.0	190,793	120,000	30.0	63,598	120	254,390
CH_4 [c]	2.30	1.73E-03	3.66	2.30	5.75E-04	1.22	2.30E-03	4.88
N_2O [c]	2.20	1.65E-03	3.50	2.20	5.50E-04	1.17	2.20E-03	4.66

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

[b] Assumes produced gas contains no sulfur

[c] AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are PM_{10})

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

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

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[1] Assumes maximum development scenario

Kleinfelder/Buys

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Date: 5/3/2011

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size:	21.2	Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines:	73	wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	165.8
CO	3.72	18.7	0.87	279.1
VOC	0.03	0.15	0.01	2.2
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	1.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	1.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.12
Toluene	5.58E-04	2.80E-03	1.3E-04	0.04
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	1.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.21
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.20
Methanol	3.06E-03	1.54E-02	7.2E-04	0.23
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	1.90E-03
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	1.15E-03
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	9.53E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	4.98E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	1.33E-03
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	9.68E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	1.03E-03
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	1.60E-03
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	3.09E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	7.29E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	8.93E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	5.39E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	1.06E-02
Greenhouse Gases				
CO_2 [5]	110	2,557	120	38,217
CH_4	0.23	1.15	0.05	17

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	30
CO	-	4.0	0.19	60
VOC	-	1.0	0.05	15
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	1.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	1.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.12
Toluene	5.58E-04	2.80E-03	1.3E-04	0.04
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	1.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.21
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.20
Methanol	3.06E-03	1.54E-02	7.2E-04	0.23
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	1.90E-03
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	1.15E-03
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	9.53E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	4.98E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	1.33E-03
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	9.68E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	1.03E-03
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	1.60E-03
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	3.09E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	7.29E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	8.93E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	5.39E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	1.06E-02
Greenhouse Gases				
CO_2 [5]	110	2,557	120	38,217
CH_4	0.23	1.15	0.05	17

Note: The change from existing engines to JJJJ compliant engines results in emission changes of:

NOx	-135.95	tons/yr
CO	-219.37	tons/yr
VOC	12.72	tons/yr

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00

[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)

[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)

[4] PM = sum of PM filterable and PM condensable

[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)

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

[7] Estimated at full project production.

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26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	212	0.0	0.0	30	15.8	0.0	258
CO	178	0.0	0.0	60	44.0	0.0	282
VOC	2.63	961	1,489	15	9.01	13	2,489
SO_2	0.0	0.0	0.0	0.0	0.65	0.0	0.65
PM_{10}	16.1	0.0	0.0	1.5	1.36	0.0	19
$PM_{2.5}$	16.1	0.0	0.0	1.5	0.14	0.0	17.7
Hazardous Air Pollutants							
Benzene	4.5E-03	7.3	156	0.12	0.0	0.06	163
Toluene	7.2E-03	5.8	351	0.04	0.0	0.06	357
Ethylbenzene	0.0	0.00	20.8	0.00	0.0	0.00	20.8
Xylene	0.0	0.97	309	0.01	0.0	0.02	310
n-Hexane	3.82	21.8	12.7	0.0	0.0	0.31	39
Formaldehyde	0.16	0.0	0.0	1.5	0.0	0.0	1.7
Total HAPs	3.99	36	849	1.7	0.0	0.45	891
Greenhouse Gases							
CO_2	254,390	0.0	0.0	38,217	0.0	0.9	292,608
CH_4	4.88	0.0	147	17	0.48	88	258
N_2O	4.66	0.0	0.0	0.0	0.0	0.0	4.66

[a] Well pumping unit engine emissions are for IIII compliant engines

[b] Emissions for Peak Field Development

1.986 3.075636

27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	9	Facilities

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1{,}000\ \text{(Btu/MBtu)} * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions[1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions[1] (tons/yr)	Total Emissions (lb/hr)	Total Emissions[1] (tons/yr)
Criteria Pollutants & VOC								
NOx[a]	100	0.075	2.96	100	0.075	2.957	0.750	5.91
CO[a]	84.0	0.063	2.48	84.0	0.063	2.483	0.630	4.97
TOC[c]	11.0	0.008	0.325	11.0	0.008	0.325	0.083	0.65
VOC	N.A.	0.001	0.036	N.A.	0.001	0.036	0.009	0.07
SO_x[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP[c]	7.60	5.70E-03	0.225	7.60	5.70E-03	0.225	0.057	0.449
PM_{10}[c]	7.60	5.70E-03	0.225	7.60	5.70E-03	0.225	0.057	0.449
$PM_{2.5}$[c]	7.60	5.70E-03	0.225	7.60	5.70E-03	0.225	0.057	0.449
Hazardous Air Pollutants								
Benzene[d]	2.10E-03	1.58E-06	6.21E-05	2.10E-03	1.58E-06	6.21E-05	1.58E-05	1.24E-04
Toluene[d]	3.40E-03	2.55E-06	1.01E-04	3.40E-03	2.55E-06	1.01E-04	2.55E-05	2.01E-04
Hexane[d]	1.80	1.35E-03	5.32E-02	1.80	1.35E-03	5.32E-02	0.014	0.106
Formaldehyde[d]	7.50E-02	5.63E-05	2.22E-03	7.50E-02	5.63E-05	2.22E-03	5.63E-04	4.43E-03
Dichlorobenzene[d]	1.2E-03	9.00E-07	3.55E-05	1.2E-03	9.00E-07	3.55E-05	1.80E-06	7.10E-05
Naphthalene[d]	6.1E-04	4.58E-07	1.80E-05	6.1E-04	4.58E-07	1.80E-05	9.15E-07	3.61E-05
POM 2[e,f]	5.9E-05	4.43E-08	1.74E-06	5.9E-05	4.43E-08	1.74E-06	8.85E-08	3.49E-06
POM 3[e,g]	1.6E-05	1.20E-08	4.73E-07	1.6E-05	1.20E-08	4.73E-07	2.40E-08	9.46E-07
POM 4[e,h]	1.8E-06	1.35E-09	5.32E-08	1.8E-06	1.35E-09	5.32E-08	2.70E-09	1.06E-07
POM 5[e,i]	2.4E-06	1.80E-09	7.10E-08	2.4E-06	1.80E-09	7.10E-08	3.60E-09	1.42E-07
POM 6[e,j]	7.2E-06	5.40E-09	2.13E-07	7.2E-06	5.40E-09	2.13E-07	1.08E-08	4.26E-07
POM 7[e,k]	1.8E-06	1.35E-09	5.32E-08	1.8E-06	1.35E-09	5.32E-08	2.70E-09	1.06E-07
Greenhouse Gases								
CO_2[c]	120,000	90.0	3,548	120,000	90.0	3,548	180.0	7,096
CH_4[c]	2.30	1.73E-03	6.80E-02	2.30	1.73E-03	0.068	3.45E-03	0.136
N_2O[c]	2.20	1.65E-03	6.50E-02	2.20	1.65E-03	0.065	3.30E-03	0.130

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

[b] Assumes produced gas contains no sulfur

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

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

[e] POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[1] Assumes maximum development scenario

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28. Central Facility Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate :

Facility 1	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 2	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 3	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 4	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 5	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 6	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 7	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 8	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 9	10.85	bbls condensate per day (Estimate based on similar facility data)
Total Facilities	9	

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	40.50	365
Hazardous Air Pollutants		
Benzene	0.140	1.26
Toluene	0.140	1.26
Ethylbenzene	0.010	0.09
Xylenes	0.040	0.36
n-Hexane	0.520	4.68
Total HAP's	0.690	6.21
Greenhouse Gases		
CO_2	0.310	2.79
CH_4	8.00	72.0

* Includes 9 Facilities

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 100 MMscf/day total

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total* Project Emissions (tons/year)
VOC	10.60	46.4
Benzene	1.12	4.9
Toluene	2.85	12.5
Ethylbenzene	0.20	0.9
Xylenes	2.78	12.2
n-Hexane	0.09	0.4
Total HAPs	7.05	30.9
Greenhouse Gases		
CH_4	3.61	15.8

* Includes 9 Facilities and year around operation

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30. Central Compression

Assumptions:

Engine Type: TBD

Maximum Engine Capacity Increase: 8,520 horsepower (Proponent)

Equations:

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

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

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	18.8	82.3
CO [d]	-	0.190	3.6	15.6
VOC [d]	-	0.460	9	37.8
PM_{10} [e]	9.95E-03	0.036	0.68	2.97
$PM_{2.5}$ [e]	9.95E-03	0.036	0.68	2.97
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	7.20E-03	3.15E-02
Toluene	4.08E-04	3.55E-04	6.67E-03	2.92E-02
Ethylbenzene	3.97E-05	3.46E-05	6.49E-04	2.84E-03
Xylenes	1.84E-04	1.60E-04	3.01E-03	1.32E-02
n-Hexane	1.11E-03	9.67E-04	1.82E-02	7.95E-02
Formaldehyde	-	6.00E-02	1.13E+00	4.94E+00
Acetaldehyde	8.36E-03	7.28E-03	1.37E-01	5.99E-01
Acrolein	5.14E-03	4.48E-03	8.41E-02	3.68E-01
Methanol	2.50E-03	2.18E-03	4.09E-02	1.79E-01
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	6.54E-04	2.87E-03
1,1,2-Trichloroethane	3.18E-05	2.77E-05	5.20E-04	2.28E-03
1,3-Dichloropropene	2.64E-05	2.30E-05	4.32E-04	1.89E-03
1,3-Butadiene	2.67E-04	2.33E-04	4.37E-03	1.91E-02
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	4.09E-03	1.79E-02
Biphenyl	2.12E-04	1.85E-04	3.47E-03	1.52E-02
Carbon Tetrachloride	3.67E-05	3.20E-05	6.00E-04	2.63E-03
Chlorobenzene	3.04E-05	2.65E-05	4.97E-04	2.18E-03
Chloroform	2.85E-05	2.48E-05	4.66E-04	2.04E-03
Ethylene Dibromide	4.43E-05	3.86E-05	7.25E-04	3.17E-03
Methylene Chloride	2.00E-05	1.74E-05	3.27E-04	1.43E-03
Naphthalene	7.44E-05	6.48E-05	1.22E-03	5.33E-03
Phenol	2.40E-05	2.09E-05	3.93E-04	1.72E-03
Styrene	2.36E-05	2.06E-05	3.86E-04	1.69E-03
Tetrachloroethane	2.48E-06	2.16E-06	4.06E-05	1.78E-04
Vinyl Chloride	1.49E-05	1.30E-05	2.44E-04	1.07E-03
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	4.40E-04	1.93E-03
POM 2 [h, i]	5.93E-05	5.17E-05	9.71E-04	4.25E-03
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	2.72E-06	1.19E-05
Chrysene/POM7 [h]	6.93E-07	6.04E-07	1.13E-05	4.97E-05
Greenhouse Gases				
CO_2	110	399	7,498	32,839
CH_4	1.25	4.54	85	373

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

[f] Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

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

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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

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31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year)[a]					Total
	Construction	Drilling[b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.23	192	26.0	0.03	0.00	218
CO	1.20	154	22.4	0.27	0.00	178
VOC	0.14	45.6	17	0.02	0.00	63
SO_2	0.01	0.70	0.30	0.002	0.00	1.0
PM_{10}	8.88	496	210	1.59	0.03	716
$PM_{2.5}$	0.95	54.6	21.2	0.16	3.84E-03	77
Benzene	0.00	0.10	0.07	0.00	0.00	0.2
Toluene	0.00	0.04	0.06	0.00	0.00	0.1
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.002
Xylene	0.00	0.02	0.02	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.31	0.00	0.00	0.3
Formaldehyde	0.00	9.97E-03	5.73E-04	0.00	0.00	0.011
Acrolein	0.00	9.96E-04	5.49E-05	0.00	0.00	1.1E-03
1,3-Butadiene	0.00	0.00	3.48E-06	0.00	0.00	3.5E-06
Greenhouses Gases						
CO_2	0.00	19,541	932	0.00	0.00	20,472
CH_4	8.65E-03	12.4	89	1.55E-03	0.00	101
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes maximum development scenario

[b] Total drilling emissions includes Tier II drill rig engines

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total [a]
	Pump Unit Engines	Production Heaters	Oil Tanks	TEG Dehydrators	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	30	218	0.00	0.00	15.8	0.0	82	346
CO	60	183	0.00	0.00	44.0	0.0	16	302
VOC	15	2.68	1,326	1,535	9.01	2196.5	38	5,122
SO_2	0.00	0.00	0.00	0.00	0.65	0.0	0.00	0.65
PM_{10}	1.5	16.6	0.00	0.00	1.36	0.0	3.0	22
$PM_{2.5}$	1.5	16.6	0.00	0.00	0.14	0.0	3.0	21
Hazardous Air Pollutants								
Benzene	0.12	0.00	8.5	161	0.00	0.0	0.03	170
Toluene	0.04	0.01	7.1	363	0.00	0.0	0.03	370
Ethylbenzene	0.00	0.00	0.1	21.7	0.00	0.0	0.00	21.8
Xylene	0.01	0.00	1.3	321	0.00	0.0	0.01	323
n-Hexane	0.00	3.92	26.5	13.1	0.00	0.0	0.08	44
Formaldehyde	1.5	0.16	0.00	0.00	0.00	0.0	4.9	6.6
Acetaldehyde	0.21	0.00	0.00	0.00	0.00	0.0	0.6	0.8
Acrolein	0.20	0.00	0.00	0.00	0.00	0.0	0.37	0.57
Methanol	0.23	0.00	0.00	0.00	0.00	0.0	0.18	0.41
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.05	0.00	0.00	0.00	0.00	0.0	0.02	0.07
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.02	0.02
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.02	0.02
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.01	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.01	0.00	0.00	0.00	0.00	0.0	0.00	0.01
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	1.19E-05	1.19E-05
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	4.97E-05	4.97E-05
Greenhouse Gases								
CO_2	38,217	261,486	11.0	0.00	0.00	0.0	32,839	332,553
CH_4	17	5.01	446	163	0.48	8634.1	373	9,639
N_2O	0.00	4.79	0.00	0.00	0.00	0.0	0.00	4.79

a Assumes maximum development scenario

APPENDIX F-2

Emissions Inventories for Alternative D

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	1.12	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	1.12	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 3.01 lbs TSP/well pad

Emissions = 1.44 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	3.01	0.30	1.51E-03	3.83E-02
PM_{15}	1.44	0.14	7.21E-04	1.83E-02
PM_{10}	0.86	0.09	4.32E-04	1.10E-02
$PM_{2.5}$	0.09	0.01	4.67E-05	1.19E-03

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.38	0.0019	0.05	0.19
$PM_{2.5}$	0.21	0.0031	0.08	0.21	0.0010	0.03	0.11

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

b Assumes maximum development scenario

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2	day grading per well pad and road (Estimate)
	10	hours/day
	20	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr** [a]
TSP	5.54	0.28	0.0028	0.07
PM_{15}	2.65	0.13	0.0013	0.03
PM_{10}	1.59	0.08	0.0008	0.02
$PM_{2.5}$	0.17	0.01	0.0001	0.002

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	3.01	0.301	1.51E-04
PM_{15}	1.44	0.144	7.21E-05
PM_{10}	0.86	0.086	4.32E-05
$PM_{2.5}$	0.09	0.009	4.67E-06

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	0.0791
PM_{15}	0.0202
PM_{10}	0.0142
$PM_{2.5}$	0.0078

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	9.69	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	9.69	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 26.04 lbs TSP/well

Emissions = 12.46 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	26.04	0.87	0.0130	0.33
PM_{15}	12.46	0.42	0.0062	0.16
PM_{10}	7.48	0.25	0.0037	0.10
$PM_{2.5}$	0.81	0.03	0.0004	0.010

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

Hours per day 10
Days per pad 9

Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Semi: Hvy Equip Hauler	60,000	3					
Haul Trucks: Equipment/Fuel/Water	48,000	5					
Pickup Truck: Crew	7,000	10					
Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
				Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
				9.5		0.9	

Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.067	98.6	11.0	9.9	1.1
		Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
		1.25		0.13	

Vertical Drilling (days/well)

Hours per day 10
Days per well 14

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				87.2		8.7	

Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.113	165.4	11.8	16.5	1.2
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		1.39		0.14	

Directional Drilling (days/well)

Hours per day 10
Days per well 21

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				224.2		22.4	

Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.113	165.4	7.9	16.5	0.8
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		3.57		0.36	

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				129.2		12.9	

Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.134	195.8	19.6	19.6	2.0
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		5.87		0.59	

Interim Reclamation (days/well)

Hours per day 10
Days per pad 2

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Pickup: Crew	7,000	4					
Haul Trucks: Equipment	60,000	1					
Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.4		0.1	

Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.035	51.5	25.7	5.1	2.6
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		0.43		0.04	

Annual Traffic Fugitive Dust Emissions (tons/year)

Unpaved Roads PM_{10} (tons)	Unpaved Roads $PM_{2.5}$ (tons)
452	45.2
Paved Roads PM_{10} (tons)	**Paved Roads $PM_{2.5}$ (tons)**
12.52	1.25

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9. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	acres total disturbance
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{*)}$	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

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

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

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

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

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

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10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.280
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	1.474
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.177
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	1.36E-02
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	1.06E-02

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	25	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/mile)} * \text{Trip Distance (miles)} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	4.23E-04
CO	1.15E-03	9.09E-04
VOC [d]	3.17E-04	2.51E-04
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

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12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	457	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.510	0.117	3.23	0.143	0.033	0.653	8.9
CO	17.5	1.097	0.251	36.8	1.63	0.372	2.72	37.3
VOC [c]	4.83	0.303	0.069	2.29	0.101	0.023	0.404	5.54
SO_2	0.321	2.01E-02	4.60E-03	0.214	9.45E-03	2.16E-03	2.96E-02	0.406
CH_4 [e, f]	0.230	1.44E-02	3.30E-03	0.180	7.95E-03	1.82E-03	2.24E-02	0.307

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	4.327
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	11.569
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	2.598
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.177
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.129

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.041
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.317
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.027
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	2.27E-03
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.83E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	457	hours/well (Proposed Action)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	263
CO [b]	5.50E-03	4.40	60
VOC [b]	7.05E-04	0.56	7.7
PM_{10} [b]	4.30E-04	0.34	4.71
$PM_{2.5}$ [b]	3.59E-04	0.29	3.94
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	116
CO [a]	5.70E-03	4.56	63
VOC [a]	2.20E-03	1.76	24.1
PM_{10} [a]	3.30E-04	0.26	3.62
$PM_{2.5}$ [b]	3.30E-04	0.26	3.62
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	-147	ton/yr
CO	2	ton/yr
VOC	16.4	ton/yr
PM_{10}	-1.09	ton/yr
$PM_{2.5}$	-0.32	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

[f] PAH (Polycyclic Aromatic Hydrocarbons) includes naphthalene and are a HAP because they are polycyclic organic matter (POM)

[g] Assumes maximum development scenario

16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO_2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	102.000	12.24
CO [a]	5.50E-03	23.375	2.81
VOC [a,b]	7.05E-04	2.996	0.36
PM_{10} [a,c]	4.30E-04	1.8264	0.2192
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.1832
SO_2 [a]	4.05E-06	0.017	0.002
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	2.97E-03
Toluene [e]	2.11E-06	8.96E-03	1.07E-03
Xylenes [e]	1.45E-06	6.15E-03	7.38E-04
Formaldehyde [e]	5.92E-07	2.51E-03	3.02E-04
Acetaldehyde [e]	1.89E-07	8.03E-04	9.64E-05
Acrolein [e]	5.91E-08	2.51E-04	3.01E-05
Naphthalene [f]	9.75E-07	4.14E-03	4.97E-04
Total PAH [f]	1.59E-06	6.76E-03	8.11E-04
Greenhouse Gases			
CO_2 [a]	1.16	4,930	592
CH_4 [a]	7.05E-04	2.996	0.360

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.24
CO [g]	6.68E-03	0.43	0.05
VOC [h,g]	2.47E-03	0.16	0.02
PM_{10} [g]	2.20E-03	0.14	0.02
$PM_{2.5}$ [g]	2.20E-03	0.14	0.02
SO_2 [g]	2.05E-03	0.13	0.02
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	5.35E-05
Toluene [h]	3.07E-06	1.96E-04	2.35E-05
Xylenes [h]	2.14E-06	1.36E-04	1.64E-05
Formaldehyde [h]	8.85E-06	5.64E-04	6.77E-05
Acetaldehyde [h]	5.75E-06	3.67E-04	4.40E-05
Acrolein [h]	6.94E-07	4.42E-05	5.31E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	2.24E-06
Naphthalene [h]	6.36E-07	4.05E-05	4.87E-06
Total PAH [h]	1.26E-06	8.03E-05	9.64E-06
Greenhouse Gases			
CO_2 [g]	1.15	73.3	8.8
CH_4 [h,g]	2.47E-03	0.157	0.02

[a] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
[b] Emission Factor represents total Hydrocarbon Emissions
[c] Total particulate emission factor is 0.0007, Total PM_{10} fraction determined from Table 3.4-2
[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2
[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96
[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96
[g] AP-42 Table 3.3-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[h] AP-42 Table 3.3-2, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[i] Assumes maximum development scenario

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
Total:	1.0000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
I-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. Well Development Venting

Assumptions:		Following completion, wells are vented prior to connnection to the gathering pipeline
Venting Period	48	hours (Project Proponents)
Amount of Vented Gas:	1.0	MMscf day (Average volume estimated by proponents)
Development Rate:	60	Wells per year (Project Proponents)
Control Rate	95	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	57
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	6.78
Propane	44.1	2.17	0.957	0.052	21.7	52.5	3.78
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	0.93
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	1.21
i-Pentane	72.2	0.197	0.142	0.008	1.97	7.78	0.56
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.45
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.41
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.39
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.12
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.04
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.04
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.01
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.20
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.46
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.58
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		3.79	2.06	0.11	37.9	113	8.15
HAP Subtotal		0.09	0.07	0.00	0.86	4.07	0.29
Total		100	18.4	1.00	1,000	1,012	73

19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	5	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	90,000	miles/year
Number of Condensate Haul Truck Round Trips:	4	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	10	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	531,750	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (Typical value)
Fuel density	7.08	lbs/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	3.23	0.18	0.32	8.13	2.62	4.8	2.79	5.1
CO	36.8	2.01	3.7	17.5	5.6	10.3	7.6	14.0
VOC [c]	2.11	0.11	0.21	4.60	1.48	2.71	1.60	2.92
SO_2	0.21	0.01	0.02	0.32	0.10	0.19	0.12	0.21
Greenhouse Gases								
CH_4 [d]	0.18	0.01	0.02	0.23	0.07	0.14	0.08	0.15

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)

[c] Emission factor is for total Hydrocarbons - Methane Offset

[d] AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

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20. Operations Pneumatic Emissions

Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas flow Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (Mscf/day)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
	VOC Subtotal	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	150	234	1117.7

Liquid Level Controller Specifications

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

Pneumatic Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
1	Pneumatic pump	0.23	0.99
	Totals (per well) =	0.36	1.56

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
1	Pneumatic pump	1.58	3.46
	Totals (per well) =	2.49	7.45

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
W = average weight in tons of vehicles traveling the road		
Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	5.3						
Haul Truck: Oil	48,000	2.2						
Haul Truck: Water	48,000	9.6	Paved	2.14	803	2.20	80	0.22
Mean Weight	35,327	17.0	Unpaved	0.101	38	0.10	3.8	0.01
					PM_{10}		$PM_{2.5}$	
Annual Traffic Fugitive Dust Emissions (tons/year)			Paved		0.40		0.040	
			Unpaved		0.019		0.002	
			Total		0.42		0.042	

Assume 3 barrels per day condensate per well
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 150 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	298
Hazardous Air Pollutants			
Benzene		0.015	2.3
Toluene		0.012	1.8
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.30
n-Hexane		0.045	6.8
Total HAPS		0.080	12.0
Greenhouse Gases			
CO_2		0.017	2.55
CH_4		0.77	116

a Assumes maximum development scenario

23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 150 wells at Peak Production
Wells Requiring Dehydrators: 150 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	461
Hazardous Air Pollutants				
Benzene		0.074	0.32	48
Toluene		0.165	0.72	109
Ethylbenzene		0.010	0.04	6.4
Xylenes		0.146	0.64	96
n-Hexane		0.006	0.03	3.9
Greenhouse Gases				
CH_4		0.069	0.30	46

25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@250, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	150	new wells

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1{,}000\ \text{(Btu/MBtu)} * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

VOC Emissions (tons/yr) = TOC Emissions (tons/yr) * VOC wt. fraction

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [f] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [f] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	49	100	0.025	16	0.100	66
CO [a]	84.0	0.063	41	84.0	0.021	13.8	0.084	55
TOC [c]	11.0	0.008	5.4	11.0	0.003	1.8	0.011	7.2
VOC	-	0.001	0.61	-	0.000	0.20	0.001	0.81
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	3.7	7.60	0.002	0.008	0.008	3.8
PM_{10} [c]	7.60	0.006	3.7	7.60	0.002	1.248	0.008	5.0
$PM_{2.5}$ [c]	7.60	0.006	3.7	7.60	0.002	1.248	0.008	5.0
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	1.03E-03	2.10E-03	5.25E-07	3.45E-04	2.10E-06	1.38E-03
Toluene [d]	3.40E-03	2.55E-06	1.68E-03	3.40E-03	8.50E-07	5.58E-04	3.40E-06	2.23E-03
Hexane [d]	1.80E+00	1.35E-03	8.87E-01	1.80E+00	4.50E-04	2.96E-01	1.80E-03	1.18E+00
Formaldehyde [d]	7.50E-02	5.63E-05	3.70E-02	7.50E-02	1.88E-05	1.23E-02	7.50E-05	4.93E-02
Dichlorobenzene [d]	1.20E-03	9.00E-07	5.91E-04	1.20E-03	3.00E-07	1.97E-04	1.20E-06	7.88E-04
Naphthalene [d]	6.10E-04	4.58E-07	3.01E-04	6.10E-04	1.53E-07	1.00E-04	6.10E-07	4.01E-04
POM 2 [d,e,f]	5.90E-05	4.43E-08	2.91E-05	5.90E-05	1.48E-08	9.69E-06	5.90E-08	3.88E-05
POM 3 [d,g]	1.60E-05	1.20E-08	7.88E-06	1.60E-05	4.00E-09	2.63E-06	1.60E-08	1.05E-05
POM 4 [d,h]	1.80E-06	1.35E-09	8.87E-07	1.80E-06	4.50E-10	2.96E-07	1.80E-09	1.18E-06
POM 5 [d,i]	2.40E-06	1.80E-09	1.18E-06	2.40E-06	6.00E-10	3.94E-07	2.40E-09	1.58E-06
POM 6 [d,j]	7.20E-06	5.40E-09	3.55E-06	7.20E-06	1.80E-09	1.18E-06	7.20E-09	4.73E-06
POM 7 [d,k]	1.8E-06	1.35E-09	8.87E-07	1.8E-06	4.50E-10	2.96E-07	1.80E-09	1.18E-06
Greenhouse Gases								
CO_2 [c]	120,000	90.0	59,130	120,000	30.0	19,710	120	78,840
CH_4 [c]	2.30	1.73E-03	1.13	2.30	5.75E-04	0.38	2.30E-03	1.51
N_2O [c]	2.20	1.65E-03	1.08	2.20	5.50E-04	0.36	2.20E-03	1.45

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

[b] Assumes produced gas contains no sulfur

[c] AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are PM_{10})

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

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

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[l] Assumes maximum development scenario

Kleinfelder/Buys

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24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size: 21.2 Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines: 23 wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	52.2
CO	3.72	18.7	0.87	87.9
VOC	0.03	0.15	0.01	0.7
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.04
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.07
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.06
Methanol	3.06E-03	1.54E-02	7.2E-04	0.07
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	5.98E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	3.62E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	3.00E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.57E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	4.18E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	3.05E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	3.24E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	5.04E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	9.74E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	2.30E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	2.81E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.70E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	3.33E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	12,041
CH_4	0.23	1.15	0.05	5

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	9
CO	-	4.0	0.19	19
VOC	-	1.0	0.05	5
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.04
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.07
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.06
Methanol	3.06E-03	1.54E-02	7.2E-04	0.07
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	5.98E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	3.62E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	3.00E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.57E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	4.18E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	3.05E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	3.24E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	5.04E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	9.74E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	2.30E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	2.81E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.70E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	3.33E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	12,041
CH_4	0.23	1.15	0.05	5

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00
[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)
[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)
[4] PM = sum of PM filterable and PM condensable
[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)
[6] Polycyclic Aromatic Hydrocarbons (PAH), POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
[7] Estimated at full project production.

26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	66	0.0	0.0	9	5.1	0.0	80
CO	55	0.0	0.0	19	14.0	0.0	88
VOC	0.81	298	461	5	2.92	8	776
SO_2	0.0	0.0	0.0	0.0	0.21	0.0	0.21
PM_{10}	5.0	0.0	0.0	0.5	0.42	0.0	6
$PM_{2.5}$	5.0	0.0	0.0	0.5	0.04	0.0	5.5
Hazardous Air Pollutants							
Benzene	1.4E-03	2.3	48	0.04	0.0	0.04	51
Toluene	2.2E-03	1.8	109	0.01	0.0	0.04	111
Ethylbenzene	0.0	0.00	6.4	0.00	0.0	0.00	6.4
Xylene	0.0	0.30	96	0.00	0.0	0.01	96
n-Hexane	1.18	6.8	3.9	0.0	0.0	0.20	12
Formaldehyde	0.05	0.0	0.0	0.5	0.0	0.0	0.5
Total HAPs	1.24	11	263	0.5	0.0	0.29	276
Greenhouse Gases							
CO_2	78,840	0.0	0.0	12,041	0.0	0.6	90,881
CH_4	1.51	0.0	46	5	0.15	57	110
N_2O	1.45	0.0	0.0	0.0	0.0	0.0	1.45

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

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27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)		
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr		
Total Central Facility Heater Requirement	1500	Mbtu/hr		
Firing Rate	60	minutes/hour on average for entire year (Typical value)		
	8760	hours/year		
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)	0.309917	0.340000
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)		
Development size	3	Facilities	9	5.13

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1{,}000\ (\text{Btu/MBtu}) * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1{,}000{,}000\ (\text{scf/MMscf})}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions[1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions[1] (tons/yr)	Total Emissions (lb/hr)	Total Emissions[1] (tons/yr)
Criteria Pollutants & VOC								
NOx[a]	100	0.075	0.99	100	0.075	0.986	0.750	1.97
CO[a]	84.0	0.063	0.83	84.0	0.063	0.828	0.630	1.66
TOC[c]	11.0	0.008	0.108	11.0	0.008	0.108	0.083	0.22
VOC	N.A.	0.001	0.012	N.A.	0.001	0.012	0.009	0.02
SO_X[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP[a]	7.60	5.70E-03	0.075	7.60	5.70E-03	0.075	0.057	0.150
PM_{10}[a]	7.60	5.70E-03	0.075	7.60	5.70E-03	0.075	0.057	0.150
$PM_{2.5}$[a]	7.60	5.70E-03	0.075	7.60	5.70E-03	0.075	0.057	0.150
Hazardous Air Pollutants								
Benzene[d]	2.10E-03	1.58E-06	2.07E-05	2.10E-03	1.58E-06	2.07E-05	1.58E-05	4.14E-05
Toluene[d]	3.40E-03	2.55E-06	3.35E-05	3.40E-03	2.55E-06	3.35E-05	2.55E-05	6.70E-05
Hexane[d]	1.80	1.35E-03	1.77E-02	1.80	1.35E-03	1.77E-02	0.014	0.035
Formaldehyde[d]	7.50E-02	5.63E-05	7.39E-04	7.50E-02	5.63E-05	7.39E-04	5.63E-04	1.48E-03
Dichlorobenzene[d]	1.2E-03	9.00E-07	1.18E-05	1.2E-03	9.00E-07	1.18E-05	1.80E-06	2.37E-05
Naphthalene[d]	6.1E-04	4.58E-07	6.01E-06	6.1E-04	4.58E-07	6.01E-06	9.15E-07	1.20E-05
POM 2[e,g]	5.9E-05	4.43E-08	5.81E-07	5.9E-05	4.43E-08	5.81E-07	8.85E-08	1.16E-06
POM 3[f,g]	1.6E-05	1.20E-08	1.58E-07	1.6E-05	1.20E-08	1.58E-07	2.40E-08	3.15E-07
POM 4[e,h]	1.8E-06	1.35E-09	1.77E-08	1.8E-06	1.35E-09	1.77E-08	2.70E-09	3.55E-08
POM 5[e,i]	2.4E-06	1.80E-09	2.37E-08	2.4E-06	1.80E-09	2.37E-08	3.60E-09	4.73E-08
POM 6[e,j]	7.2E-06	5.40E-09	7.10E-08	7.2E-06	5.40E-09	7.10E-08	1.08E-08	1.42E-07
POM 7[e,k]	1.8E-06	1.35E-09	1.77E-08	1.8E-06	1.35E-09	1.77E-08	2.70E-09	3.55E-08
Greenhouse Gases								
CO_2[a]	120,000	90.0	1,183	120,000	90.0	1,183	180.0	2,365
CH_4[a]	2.30	1.73E-03	2.27E-02	2.30	1.73E-03	0.023	3.45E-03	0.045
N_2O[c]	2.20	1.65E-03	2.17E-02	2.20	1.65E-03	0.022	3.30E-03	0.043

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

[b] Assumes produced gas contains no sulfur

[c] AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{2.5}$)

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

[e] POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999

[f] POM 2 includes: Acenaphthene, acenaphthylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene

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

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

[k] POM 7 includes: Chrysene.

[l] Assumes maximum development scenario

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28. Central Facility Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate :
Per Facility 10.85 bbls condensate per day (Estimate based on similar facility data)

Total new/modified Facilities 3

Calculations:

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample
Assumes 95% emission control

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	2.03	6
Hazardous Air Pollutants		
Benzene	0.01	0.02
Toluene	0.01	0.02
Ethylbenzene	0.00	0.00
Xylenes	0.00	0.01
n-Hexane	0.03	0.08
Total HAP's	0.03	0.10
Greenhouse Gases		
CO_2	0.31	0.93
CH_4	0.40	1.2

*Based on total facilities

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 34 MMscf/day total (all new production)

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	3.61	15.8
Benzene	0.38	1.7
Toluene	0.97	4.2
Ethylbenzene	0.07	0.3
Xylenes	0.95	4.2
n-Hexane	0.03	0.1
Total HAPs	2.40	10.5
Greenhouse Gases		
CH_4	1.23	5.4

30. Central Compression

Assumptions:

Engine Type: TBD
Proposed Engine Capacity Increase: 2,905 horsepower (Proponent)

Equations:

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

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

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	6.4	28.1
CO [d]	-	0.190	1.2	5.3
VOC [d]	-	0.460	3	12.9
PM_{10} [e]	9.95E-03	0.036	0.23	1.01
$PM_{2.5}$ [e]	9.95E-03	0.036	0.23	1.01
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	2.45E-03	1.07E-02
Toluene	4.08E-04	3.55E-04	2.28E-03	9.97E-03
Ethylbenzene	3.97E-05	3.46E-05	2.21E-04	9.70E-04
Xylenes	1.84E-04	1.60E-04	1.03E-03	4.50E-03
n-Hexane	1.11E-03	9.67E-04	6.19E-03	2.71E-02
Formaldehyde	-	6.00E-02	3.84E-01	1.68E+00
Acetaldehyde	8.36E-03	7.28E-03	4.66E-02	2.04E-01
Acrolein	5.14E-03	4.48E-03	2.87E-02	1.26E-01
Methanol	2.50E-03	2.18E-03	1.39E-02	6.11E-02
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	2.23E-04	9.77E-04
1,1,2-Trichloroethane	3.18E-05	2.77E-05	1.77E-04	7.77E-04
1,3-Dichloropropene	2.64E-05	2.30E-05	1.47E-04	6.45E-04
1,3-Butadiene	2.67E-04	2.33E-04	1.49E-03	6.52E-03
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	1.39E-03	6.11E-03
Biphenyl	2.12E-04	1.85E-04	1.18E-03	5.18E-03
Carbon Tetrachloride	3.67E-05	3.20E-05	2.05E-04	8.97E-04
Chlorobenzene	3.04E-05	2.65E-05	1.70E-04	7.43E-04
Chloroform	2.85E-05	2.48E-05	1.59E-04	6.96E-04
Ethylene Dibromide	4.43E-05	3.86E-05	2.47E-04	1.08E-03
Methylene Chloride	2.00E-05	1.74E-05	1.12E-04	4.89E-04
Naphthalene	7.44E-05	6.48E-05	4.15E-04	1.82E-03
Phenol	2.40E-05	2.09E-05	1.34E-04	5.86E-04
Styrene	2.36E-05	2.06E-05	1.32E-04	5.77E-04
Tetrachloroethane	2.48E-06	2.16E-06	1.38E-05	6.06E-05
Vinyl Chloride	1.49E-05	1.30E-05	8.31E-05	3.64E-04
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	1.50E-04	6.57E-04
POM 2 [h, i]	5.93E-05	5.17E-05	3.31E-04	1.45E-03
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	9.26E-07	4.06E-06
Chrysene/POM7 [h]	6.93E-07	6.04E-07	3.87E-06	1.69E-05
Greenhouse Gases				
CO_2	110	399	2,556	11,197
CH_4	1.25	4.54	29	127

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

[f] Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

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

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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

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31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling[b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.28	125	16.8	0.04	0.00	142
CO	1.48	100	14.4	0.32	0.00	116
VOC	0.18	29.7	11	0.03	0.00	41
SO_2	0.01	0.45	0.20	0.002	0.00	0.7
PM_{10}	10.90	320	135	1.88	0.03	468
$PM_{2.5}$	1.16	35.3	13.7	0.19	3.84E-03	50
Benzene	0.00	0.06	0.04	0.00	0.00	0.1
Toluene	0.00	0.02	0.04	0.00	0.00	0.1
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.001
Xylene	0.00	0.02	0.01	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.20	0.00	0.00	0.2
Formaldehyde	0.00	6.49E-03	3.69E-04	0.00	0.00	0.007
Acrolein	0.00	6.48E-04	3.54E-05	0.00	0.00	6.8E-04
1,3-Butadiene	0.00	0.00	2.24E-06	0.00	0.00	2.2E-06
Greenhouses Gases						
CO_2	0.00	12,722	601	0.00	0.00	13,323
CH_4	1.06E-02	8.0	57	1.83E-03	0.00	65
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes 60 wells/yr development scenario

[b] Drilling emissions assumes Tier II drill rig engines

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total
	Pump Unit Engines	Production Heaters	Stock Tanks	TEG Dehys	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	9	68	0.00	0.00	5.1	0.0	28	110
CO	19	57	0.00	0.00	14.0	0.0	5	95
VOC	5	0.83	304	477	2.92	234.4	13	1,037
SO_2	0.00	0.00	0.00	0.00	0.21	0.0	0.00	0.21
PM_{10}	0.5	5.1	0.00	0.00	0.42	0.0	1.0	7
$PM_{2.5}$	0.5	5.1	0.00	0.00	0.04	0.0	1.0	7
Hazardous Air Pollutants								
Benzene	0.04	0.00	2.3	50	0.00	0.0	0.01	52
Toluene	0.01	0.00	1.8	113	0.00	0.0	0.01	115
Ethylbenzene	0.00	0.00	0.0	6.7	0.00	0.0	0.00	6.7
Xylene	0.00	0.00	0.3	100	0.00	0.0	0.00	100
n-Hexane	0.00	1.22	6.8	4.1	0.00	0.0	0.03	12
Formaldehyde	0.5	0.05	0.00	0.00	0.00	0.0	1.7	2.2
Acetaldehyde	0.07	0.00	0.00	0.00	0.00	0.0	0.2	0.3
Acrolein	0.06	0.00	0.00	0.00	0.00	0.0	0.13	0.19
Methanol	0.07	0.00	0.00	0.00	0.00	0.0	0.06	0.13
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.02	0.00	0.00	0.00	0.00	0.0	0.01	0.02
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	4.06E-06	4.06E-06
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	1.69E-05	1.69E-05
Greenhouse Gases								
CO_2	12,041	81,205	3.5	0.00	0.00	0.0	11,197	104,447
CH_4	5	1.56	117	51	0.15	1117.7	127	1,420
N_2O	0.00	1.49	0.00	0.00	0.00	0.0	0.00	1.49

a Assumes maximum development scenario

APPENDIX F-3

Emissions Inventories for Alternative C

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	0.67	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	0.67	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.81 lbs TSP/well pad

Emissions = 0.86 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	1.81	0.18	9.04E-04	2.30E-02
PM_{15}	0.86	0.09	4.32E-04	1.10E-02
PM_{10}	0.52	0.05	2.59E-04	6.60E-03
$PM_{2.5}$	0.06	0.01	2.80E-05	7.13E-04

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.38	0.0019	0.05	0.19
$PM_{2.5}$	0.21	0.0031	0.08	0.21	0.0010	0.03	0.11

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2 10 20	day grading per well pad and road (Estimate) hours/day hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	5.54	0.28	0.0028	0.07
PM_{15}	2.65	0.13	0.0013	0.03
PM_{10}	1.59	0.08	0.0008	0.02
$PM_{2.5}$	0.17	0.01	0.0001	0.002

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	1.81	0.181	9.04E-05
PM_{15}	0.86	0.086	4.32E-05
PM_{10}	0.52	0.052	2.59E-05
$PM_{2.5}$	0.06	0.006	2.80E-06

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	0.0790
PM_{15}	0.0202
PM_{10}	0.0142
$PM_{2.5}$	0.0078

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	5.82	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	5.82	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 15.62 lbs TSP/well

Emissions = 7.48 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	15.62	0.52	0.0078	0.20
PM_{15}	7.48	0.25	0.0037	0.10
PM_{10}	4.49	0.15	0.0022	0.06
$PM_{2.5}$	0.48	0.02	0.0002	0.006

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

Hours per day 10
Days per pad 9

Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Semi: Hvy Equip Hauler	60,000	3					
Haul Trucks: Equipment/Fuel/Water	48,000	5					
Pickup Truck: Crew	7,000	10					
Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
				Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
				9.5		0.9	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.067	98.6	11.0	9.9	1.1
				Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
				1.25		0.13	

Vertical Drilling (days/well)

Hours per day 10
Days per well 14

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				87.2		8.7	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	11.8	16.5	1.2
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.39		0.14	

Directional Drilling (days/well)

Hours per day 10
Days per well 21

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				224.2		22.4	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	7.9	16.5	0.8
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				3.57		0.36	

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads		**Unpaved Roads**	

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

		PM_{10}/Annual Wells (tons)		$PM_{2.5}$/Annual Wells (tons)	
		129.2		12.9	
Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.134	195.8	19.6	19.6	2.0
		Paved Roads PM_{10}/Annual Wells (tons)		Paved Roads $PM_{2.5}$/Annual Wells (tons)	
		5.87		0.59	

Interim Reclamation (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Hours per day 10								
Days per pad 2								
	Pickup: Crew	7,000	4					
	Haul Trucks: Equipment	60,000	1					
	Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
					Unpaved Roads PM_{10}/Annual Wells (tons)		Unpaved Roads $PM_{2.5}$/Annual Wells (tons)	
					1.4		0.1	
			Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
				0.035	51.5	25.7	5.1	2.6
					Paved Roads PM_{10}/Annual Wells (tons)		Paved Roads $PM_{2.5}$/Annual Wells (tons)	
					0.43		0.04	

Annual Traffic Fugitive Dust Emissions (tons/year)

Unpaved Roads PM_{10} (tons)	Unpaved Roads $PM_{2.5}$ (tons)
452	45.2
Paved Roads PM_{10} (tons)	**Paved Roads $PM_{2.5}$ (tons)**
12.52	1.25

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

9. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	acres total disturbance
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{*})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

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

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

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

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

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

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10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.280
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	1.474
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.177
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	1.36E-02
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	1.06E-02

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	25	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/mile)} * \text{Trip Distance (miles)} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	4.23E-04
CO	1.15E-03	9.09E-04
VOC [d]	3.17E-04	2.51E-04
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	457	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.510	0.117	3.23	0.143	0.033	0.653	8.9
CO	17.5	1.097	0.251	36.8	1.63	0.372	2.72	37.3
VOC [c]	4.83	0.303	0.069	2.29	0.101	0.023	0.404	5.54
SO_2	0.321	2.01E-02	4.60E-03	0.214	9.45E-03	2.16E-03	2.96E-02	0.406
CH_4 [e, f]	0.230	1.44E-02	3.30E-03	0.180	7.95E-03	1.82E-03	2.24E-02	0.307

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	4.327
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	11.569
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	2.598
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.177
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.129

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.041
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.317
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.027
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	2.27E-03
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.83E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	457	hours/well (Proposed Action)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	263
CO [b]	5.50E-03	4.40	60
VOC [b]	7.05E-04	0.56	7.7
PM_{10} [b]	4.30E-04	0.34	4.71
$PM_{2.5}$ [b]	3.59E-04	0.29	3.94
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	116
CO [a]	5.70E-03	4.56	63
VOC [a]	2.20E-03	1.76	24.1
PM_{10} [a]	3.30E-04	0.26	3.62
$PM_{2.5}$ [b]	3.30E-04	0.26	3.62
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	-147	ton/yr
CO	2	ton/yr
VOC	16.4	ton/yr
PM_{10}	-1.09	ton/yr
$PM_{2.5}$	-0.32	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

[f] PAH (Polycyclic Aromatic Hydrocarbons) includes naphthalene and are a HAP because they are polycyclic organic matter (POM)

[g] Assumes maximum development scenario

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16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 \text{ (lb/tons)}}$$

SO_2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	102.000	12.24
CO [a]	5.50E-03	23.375	2.81
VOC [a,b]	7.05E-04	2.996	0.36
PM_{10} [a,c]	4.30E-04	1.8264	0.2192
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.1832
SO_2 [a]	4.05E-06	0.017	0.002
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	2.97E-03
Toluene [e]	2.11E-06	8.96E-03	1.07E-03
Xylenes [e]	1.45E-06	6.15E-03	7.38E-04
Formaldehyde [e]	5.92E-07	2.51E-03	3.02E-04
Acetaldehyde [e]	1.89E-07	8.03E-04	9.64E-05
Acrolein [e]	5.91E-08	2.51E-04	3.01E-05
Naphthalene [f]	9.75E-07	4.14E-03	4.97E-04
Total PAH [f]	1.59E-06	6.76E-03	8.11E-04
Greenhouse Gases			
CO_2 [a]	1.16	4,930	592
CH_4 [a]	7.05E-04	2.996	0.360

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.24
CO [g]	6.68E-03	0.43	0.05
VOC [b,g]	2.47E-03	0.16	0.02
PM_{10} [g]	2.20E-03	0.14	0.02
$PM_{2.5}$ [g]	2.20E-03	0.14	0.02
SO_2 [g]	2.05E-03	0.13	0.02
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	5.35E-05
Toluene [h]	3.07E-06	1.96E-04	2.35E-05
Xylenes [h]	2.14E-06	1.36E-04	1.64E-05
Formaldehyde [h]	8.85E-06	5.64E-04	6.77E-05
Acetaldehyde [h]	5.75E-06	3.67E-04	4.40E-05
Acrolein [h]	6.94E-07	4.42E-05	5.31E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	2.24E-06
Naphthalene [h]	6.36E-07	4.05E-05	4.87E-06
Total PAH [h]	1.26E-06	8.03E-05	9.64E-06
Greenhouse Gases			
CO_2 [g]	1.15	73.3	8.8
CH_4 [b,g]	2.47E-03	0.157	0.02

[a] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
[b] Emission Factor represents total Hydrocarbon Emissions
[c] Total particulate emission factor is 0.0007, Total PM_{10} fraction determined from Table 3.4-2
[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2
[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96
[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96
[g] AP-42 Table 3.3-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[h] AP-42 Table 3.3-2, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[i] Assumes maximum development scenario

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
Total:	1.0000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	100	-	18.4	1.00	-	1,123	-	1,011

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. Well Development Venting

Assumptions:		Following completion, wells are vented prior to connnection to the gathering pipeline
Venting Period	48	hours (Project Proponents)
Amount of Vented Gas:	1.0	MMscf day (Average volume estimated by proponents)
Development Rate:	60	Wells per year (Project Proponents)
Control Rate	95	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	57
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	6.78
Propane	44.1	2.17	0.957	0.052	21.7	52.5	3.78
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	0.93
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	1.21
i-Pentane	72.2	0.197	0.142	0.008	1.97	7.78	0.56
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.45
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.41
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.39
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.12
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.04
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.04
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.01
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.20
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.46
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.58
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		3.79	2.06	0.11	37.9	113	8.15
HAP Subtotal		0.09	0.07	0.00	0.86	4.07	0.29
Total		100	18.4	1.00	1,000	1,012	73

19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	9	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	162,000	miles/year
Number of Condensate Haul Truck Round Trips:	6	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	16	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	835,430	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (Typical value)
Fuel density	7.08	lbs/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{453.6 (g/lb)} * \text{2000 (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * \text{453.6 (g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	3.23	0.32	0.58	8.13	4.11	7.5	4.43	8.1
CO	36.8	3.61	6.6	17.5	8.8	16.2	12.5	22.8
VOC [c]	2.11	0.21	0.38	4.60	2.33	4.25	2.53	4.63
SO_2	0.21	0.02	0.04	0.32	0.16	0.30	0.18	0.34
Greenhouse Gases								
CH_4 [d]	0.18	0.02	0.03	0.23	0.12	0.21	0.13	0.25

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)

[c] Emission factor is for total Hydrocarbons - Methane Offset

[d] AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

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20. Operations Pneumatic Emissions

Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas flow Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (Mscf/day)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC Subtotal		**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
HAP Subtotal		**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
Total		**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	250	391	1862.9

Liquid Level Controller Specifications

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

Pneumatic Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
1	Pneumatic pump	0.23	0.99
	Totals (per well) =	0.36	1.56

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
1	Pneumatic pump	1.58	3.46
	Totals (per well) =	2.49	7.45

Kleinfelder/Buys

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
W = average weight in tons of vehicles traveling the road		
Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	8.8						
Haul Truck: Oil	48,000	3.6						
Haul Truck: Water	48,000	16.0	Paved	2.14	1,338	3.67	134	0.37
Mean Weight	35,327	28.4	Unpaved	0.101	63	0.17	6.3	0.02
					PM_{10}		$PM_{2.5}$	
Annual Traffic Fugitive Dust Emissions (tons/year)			Paved		0.67		0.067	
			Unpaved		0.032		0.003	
			Total		0.70		0.070	

Assume 3 barrels per day condensate per well
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 250 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:
Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	497
Hazardous Air Pollutants			
Benzene		0.015	3.8
Toluene		0.012	3.0
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.50
n-Hexane		0.045	11.3
Total HAPS		0.080	20.0
Greenhouse Gases			
CO_2		0.017	4.25
CH_4		0.77	193

a Assumes maximum development scenario

23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 250 wells at Peak Production
Wells Requiring Dehydrators: 250 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Tons per year per well are calculated with the conservative estimate that the wellsite dehys could theoretically run 8,760 hours out of the year

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	769
Hazardous Air Pollutants				
Benzene		0.074	0.32	81
Toluene		0.165	0.72	181
Ethylbenzene		0.010	0.04	10.7
Xylenes		0.146	0.64	160
n-Hexane		0.006	0.03	6.6
Greenhouse Gases				
CH_4		0.069	0.30	76

25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	250	new wells

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1{,}000\ \text{(Btu/MBtu)} * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [j] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [i] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	82	100	0.025	27	0.100	110
CO [a]	84.0	0.063	69	84.0	0.021	23.0	0.084	92
TOC [c]	11.0	0.008	9.0	11.0	0.003	3.0	0.011	12.0
VOC	-	0.001	1.01	-	0.000	0.34	0.001	1.35
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	6.2	7.60	0.002	0.008	0.008	6.2
PM_{10} [c]	7.60	0.006	6.2	7.60	0.002	2.081	0.008	8.3
$PM_{2.5}$ [c]	7.60	0.006	6.2	7.60	0.002	2.081	0.008	8.3
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	1.72E-03	2.10E-03	5.25E-07	5.75E-04	2.10E-06	2.30E-03
Toluene [d]	3.40E-03	2.55E-06	2.79E-03	3.40E-03	8.50E-07	9.31E-04	3.40E-06	3.72E-03
Hexane [d]	1.80E+00	1.35E-03	1.48E+00	1.80E+00	4.50E-04	4.93E-01	1.80E-03	1.97E+00
Formaldehyde [d]	7.50E-02	5.63E-05	6.16E-02	7.50E-02	1.88E-05	2.05E-02	7.50E-05	8.21E-02
Dichlorobenzene [d]	1.20E-03	9.00E-07	9.86E-04	1.20E-03	3.00E-07	3.29E-04	1.20E-06	1.31E-03
Naphthalene [d]	6.10E-04	4.58E-07	5.01E-04	6.10E-04	1.53E-07	1.67E-04	6.10E-07	6.68E-04
POM 2 [d,e,f]	5.90E-05	4.43E-08	4.85E-05	5.90E-05	1.48E-08	1.62E-05	5.90E-08	6.46E-05
POM 3 [d,g]	1.60E-05	1.20E-08	1.31E-05	1.60E-05	4.00E-09	4.38E-06	1.60E-08	1.75E-05
POM 4 [d,h]	1.80E-06	1.35E-09	1.48E-06	1.80E-06	4.50E-10	4.93E-07	1.80E-09	1.97E-06
POM 5 [d,j]	2.40E-06	1.80E-09	1.97E-06	2.40E-06	6.00E-10	6.57E-07	2.40E-09	2.63E-06
POM 6 [d,j]	7.20E-06	5.40E-09	5.91E-06	7.20E-06	1.80E-09	1.97E-06	7.20E-09	7.88E-06
POM 7 [d,k]	1.8E-06	1.35E-09	1.48E-06	1.8E-06	4.50E-10	4.93E-07	1.80E-09	1.97E-06
Greenhouse Gases								
CO_2 [c]	120,000	90.0	98,550	120,000	30.0	32,850	120	131,400
CH_4 [c]	2.30	1.73E-03	1.89	2.30	5.75E-04	0.63	2.30E-03	2.52
N_2O [c]	2.20	1.65E-03	1.81	2.20	5.50E-04	0.60	2.20E-03	2.41

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

[b] Assumes produced gas contains no sulfur

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

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

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

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[l] Assumes maximum development scenario

Kleinfelder/Buys

Project: XTO RBU, Alternative C
Date: 11/15/2011

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size:	21.2	Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines:	38	wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	86.3
CO	3.72	18.7	0.87	145.3
VOC	0.03	0.15	0.01	1.2
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.8
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.8
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.06
Toluene	5.58E-04	2.80E-03	1.3E-04	0.02
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.8
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.11
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.10
Methanol	3.06E-03	1.54E-02	7.2E-04	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	9.88E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	5.98E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	4.96E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	2.59E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	6.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	5.04E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	5.35E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	8.32E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	1.61E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	3.79E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	4.65E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	2.80E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	5.51E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	19,894
CH_4	0.23	1.15	0.05	9

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	16
CO	-	4.0	0.19	31
VOC	-	1.0	0.05	8
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.8
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.8
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.06
Toluene	5.58E-04	2.80E-03	1.3E-04	0.02
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.8
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.11
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.10
Methanol	3.06E-03	1.54E-02	7.2E-04	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	9.88E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	5.98E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	4.96E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	2.59E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	6.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	5.04E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	5.35E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	8.32E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	1.61E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	3.79E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	4.65E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	2.80E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	5.51E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	19,894
CH_4	0.23	1.15	0.05	9

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00

[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)

[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)

[4] PM = sum of PM filterable and PM condensable

[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)

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

[7] Estimated at full project production.

26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	110	0.0	0.0	16	8.1	0.0	133
CO	92	0.0	0.0	31	22.8	0.0	146
VOC	1.35	497	769	8	4.63	8	1,287
SO_2	0.0	0.0	0.0	0.0	0.34	0.0	0.34
PM_{10}	8.3	0.0	0.0	0.8	0.70	0.0	10
$PM_{2.5}$	8.3	0.0	0.0	0.8	0.07	0.0	9.2
Hazardous Air Pollutants							
Benzene	2.3E-03	3.8	81	0.06	0.0	0.04	84
Toluene	3.7E-03	3.0	181	0.02	0.0	0.04	184
Ethylbenzene	0.0	0.00	10.7	0.00	0.0	0.00	10.7
Xylene	0.0	0.50	160	0.01	0.0	0.01	160
n-Hexane	1.97	11.3	6.6	0.0	0.0	0.20	20
Formaldehyde	0.08	0.0	0.0	0.8	0.0	0.0	0.9
Total HAPs	2.06	19	439	0.9	0.0	0.29	461
Greenhouse Gases							
CO_2	131,400	0.0	0.0	19,894	0.0	0.6	151,294
CH_4	2.52	0.0	76	9	0.25	57	145
N_2O	2.41	0.0	0.0	0.0	0.0	0.0	2.41

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	5	Facilities

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1{,}000\ \text{(Btu/MBtu)} * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions[1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions[1] (tons/yr)	Total Emissions (lb/hr)	Total Emissions[1] (tons/yr)
Criteria Pollutants & VOC								
NO_X [a]	100	0.075	1.64	100	0.075	1.643	0.750	3.29
CO [a]	84.0	0.063	1.38	84.0	0.063	1.380	0.630	2.76
TOC [c]	11.0	0.008	0.181	11.0	0.008	0.181	0.083	0.36
VOC	N.A.	0.001	0.020	N.A.	0.001	0.020	0.009	0.04
SO_X [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP [c]	7.60	5.70E-03	0.125	7.60	5.70E-03	0.125	0.057	0.250
PM_{10} [c]	7.60	5.70E-03	0.125	7.60	5.70E-03	0.125	0.057	0.250
$PM_{2.5}$ [c]	7.60	5.70E-03	0.125	7.60	5.70E-03	0.125	0.057	0.250
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	3.45E-05	2.10E-03	1.58E-06	3.45E-05	1.58E-05	6.90E-05
Toluene [d]	3.40E-03	2.55E-06	5.58E-05	3.40E-03	2.55E-06	5.58E-05	2.55E-05	1.12E-04
Hexane [d]	1.80	1.35E-03	2.96E-02	1.80	1.35E-03	2.96E-02	0.014	0.059
Formaldehyde [d]	7.50E-02	5.63E-05	1.23E-03	7.50E-02	5.63E-05	1.23E-03	5.63E-04	2.46E-03
Dichlorobenzene [d]	1.2E-03	9.00E-07	1.97E-05	1.2E-03	9.00E-07	1.97E-05	1.80E-06	3.94E-05
Naphthalene [d]	6.1E-04	4.58E-07	1.00E-05	6.1E-04	4.58E-07	1.00E-05	9.15E-07	2.00E-05
POM 2[d,e,f]	5.9E-05	4.43E-08	9.69E-07	5.9E-05	4.43E-08	9.69E-07	8.85E-08	1.94E-06
POM 3[d,g]	1.6E-05	1.20E-08	2.63E-07	1.6E-05	1.20E-08	2.63E-07	2.40E-08	5.26E-07
POM 4[d,h]	1.8E-06	1.35E-09	2.96E-08	1.8E-06	1.35E-09	2.96E-08	2.70E-09	5.91E-08
POM 5[d,i]	2.4E-06	1.80E-09	3.94E-08	2.4E-06	1.80E-09	3.94E-08	3.60E-09	7.88E-08
POM 6[d,j]	7.2E-06	5.40E-09	1.18E-07	7.2E-06	5.40E-09	1.18E-07	1.08E-08	2.37E-07
POM 7[d,k]	1.8E-06	1.35E-09	2.96E-08	1.8E-06	1.35E-09	2.96E-08	2.70E-09	5.91E-08
Greenhouse Gases								
CO_2 [c]	120,000	90.0	1,971	120,000	90.0	1,971	180.0	3,942
CH_4 [c]	2.30	1.73E-03	3.78E-02	2.30	1.73E-03	0.038	3.45E-03	0.076
N_2O [c]	2.20	1.65E-03	3.61E-02	2.20	1.65E-03	0.036	3.30E-03	0.072

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

[b] Assumes produced gas contains no sulfur

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

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

[e] POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[l] Assumes maximum development scenario

28. Central Facility Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate :
Per Facility 10.85 bbls condensate per day (Estimate based on similar facility data)

Total new/modified Facilities 5

Calculations:

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample
Assumes 95% emission control

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	2.03	10
Hazardous Air Pollutants		
Benzene	0.01	0.04
Toluene	0.01	0.04
Ethylbenzene	0.00	0.00
Xylenes	0.00	0.01
n-Hexane	0.02	0.10
Total HAP's	0.39	1.96
Greenhouse Gases		
CO_2	0.31	1.55
CH_4	0.40	2.0

*Based on total facilities

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 57 MMscf/day total (all new production)

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	6.02	26.4
Benzene	0.64	2.8
Toluene	1.62	7.1
Ethylbenzene	0.12	0.5
Xylenes	1.58	6.9
n-Hexane	0.05	0.2
Total HAPs	4.00	17.5
Greenhouse Gases		
CH_4	2.05	9.0

30. Central Compression

Assumptions:

Engine Type: TBD
Proposed Engine Capacity Increase: 4,841 horsepower (Proponent)

Equations:

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

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

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	10.7	46.7
CO [d]	-	0.190	2.0	8.9
VOC [d]	-	0.460	5	21.5
PM_{10} [e]	9.95E-03	0.036	0.39	1.69
$PM_{2.5}$ [e]	9.95E-03	0.036	0.39	1.69
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	4.09E-03	1.79E-02
Toluene	4.08E-04	3.55E-04	3.79E-03	1.66E-02
Ethylbenzene	3.97E-05	3.46E-05	3.69E-04	1.62E-03
Xylenes	1.84E-04	1.60E-04	1.71E-03	7.49E-03
n-Hexane	1.11E-03	9.67E-04	1.03E-02	4.52E-02
Formaldehyde	-	6.00E-02	6.40E-01	2.80E+00
Acetaldehyde	8.36E-03	7.28E-03	7.77E-02	3.40E-01
Acrolein	5.14E-03	4.48E-03	4.78E-02	2.09E-01
Methanol	2.50E-03	2.18E-03	2.32E-02	1.02E-01
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	3.72E-04	1.63E-03
1,1,2-Trichloroethane	3.18E-05	2.77E-05	2.96E-04	1.29E-03
1,3-Dichloropropene	2.64E-05	2.30E-05	2.45E-04	1.07E-03
1,3-Butadiene	2.67E-04	2.33E-04	2.48E-03	1.09E-02
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	2.32E-03	1.02E-02
Biphenyl	2.12E-04	1.85E-04	1.97E-03	8.63E-03
Carbon Tetrachloride	3.67E-05	3.20E-05	3.41E-04	1.49E-03
Chlorobenzene	3.04E-05	2.65E-05	2.83E-04	1.24E-03
Chloroform	2.85E-05	2.48E-05	2.65E-04	1.16E-03
Ethylene Dibromide	4.43E-05	3.86E-05	4.12E-04	1.80E-03
Methylene Chloride	2.00E-05	1.74E-05	1.86E-04	8.14E-04
Naphthalene	7.44E-05	6.48E-05	6.92E-04	3.03E-03
Phenol	2.40E-05	2.09E-05	2.23E-04	9.77E-04
Styrene	2.36E-05	2.06E-05	2.19E-04	9.61E-04
Tetrachloroethane	2.48E-06	2.16E-06	2.31E-05	1.01E-04
Vinyl Chloride	1.49E-05	1.30E-05	1.38E-04	6.07E-04
PAH -POM 1 [g, b]	2.69E-05	2.34E-05	2.50E-04	1.10E-03
POM 2 [h, i]	5.93E-05	5.17E-05	5.52E-04	2.42E-03
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	1.54E-06	6.76E-06
Chrysene/POM7 [h]	6.93E-07	6.04E-07	6.44E-06	2.82E-05
Greenhouse Gases				
CO_2	110	399	4,260	18,659
CH_4	1.25	4.54	48	212

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

[f] Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

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

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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling [b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.28	125	16.8	0.04	0.00	142
CO	1.48	100	14.4	0.32	0.00	116
VOC	0.18	29.7	11	0.03	0.00	41
SO_2	0.01	0.45	0.20	0.002	0.00	0.7
PM_{10}	10.90	320	135	1.88	0.03	468
$PM_{2.5}$	1.16	35.3	13.7	0.19	3.84E-03	50
Benzene	0.00	0.06	0.04	0.00	0.00	0.1
Toluene	0.00	0.02	0.04	0.00	0.00	0.1
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.001
Xylene	0.00	0.02	0.01	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.20	0.00	0.00	0.2
Formaldehyde	0.00	6.49E-03	3.69E-04	0.00	0.00	0.007
Acrolein	0.00	6.48E-04	3.54E-05	0.00	0.00	6.8E-04
1,3-Butadiene	0.00	0.00	2.24E-06	0.00	0.00	2.2E-06
Greenhouses Gases						
CO_2	0.00	12,722	601	0.00	0.00	13,323
CH_4	1.06E-02	8.0	57	1.83E-03	0.00	65
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes 60 wells/yr development scenario

[b] Drilling emissions assumes Tier II drill rig engines

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [b]							Total [a]
	Pump Unit Engines	Production Heaters	Stock Tanks	TEG Dehys	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	16	113	0.00	0.00	8.1	0.0	47	183
CO	31	95	0.00	0.00	22.8	0.0	9	157
VOC	8	1.39	507	795	4.63	390.7	22	1,728
SO_2	0.00	0.00	0.00	0.00	0.34	0.0	0.00	0.34
PM_{10}	0.8	8.6	0.00	0.00	0.70	0.0	1.7	12
$PM_{2.5}$	0.8	8.6	0.00	0.00	0.07	0.0	1.7	11
Hazardous Air Pollutants								
Benzene	0.06	0.00	3.8	83	0.00	0.0	0.02	87
Toluene	0.02	0.00	3.0	188	0.00	0.0	0.02	191
Ethylbenzene	0.00	0.00	0.0	11.3	0.00	0.0	0.00	11.3
Xylene	0.01	0.00	0.5	167	0.00	0.0	0.01	167
n-Hexane	0.00	2.03	11.4	6.8	0.00	0.0	0.05	20
Formaldehyde	0.8	0.08	0.00	0.00	0.00	0.0	2.8	3.7
Acetaldehyde	0.11	0.00	0.00	0.00	0.00	0.0	0.3	0.4
Acrolein	0.10	0.00	0.00	0.00	0.00	0.0	0.21	0.31
Methanol	0.12	0.00	0.00	0.00	0.00	0.0	0.10	0.22
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.03	0.00	0.00	0.00	0.00	0.0	0.01	0.04
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.01
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.01	0.00	0.00	0.00	0.00	0.0	0.00	0.01
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	6.76E-06	6.76E-06
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	2.82E-05	2.82E-05
Greenhouse Gases								
CO_2	19,894	135,342	5.8	0.00	0.00	0.0	18,659	173,901
CH_4	9	2.59	195	85	0.25	1862.9	212	2,367
N_2O	0.00	2.48	0.00	0.00	0.00	0.0	0.00	2.48

a Assumes maximum development scenario

APPENDIX F-4

Emissions Inventories for Alternative B

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.12	1.97	0.0099	0.04	0.16
PM_{15}	0.50	0.0075	0.03	0.50	0.0025	0.01	0.04
PM_{10}	0.38	0.0056	0.02	0.19	0.0009	0.00	0.03
$PM_{2.5}$	0.21	0.0031	0.01	0.10	0.0005	0.00	0.01

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	47.10	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	47.10	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 126.53 lbs TSP/well pad

Emissions = 60.54 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	126.53	12.65	6.33E-02	2.53E-01
PM_{15}	60.54	6.05	3.03E-02	1.21E-01
PM_{10}	36.33	3.63	1.82E-02	7.27E-02
$PM_{2.5}$	3.92	0.39	1.96E-03	7.84E-03

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.12	1.97	0.0099	0.04	0.16
PM_{15}	0.50	0.0075	0.03	0.50	0.0025	0.01	0.04
PM_{10}	0.38	0.0056	0.02	0.38	0.0019	0.01	0.03
$PM_{2.5}$	0.21	0.0031	0.01	0.21	0.0010	0.00	0.02

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2	day grading per well pad and road (Estimate)
	10	hours/day
	20	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	5.54	0.28	0.0028	0.01
PM_{15}	2.65	0.13	0.0013	0.01
PM_{10}	1.59	0.08	0.0008	0.00
$PM_{2.5}$	0.17	0.01	0.0001	0.000

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	126.53	12.653	6.33E-03
PM_{15}	60.54	6.054	3.03E-03
PM_{10}	36.33	3.633	1.82E-03
$PM_{2.5}$	3.92	0.392	1.96E-04

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	0.0853
PM_{15}	0.0232
PM_{10}	0.0160
$PM_{2.5}$	0.0080

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1.97 lbs TSP/hour/piece of equipment

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

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.12	1.97	0.0099	0.04	0.16
PM_{15}	0.50	0.0075	0.03	0.50	0.0025	0.01	0.04
PM_{10}	0.38	0.0056	0.02	0.19	0.0009	0.00	0.03
$PM_{2.5}$	0.21	0.0031	0.01	0.10	0.0005	0.00	0.01

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

b Assumes maximum development scenario

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	407.10	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	407.10	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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

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

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

Emissions = 1093.65 lbs TSP/well

Emissions = 523.31 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	1093.65	36.45	0.5468	2.19
PM_{15}	523.31	17.44	0.2617	1.05
PM_{10}	313.99	10.47	0.1570	0.63
$PM_{2.5}$	33.90	1.13	0.0170	0.068

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

Hours per day 10
Days per pad 9

Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Semi: Hvy Equip Hauler	60,000	3					
Haul Trucks: Equipment/Fuel/Water	48,000	5					
Pickup Truck: Crew	7,000	10					
Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
				Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{1.5/15}$ Pads (tons)**	
				1.5		0.1	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.067	98.6	11.0	9.9	1.1
				Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
				0.20		0.02	

Vertical Drilling (days/well)

Hours per day 10
Days per well 14

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				5.2		0.5	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	11.8	16.5	1.2
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				0.08		0.01	

Directional Drilling (days/well)

Hours per day 10
Days per well 21

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				77.9		7.8	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	7.9	16.5	0.8
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.24		0.12	

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads		**Unpaved Roads**	

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

		PM_{10}/Annual Wells (tons)		$PM_{2.5}$/Annual Wells (tons)	
		34.4		3.4	
Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
	0.134	195.8	19.6	19.6	2.0
		Paved Roads PM_{10}/Annual Wells (tons)		Paved Roads $PM_{2.5}$/Annual Wells (tons)	
		1.57		0.16	

Interim Reclamation (days/well)

Hours per day 10
Days per pad 2

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Pickup: Crew	7,000	4					
Haul Trucks: Equipment	60,000	1					
Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
				Unpaved Roads PM_{10}/Annual Wells (tons)		Unpaved Roads $PM_{2.5}$/Annual Wells (tons)	
				0.1		0.0	
		Paved:	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
			0.035	51.5	25.7	5.1	2.6
				Paved Roads PM_{10}/Annual Wells (tons)		Paved Roads $PM_{2.5}$/Annual Wells (tons)	
				0.03		0.00	

Annual Traffic Fugitive Dust Emissions (tons/year)

Unpaved Roads PM_{10} (tons)	Unpaved Roads $PM_{2.5}$ (tons)
119	11.9
Paved Roads PM_{10} (tons)	**Paved Roads $PM_{2.5}$ (tons)**
3.11	0.31

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

9. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	acres total disturbance
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{*})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

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

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

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

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

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.044
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	0.232
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.028
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	2.14E-03
CH_4 [e,f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	1.67E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	4	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/mile)} * \text{Trip Distance (miles)} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	6.65E-05
CO	1.15E-03	1.43E-04
VOC [d]	3.17E-04	3.95E-05
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	494	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.472	0.117	3.23	0.132	0.033	0.604	2.4
CO	17.5	1.016	0.251	36.8	1.51	0.372	2.52	10.0
VOC [c]	4.83	0.280	0.069	2.29	0.094	0.023	0.374	1.48
SO_2	0.321	1.87E-02	4.60E-03	0.214	8.75E-03	2.16E-03	2.74E-02	0.108
CH_4 [e,f]	0.230	1.34E-02	3.30E-03	0.180	7.36E-03	1.82E-03	2.07E-02	0.082

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	1.154
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	3.085
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	0.693
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.047
CH_4 [e,f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.034

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (Typical value)
Diesel Fuel density	7.08	lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{\# Trips} * \text{Trip Distance (miles)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.002
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.019
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.002
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	1.35E-04
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.09E-04

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	494	hours/well (Proposed Action)
Development Rate	16	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	76
CO [b]	5.50E-03	4.40	17
VOC [b]	7.05E-04	0.56	2.2
PM_{10} [b]	4.30E-04	0.34	1.36
$PM_{2.5}$ [b]	3.59E-04	0.29	1.13
SO_2 [b]	4.05E-06	3.24E-03	1.28E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	1.84E-02
Toluene [d]	2.11E-06	1.69E-03	6.66E-03
Xylenes [d]	1.45E-06	1.16E-03	4.57E-03
Formaldehyde [d]	5.92E-07	4.73E-04	1.87E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	5.97E-04
Acrolein [d]	5.91E-08	4.73E-05	1.87E-04
Naphthalene [e]	9.75E-07	7.80E-04	3.08E-03
Total PAH [e,f]	1.59E-06	1.27E-03	5.02E-03
Greenhouse Gases			
CO_2 [b]	1.16	928	3,664
CH_4 [b,c]	7.05E-04	0.56	2.2

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	33
CO [a]	5.70E-03	4.56	18
VOC [a]	2.20E-03	1.76	6.9
PM_{10} [a]	3.30E-04	0.26	1.04
$PM_{2.5}$ [b]	3.30E-04	0.26	1.04
SO_2 [b]	4.05E-06	3.24E-03	1.28E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	1.84E-02
Toluene [d]	2.11E-06	1.69E-03	6.66E-03
Xylenes [d]	1.45E-06	1.16E-03	4.57E-03
Formaldehyde [d]	5.92E-07	4.73E-04	1.87E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	5.97E-04
Acrolein [d]	5.91E-08	4.73E-05	1.87E-04
Naphthalene [e]	9.75E-07	7.80E-04	3.08E-03
Total PAH [e,f]	1.59E-06	1.27E-03	5.02E-03
Greenhouse Gases			
CO_2 [b]	1.16	928	3,664
CH_4 [b,c]	7.05E-04	0.56	2.2

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	-42	ton/yr
CO	1	ton/yr
VOC	4.7	ton/yr
PM_{10}	-0.32	ton/yr
$PM_{2.5}$	-0.09	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

[f] PAH (Polycyclic Aromatic Hydrocarbons) includes naphthalene and are a HAP because they are polycyclic organic matter (POM)

[g] Assumes maximum development scenario

16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	16	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/tons)}}$$

SO_2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	102.000	3.26
CO [a]	5.50E-03	23.375	0.75
VOC [a,b]	7.05E-04	2.996	0.10
PM_{10} [a,c]	4.30E-04	1.8264	0.0584
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.0489
SO_2 [a]	4.05E-06	0.017	0.001
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	7.92E-04
Toluene [e]	2.11E-06	8.96E-03	2.87E-04
Xylenes [e]	1.45E-06	6.15E-03	1.97E-04
Formaldehyde [e]	5.92E-07	2.51E-03	8.05E-05
Acetaldehyde [e]	1.89E-07	8.03E-04	2.57E-05
Acrolein [e]	5.91E-08	2.51E-04	8.04E-06
Naphthalene [f]	9.75E-07	4.14E-03	1.33E-04
Total PAH [f]	1.59E-06	6.76E-03	2.16E-04
Greenhouse Gases			
CO_2 [a]	1.16	4,930	158
CH_4 [a]	7.05E-04	2.996	0.096

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.06
CO [g]	6.68E-03	0.43	0.01
VOC [b,g]	2.47E-03	0.16	0.01
PM_{10} [g]	2.20E-03	0.14	0.00
$PM_{2.5}$ [g]	2.20E-03	0.14	0.00
SO_2 [g]	2.05E-03	0.13	0.00
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	1.43E-05
Toluene [h]	3.07E-06	1.96E-04	6.26E-06
Xylenes [h]	2.14E-06	1.36E-04	4.36E-06
Formaldehyde [h]	8.85E-06	5.64E-04	1.81E-05
Acetaldehyde [h]	5.75E-06	3.67E-04	1.17E-05
Acrolein [h]	6.94E-07	4.42E-05	1.42E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	5.98E-07
Naphthalene [h]	6.36E-07	4.05E-05	1.30E-06
Total PAH [h]	1.26E-06	8.03E-05	2.57E-06
Greenhouse Gases			
CO_2 [g]	1.15	73.3	2.3
CH_4 [b,g]	2.47E-03	0.157	0.01

[a] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
[b] Emission Factor represents total Hydrocarbon Emissions
[c] Total particulate emission factor is 0.0007, Total PM_{10} fraction determined from Table 3.4-2
[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2
[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96
[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96
[g] AP-42 Table 3.3-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[h] AP-42 Table 3.3-2, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[i] Assumes maximum development scenario

Kleinfelder/Buys

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
Total:	1.0000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. Well Development Venting

Assumptions:		Following completion, wells are vented prior to connnection to the gathering pipeline
Venting Period	48	hours (Project Proponents)
Amount of Vented Gas:	1.0	MMscf day (Average volume estimated by proponents)
Development Rate:	16	Wells per year (Project Proponents)
Control Rate	95	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	15
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	1.81
Propane	44.1	2.17	0.957	0.052	21.7	52.5	1.01
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	0.25
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	0.32
i-Pentane	72.2	0.197	0.142	0.008	1.965	7.78	0.15
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.12
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.11
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.10
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.03
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.01
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.01
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.00
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.05
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.12
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.15
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		**3.79**	**2.06**	**0.11**	**37.9**	**113**	**2.17**
HAP Subtotal		**0.09**	**0.07**	**0.00**	**0.86**	**4.07**	**0.08**
Total		**100**	**18.4**	**1.00**	**1,000**	**1,012**	**19**

19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	1	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	18,000	miles/year
Number of Condensate Haul Truck Round Trips:	0	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	1	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	38,270	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (Typical value)
Fuel density	7.08	lbs/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15	miles/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10	miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	3.23	0.04	0.06	8.13	0.19	0.4	0.22	0.4
CO	36.8	0.40	0.7	17.5	0.4	0.8	0.8	1.5
VOC [c]	2.11	0.02	0.04	4.60	0.11	0.21	0.13	0.25
SO_2	0.21	0.00	0.00	0.32	0.01	0.01	0.01	0.02
Greenhouse Gases								
CH_4 [d]	0.18	0.00	0.00	0.23	0.01	0.01	0.01	0.01

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)

[c] Emission factor is for total Hydrocarbons - Methane Offset

[d] AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

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20. Operations Pneumatic Emissions

Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas flow Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (Mscf/day)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
	VOC Subtotal	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	16	25	119.2

Liquid Level Controller Specifications

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

Pneumatic Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well			VOC lb/hr	VOC ton/yr
4	Liquid level controllers		0.13	0.57
1	Pneumatic pump		0.23	0.99
		Totals (per well) =	0.36	1.56

Pneumatic sources / well			Methane lb/hr	Methane ton/yr
4	Liquid level controllers		0.91	3.99
1	Pneumatic pump		1.58	3.46
		Totals (per well) =	2.49	7.45

Kleinfelder/Buys

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

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

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

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
W = average weight in tons of vehicles traveling the road		
Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	0.6						
Haul Truck: Oil	48,000	0.2						
Haul Truck: Water	48,000	1.0	Paved	2.14	86	0.23	9	0.02
Mean Weight	35,327	1.8	Unpaved	0.101	4	0.01	0.4	0.00
					PM_{10}		$PM_{2.5}$	
Annual Traffic Fugitive Dust Emissions (tons/year)			Paved		0.04		0.004	
			Unpaved		0.002		0.000	
			Total		0.04		0.004	

Assume 3 barrels per day condensate per well
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 16 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	32
Hazardous Air Pollutants			
Benzene		0.015	0.2
Toluene		0.012	0.2
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.03
n-Hexane		0.045	0.7
Total HAPS		0.080	1.3
Greenhouse Gases			
CO_2		0.017	0.27
CH_4		0.77	12

a Assumes maximum development scenario

23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 16 wells at Peak Production
Wells Requiring Dehydrators: 16 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Tons per year per well are calculated with the conservative estimate that the wellsite dehys could theoretically run 8,760 hours out of the year

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	49
Hazardous Air Pollutants				
Benzene		0.074	0.32	5
Toluene		0.165	0.72	12
Ethylbenzene		0.010	0.04	0.7
Xylenes		0.146	0.64	10
n-Hexane		0.006	0.03	0.4
Greenhouse Gases				
CH_4		0.069	0.30	5

Kleinfelder/Buys

Project: XTO RBU, Alternative B
Date: 6/1/2012

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size: 21.2 Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines: 16 wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	36.3
CO	3.72	18.7	0.87	61.2
VOC	0.03	0.15	0.01	0.5
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.3
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.3
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.03
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.3
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.05
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.04
Methanol	3.06E-03	1.54E-02	7.2E-04	0.05
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	4.16E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	2.52E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	2.09E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.09E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	2.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	2.12E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	2.25E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	3.50E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	6.78E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	1.60E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	1.96E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.18E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	2.32E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	8,376
CH_4	0.23	1.15	0.05	4

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	7
CO	-	4.0	0.19	13
VOC	-	1.0	0.05	3
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.3
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.3
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.03
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.3
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.05
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.04
Methanol	3.06E-03	1.54E-02	7.2E-04	0.05
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	4.16E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	2.52E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	2.09E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.09E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	2.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	2.12E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	2.25E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	3.50E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	6.78E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	1.60E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	1.96E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.18E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	2.32E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	8,376
CH_4	0.23	1.15	0.05	4

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00
[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)
[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)
[4] PM = sum of PM filterable and PM condensable
[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)
[6] Polycyclic Aromatic Hydrocarbons (PAH), POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
[7] Estimated at full project production.

25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	16	new wells

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} \cdot 1{,}000\ \text{(Btu/MBtu)} \cdot \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} \cdot 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} \cdot \text{VOC wt. fraction}$$

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions[1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions[1] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	5	100	0.025	2	0.100	7
CO [a]	84.0	0.063	4	84.0	0.021	1.5	0.084	6
TOC [c]	11.0	0.008	0.6	11.0	0.003	0.2	0.011	0.8
VOC	-	0.001	0.06	-	0.000	0.02	0.001	0.09
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	0.4	7.60	0.002	0.008	0.008	0.4
PM_{10} [c]	7.60	0.006	0.4	7.60	0.002	0.133	0.008	0.5
$PM_{2.5}$ [c]	7.60	0.006	0.4	7.60	0.002	0.133	0.008	0.5
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	1.10E-04	2.10E-03	5.25E-07	3.68E-05	2.10E-06	1.47E-04
Toluene [d]	3.40E-03	2.55E-06	1.79E-04	3.40E-03	8.50E-07	5.96E-05	3.40E-06	2.38E-04
Hexane [d]	1.80E+00	1.35E-03	9.46E-02	1.80E+00	4.50E-04	3.15E-02	1.80E-03	1.26E-01
Formaldehyde [d]	7.50E-02	5.63E-05	3.94E-03	7.50E-02	1.88E-05	1.31E-03	7.50E-05	5.26E-03
Dichlorobenzene [d]	1.20E-03	9.00E-07	6.31E-05	1.20E-03	3.00E-07	2.10E-05	1.20E-06	8.41E-05
Naphthalene [d]	6.10E-04	4.58E-07	3.21E-05	6.10E-04	1.53E-07	1.07E-05	6.10E-07	4.27E-05
POM 2[d,e,f]	5.90E-05	4.43E-08	3.10E-06	5.90E-05	1.48E-08	1.03E-06	5.90E-08	4.13E-06
POM 3[d,g]	1.60E-05	1.20E-08	8.41E-07	1.60E-05	4.00E-09	2.80E-07	1.60E-08	1.12E-06
POM 4[d,h]	1.80E-06	1.35E-09	9.46E-08	1.80E-06	4.50E-10	3.15E-08	1.80E-09	1.26E-07
POM 5[d,i]	2.40E-06	1.80E-09	1.26E-07	2.40E-06	6.00E-10	4.20E-08	2.40E-09	1.68E-07
POM 6[d,j]	7.20E-06	5.40E-09	3.78E-07	7.20E-06	1.80E-09	1.26E-07	7.20E-09	5.05E-07
POM 7[d,k]	1.8E-06	1.35E-09	9.46E-08	1.8E-06	4.50E-10	3.15E-08	1.80E-09	1.26E-07
Greenhouse Gases								
CO_2 [c]	120,000	90.0	6,307	120,000	30.0	2,102	120	8,410
CH_4 [c]	2.30	1.73E-03	0.12	2.30	5.75E-04	0.04	2.30E-03	0.16
N_2O [c]	2.20	1.65E-03	0.12	2.20	5.50E-04	0.04	2.20E-03	0.15

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

[b] Assumes produced gas contains no sulfur

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

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

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

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene.

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[1] Assumes maximum development scenario

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26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	7	0.0	0.0	7	0.4	0.0	14
CO	6	0.0	0.0	13	1.5	0.0	21
VOC	0.09	32	49	3	0.25	2	87
SO_2	0.0	0.0	0.0	0.0	0.02	0.0	0.02
PM_{10}	0.5	0.0	0.0	0.3	0.04	0.0	1
$PM_{2.5}$	0.5	0.0	0.0	0.3	0.00	0.0	0.9
Hazardous Air Pollutants							
Benzene	1.5E-04	0.2	5	0.03	0.0	0.01	5
Toluene	2.4E-04	0.2	12	0.01	0.0	0.01	12
Ethylbenzene	0.0	0.00	0.7	0.00	0.0	0.00	0.7
Xylene	0.0	0.03	10	0.00	0.0	0.00	10
n-Hexane	0.13	0.7	0.4	0.0	0.0	0.05	1
Formaldehyde	0.01	0.0	0.0	0.3	0.0	0.0	0.3
Total HAPs	0.13	1	28.1	0.4	0.0	0.08	30
Greenhouse Gases							
CO_2	8,410	0.0	0.0	8,376	0.0	0.2	16,786
CH_4	0.16	0.0	5	4	0.01	15	24
N_2O	0.15	0.0	0.0	0.0	0.0	0.0	0.15

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	0	Facilities

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1{,}000\ \text{(Btu/MBtu)} * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1{,}000{,}000\ \text{(scf/MMscf)}}$$

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

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions [1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions [1] (tons/yr)	Total Emissions (lb/hr)	Total Emissions [1] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	0.00	100	0.075	0.000	0.750	0.00
CO [a]	84.0	0.063	0.00	84.0	0.063	0.000	0.630	0.00
TOC [c]	11.0	0.008	0.000	11.0	0.008	0.000	0.083	0.00
VOC	N.A.	0.001	0.000	N.A.	0.001	0.000	0.009	0.00
SO_X [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP [c]	7.60	5.70E-03	0.000	7.60	5.70E-03	0.000	0.057	0.000
PM_{10} [c]	7.60	5.70E-03	0.000	7.60	5.70E-03	0.000	0.057	0.000
$PM_{2.5}$ [c]	7.60	5.70E-03	0.000	7.60	5.70E-03	0.000	0.057	0.000
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	0.00E+00	2.10E-03	1.58E-06	0.00E+00	1.58E-05	0.00E+00
Toluene [d]	3.40E-03	2.55E-06	0.00E+00	3.40E-03	2.55E-06	0.00E+00	2.55E-05	0.00E+00
Hexane [d]	1.80	1.35E-03	0.00E+00	1.80	1.35E-03	0.00E+00	0.014	0.000
Formaldehyde [d]	7.50E-02	5.63E-05	0.00E+00	7.50E-02	5.63E-05	0.00E+00	5.63E-04	0.00E+00
Dichlorobenzene [d]	1.2E-03	9.00E-07	0.00E+00	1.2E-03	9.00E-07	0.00E+00	1.80E-06	0.00E+00
Naphthalene [d]	6.1E-04	4.58E-07	0.00E+00	6.1E-04	4.58E-07	0.00E+00	9.15E-07	0.00E+00
POM 2 [d,e,f]	5.9E-05	4.43E-08	0.00E+00	5.9E-05	4.43E-08	0.00E+00	8.85E-08	0.00E+00
POM 3 [d,e,g]	1.6E-05	1.20E-08	0.00E+00	1.6E-05	1.20E-08	0.00E+00	2.40E-08	0.00E+00
POM 4 [d,e,h]	1.8E-06	1.35E-09	0.00E+00	1.8E-06	1.35E-09	0.00E+00	2.70E-09	0.00E+00
POM 5 [d,e,i]	2.4E-06	1.80E-09	0.00E+00	2.4E-06	1.80E-09	0.00E+00	3.60E-09	0.00E+00
POM 6 [d,e,j]	7.2E-06	5.40E-09	0.00E+00	7.2E-06	5.40E-09	0.00E+00	1.08E-08	0.00E+00
POM 7 [d,e,k]	1.8E-06	1.35E-09	0.00E+00	1.8E-06	1.35E-09	0.00E+00	2.70E-09	0.00E+00
Greenhouse Gases								
CO_2 [c]	120,000	90.0	0	120,000	90.0	0	180.0	0
CH_4 [c]	2.30	1.73E-03	0.00E+00	2.30	1.73E-03	0.000	3.45E-03	0.000
N_2O [c]	2.20	1.65E-03	0.00E+00	2.20	1.65E-03	0.000	3.30E-03	0.000

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

[b] Assumes produced gas contains no sulfur

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

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

[e] POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1990

[f] POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[g] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[h] POM 4 includes: 3-Methylchloranthrene.

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

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

[k] POM 7 includes: Chrysene.

[l] Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

28. Central Facility Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate :
Per Facility 10.85 bbls condensate per day (Estimate based on similar facility data)

Total new/modified Facilities 0

Calculations:

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample
Assumes 95% emission control

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	2.03	0
Hazardous Air Pollutants		
Benzene	0.01	0.00
Toluene	0.01	0.00
Ethylbenzene	0.00	0.00
Xylenes	0.00	0.00
n-Hexane	0.02	0.00
Total HAP's	0.03	0.00
Greenhouse Gases		
CO_2	0.31	0.00
CH_4	0.40	0.0

*Based on total facilities

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 4 MMscf/day total (all new production)

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	0.39	1.7
Benzene	0.04	0.2
Toluene	0.10	0.4
Ethylbenzene	0.01	0.0
Xylenes	0.10	0.4
n-Hexane	0.00	0.0
Total HAPs	0.26	1.1
Greenhouse Gases		
CH_4	0.13	0.6

30. Central Compression

Assumptions:

Engine Type: TBD
Proposed Engine Capacity Increase: 310 horsepower (Proponent)

Equations:

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

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

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [e] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	0.7	3.0
CO [d]	-	0.190	0.1	0.6
VOC [d]	-	0.460	0	1.4
PM_{10} [e]	9.95E-03	0.036	0.02	0.11
$PM_{2.5}$ [e]	9.95E-03	0.036	0.02	0.11
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	2.62E-04	1.15E-03
Toluene	4.08E-04	3.55E-04	2.43E-04	1.06E-03
Ethylbenzene	3.97E-05	3.46E-05	2.36E-05	1.03E-04
Xylenes	1.84E-04	1.60E-04	1.10E-04	4.80E-04
n-Hexane	1.11E-03	9.67E-04	6.61E-04	2.89E-03
Formaldehyde	-	6.00E-02	4.10E-02	1.80E-01
Acetaldehyde	8.36E-03	7.28E-03	4.98E-03	2.18E-02
Acrolein	5.14E-03	4.48E-03	3.06E-03	1.34E-02
Methanol	2.50E-03	2.18E-03	1.49E-03	6.52E-03
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	2.38E-05	1.04E-04
1,1,2-Trichloroethane	3.18E-05	2.77E-05	1.89E-05	8.29E-05
1,3-Dichloropropene	2.64E-05	2.30E-05	1.57E-05	6.88E-05
1,3-Butadiene	2.67E-04	2.33E-04	1.59E-04	6.96E-04
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	1.49E-04	6.52E-04
Biphenyl	2.12E-04	1.85E-04	1.26E-04	5.53E-04
Carbon Tetrachloride	3.67E-05	3.20E-05	2.18E-05	9.57E-05
Chlorobenzene	3.04E-05	2.65E-05	1.81E-05	7.93E-05
Chloroform	2.85E-05	2.48E-05	1.70E-05	7.43E-05
Ethylene Dibromide	4.43E-05	3.86E-05	2.64E-05	1.15E-04
Methylene Chloride	2.00E-05	1.74E-05	1.19E-05	5.21E-05
Naphthalene	7.44E-05	6.48E-05	4.43E-05	1.94E-04
Phenol	2.40E-05	2.09E-05	1.43E-05	6.26E-05
Styrene	2.36E-05	2.06E-05	1.40E-05	6.15E-05
Tetrachloroethane	2.48E-06	2.16E-06	1.48E-06	6.47E-06
Vinyl Chloride	1.49E-05	1.30E-05	8.87E-06	3.88E-05
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	1.60E-05	7.01E-05
POM 2 [h, i]	5.93E-05	5.17E-05	3.53E-05	1.55E-04
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	9.88E-08	4.33E-07
Chrysene/POM7 [h]	6.93E-07	6.04E-07	4.12E-07	1.81E-06
Greenhouse Gases				
CO_2	110	399	273	1,195
CH_4	1.25	4.54	3	14

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

[f] Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

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

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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling [b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.04	36	4.5	0.00	0.00	40
CO	0.23	28	3.8	0.02	0.00	32
VOC	0.03	8.4	3	0.00	0.00	11
SO_2	0.00	0.12	0.05	0.000	0.00	0.2
PM_{10}	1.80	85	36	0.11	0.03	123
$PM_{2.5}$	0.20	9.5	3.7	0.01	3.84E-03	13
Benzene	0.00	0.02	0.01	0.00	0.00	0.0
Toluene	0.00	0.01	0.01	0.00	0.00	0.0
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.000
Xylene	0.00	0.00	0.00	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.05	0.00	0.00	0.1
Formaldehyde	0.00	1.87E-03	9.85E-05	0.00	0.00	0.002
Acrolein	0.00	1.87E-04	9.45E-06	0.00	0.00	2.0E-04
1,3-Butadiene	0.00	0.00	5.98E-07	0.00	0.00	6.0E-07
Greenhouses Gases						
CO_2	0.00	3,664	160	0.00	0.00	3,824
CH_4	1.67E-03	2.3	15	1.09E-04	0.00	18
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes 60 wells/yr development scenario

[b] Drilling emissions assumes Tier II drill rig engines

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total [a]
	Pump Unit Engines	Production Heaters	Stock Tanks	TEG Dehys	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	7	7	0.00	0.00	0.4	0.0	3	17
CO	13	6	0.00	0.00	1.5	0.0	1	21
VOC	3	0.09	32	51	0.25	25.0	1	113
SO_2	0.00	0.00	0.00	0.00	0.02	0.0	0.00	0.02
PM_{10}	0.3	0.5	0.00	0.00	0.04	0.0	0.1	1
$PM_{2.5}$	0.3	0.5	0.00	0.00	0.00	0.0	0.1	1
Hazardous Air Pollutants								
Benzene	0.03	0.00	0.2	5	0.00	0.0	0.00	6
Toluene	0.01	0.00	0.2	12	0.00	0.0	0.00	12
Ethylbenzene	0.00	0.00	0.0	0.7	0.00	0.0	0.00	0.7
Xylene	0.00	0.00	0.0	11	0.00	0.0	0.00	11
n-Hexane	0.00	0.13	0.7	0.4	0.00	0.0	0.00	1
Formaldehyde	0.3	0.01	0.00	0.00	0.00	0.0	0.2	0.5
Acetaldehyde	0.05	0.00	0.00	0.00	0.00	0.0	0.0	0.1
Acrolein	0.04	0.00	0.00	0.00	0.00	0.0	0.01	0.06
Methanol	0.05	0.00	0.00	0.00	0.00	0.0	0.01	0.06
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.01	0.00	0.00	0.00	0.00	0.0	0.00	0.01
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	4.33E-07	4.33E-07
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	1.81E-06	1.81E-06
Greenhouse Gases								
CO_2	8,376	8,410	0.3	0.00	0.00	0.0	1,195	17,981
CH_4	4	0.16	12	5	0.01	119.2	14	155
N_2O	0.00	0.15	0.00	0.00	0.00	0.0	0.00	0.15

a Assumes maximum development scenario

APPENDIX G

Near-Field Air Quality Technical Support Document for the XTO Energy River Bend Unit Infill Development Project Environmental Assessmen

Near-Field

Air Quality Technical Support Document for the XTO Energy River Bend Unit Infill Development Project Environmental Assessment

January 2010
Updated August 2012

Prepared for:
Bureau of Land Management
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1.0 INTRODUCTION

This Near-Field Air Quality Technical Support Document (AQTSD) describes the process used to develop the Near-Field Air Quality impact assessment for the Bureau of Land Management (BLM), Vernal Field Office, Draft Environmental Assessment (EA) for XTO Energy's (XTO) infill development within the River Bend Unit project area. The River Bend project area is located approximately 34 miles south of Vernal. The River Bend project area consists of 16,719 acres including parts of Township 9 South, Range 19 East; Township 10 South, Range 19 East; and Township 10 South, Range 20 East; Salt Lake Meridian, Uintah County, Utah.

A BLM-approved air quality impact analysis was issued with the West Tavaputs Draft Environmental Impact Statement (BLM 2008). The River Bend project area is located in the Uinta Basin of Utah, and is located in near proximity to a similar project in the West Tavaputs area of the Uinta Basin. Due to the geographical proximity this AQTSD incorporates the Protocol adopted for the West Tavaputs Air Quality Assessment Technical Support Document (BLM 2008). This document provides a detailed description of the procedures applied for the EA analysis to quantify potential ambient air quality and air quality related values (AQRV) impacts that may result from the implementation of the River Bend project.

This Near-Field air quality document is one of three documents that support the air quality analysis presented in the EA. This document was initially completed in May 2010, but was updated in June 2012 to account for the availability of more recent background air quality data and updates in the emission inventory for the Proposed Action. The other supporting documents for the EA are the Emissions Inventory for the XTO River Bend Unit infill development project (Buys & Associates 2010, updated in 2011), and the XTO, RBU Ozone Assessment report. (Alpine/Buys 2010 and updated in August 2011).

2.0 PROJECT DESCRIPTION

The River Bend project area currently contains active producing wells, with accompanying production related facilities, roads, and pipelines. Under the Proposed Action, an additional 484 wells are proposed for development.
The spacing of the wells will vary according to the geologic characteristics of the formation being developed; the densest spacing expected is one well pad per 20 acres.

XTO Energy proposes the following primary components for development under the Proposed Action:

- Up to 484 natural gas wells from 243 pads over a 8 year development period and a 40 year life of project (LOP);
- Up to 12 drilling rigs operating year round;
- Up to 7,825 acres short-term surface disturbance (wells, access roads, pipelines, compressor stations); and

An additional 8,520 of new compression horsepower
The near-field analysis is being conducted and analyzed using the specifications of the proposed action, which includes the maximum development scenario throughout the life of the project (i.e.

484 wells). Analysis of the impacts associated with any of the other alternatives would yield equal or lesser impacts.

After construction of well pads and roads, drilling and completion of a well, and interconnection to the gathering pipelines, each well pad would consist of a wellhead, a three-phase separator (to separate gas, produced water, and hydrocarbon condensate), a water tank and a condensate tank. The gas would be moved to central production facilities (CPF) that would include multiple compressor engines, a central separator, and central glycol dehydration units. After processing, the gas would then be transported to a sales pipeline for further distribution.

Emissions to the atmosphere from the proposed project would consist of criteria pollutants: nitrogen oxides (NO_X), carbon monoxide (CO), particulates (PM_{10} and $PM_{2.5}$) and sulfur dioxide (SO_2). Additional emissions from the project include volatile organic compounds (VOC) and various hazardous air pollutants (HAPs).

Table 2-1 presents the summary of the emissions inventory analyzed for the Proposed Action when this document was completed in May 2010. Table 2-1 shows total (well development plus project production) NO_x emissions of 905 tons per year (TpY) and VOC emissions of 11,848 tons per year. However, an updated emission inventory was completed in 2011 (as discussed in Chapter 4 of the EA) and the emissions for the Proposed Action are now estimated as 564 TpY NOx and 5,185 TpY VOC, reductions of 38 and 56 percent, respectively (with similar changes in the other pollutant emissions as well). Near-field air quality impacts are not necessarily linearly related to total emissions; however, the impacts presented in this analysis are overstated because of the change in emission estimates for the Proposed Action.

The pollutants shown in Table 2-1 would be emitted from the following activities and sources:

- Well pad, new central facility and road construction: equipment producing fugitive dust while moving and leveling earth and vehicles generating fugitive dust on access roads;
- Drilling: vehicles generating fugitive dust on access roads and drill rig engine exhaust;
- Completion: vehicles generating fugitive dust on access roads, frac pump engine and generator emissions and completion venting emissions;
- Vehicle tailpipe emissions associated with all development phases;
- Well production operations: three-phase separator emissions, well site glycol dehydration unit emissions, flashing and breathing emissions from a condensate tank, fugitive emissions from pneumatic devices, fugitive dust and tailpipe emissions from pumpers and trucks transporting produced condensate and water from storage tanks; and
- Central production facility: compressor engines emissions, central glycol dehydration unit emissions, fugitive emissions from pneumatic devices, flare emissions from central dehydrators and central flashing and breathing emissions from condensate tanks.

Table 2-1 River Bend Emissions for the Proposed Action[a]		
Pollutant	**Project Emissions (tons/year)**	
	Well Development	**Project Production**
Criteria Pollutants & VOC		
NO_x	206	699
CO	171	947
VOC	301	11,510
SO_2	1.01	0.65
PM_{10}	698	41
$PM_{2.5}$	74.8	40
Hazardous Air Pollutants		
Benzene	1.23	445
Toluene	1.25	728
Ethylbenzene	0.04	36.8
Xylene	0.36	447
n-Hexane	6.22	139
Formaldehyde	0.00	22.1
Acetaldehyde	4.62E-06	2.9
Acrolein	9.95E-07	2.55
Methanol	0.00	2.72
1,1,2,2-Tetrachloroethane	0.00	0.02
1,1,2-Trichloroethane	0.00	0.01
1,3-Dichloropropene	0.00	0.01
1,3-Butadiene	1.19E-07	0.57
Carbon Tetrachloride	0.00	0.02
Dichlorobenzene	0.00	0.01
Ethylene Dibromide	0.00	0.02
Methylene Chloride	0.00	0.04
Naphthalene	1.20E-05	0.09
Vinyl Chloride	0.00	0.01
Benzo(b)fluoranthene [b]	0.00	3.10E-05
Chrysene [b]	0.00	5.44E-05
Total HAPs	9.09	1,827
Greenhouse Gases		
CO_2	19,122	780,053
CH_4	1,777	11,183
N_2O	0.00	5.96

[a] Emissions shown are from the initial estimates developed in 2010 for 484 additional producing wells. An updated emission inventory was completed in 2011 (for 484 wells) and emissions are on the order of one-half those shown herein. The updated 2011 emissions data are presented in Chapter 4 of the EA.
[b] Pollutants are HAPs because they are polycyclic organic matter (POM)

3.0 NEAR-FIELD DISPERSION MODEL AND METEOROLOGY

The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) version 07026, has been promulgated in the EPA Guideline on Air Quality Models to replace ISCST3 as the primary dispersion model for assessing near-field impacts (40 CFR Part 51 in 9 Nov 05,Vol 70 # 216 FR 68218-68261), and was therefore applied in this analysis. The AERMOD system contains three primary components: AERMOD (dispersion model with prime building downwash algorithms), AERMAP (terrain preprocessor), and AERMET (meteorological preprocessor). The USEPA *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W) specifies that impacts calculated with steady-state Gaussian plume models (AERMOD) are applicable and recommended at distances up to 50 km from the origin of the emission source.

Examples of AERMOD input and output files are attached to the document in Appendix A.

The AERMET system utilizes both surface and upper air measurements in order to estimate profiles of wind, turbulence, and temperature in the Planetary Boundary Layer. Minimum meteorological data requirements in the surface and upper air data files for successful execution of AERMET include horizontal wind speed, horizontal wind direction, ambient temperature, cloud cover, and a morning upper air sounding. The recent version of the model, however, has incorporated the Bulk Richardson Number scheme which removes the model dependence on cloud cover if Solar Radiation and Temperature Change with Height (SRDT) data are available. This is especially important in areas where cloud cover data are unavailable or considered to be non-representative. After entering the surface and upper air data into AERMET, the surface characteristics that pertain to the meteorological data are required, including; Albedo, Bowen Ratio and Surface Roughness.

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

In consideration of these limitations, this analysis utilized five years of recent surface measurements collected at Canyonlands National Park as part of the Clean Air Status and Trends Network (CASTNET) operated by the US Environmental Protection Agency (USEPA) and National Park Service (NPS). Evaluation of the surface characteristics surrounding the data collection site indicate that the data is likely to be representative of the meteorological conditions encountered within the modeling domain. Furthermore, the availability of SRDT data at this site allowed the application of the Bulk Richardson Number scheme providing an alternative to the less reliable ASOS data. The five years of surface data collected at Canyonlands was combined with National Weather Service twice-daily upper air soundings available at Grand Junction Walker Field in order to successfully operate AERMET and create five full years (1995-1999) of AERMOD ready meteorological data. Extracted from the Canyonlands data were wind speed, wind direction, horizontal wind direction deviation (sigma theta), solar radiation, and delta temperature (9m and 2m probes). Missing data or data outside acceptable ranges was reviewed and replaced as necessary using regulatory guidance along with professional judgment.

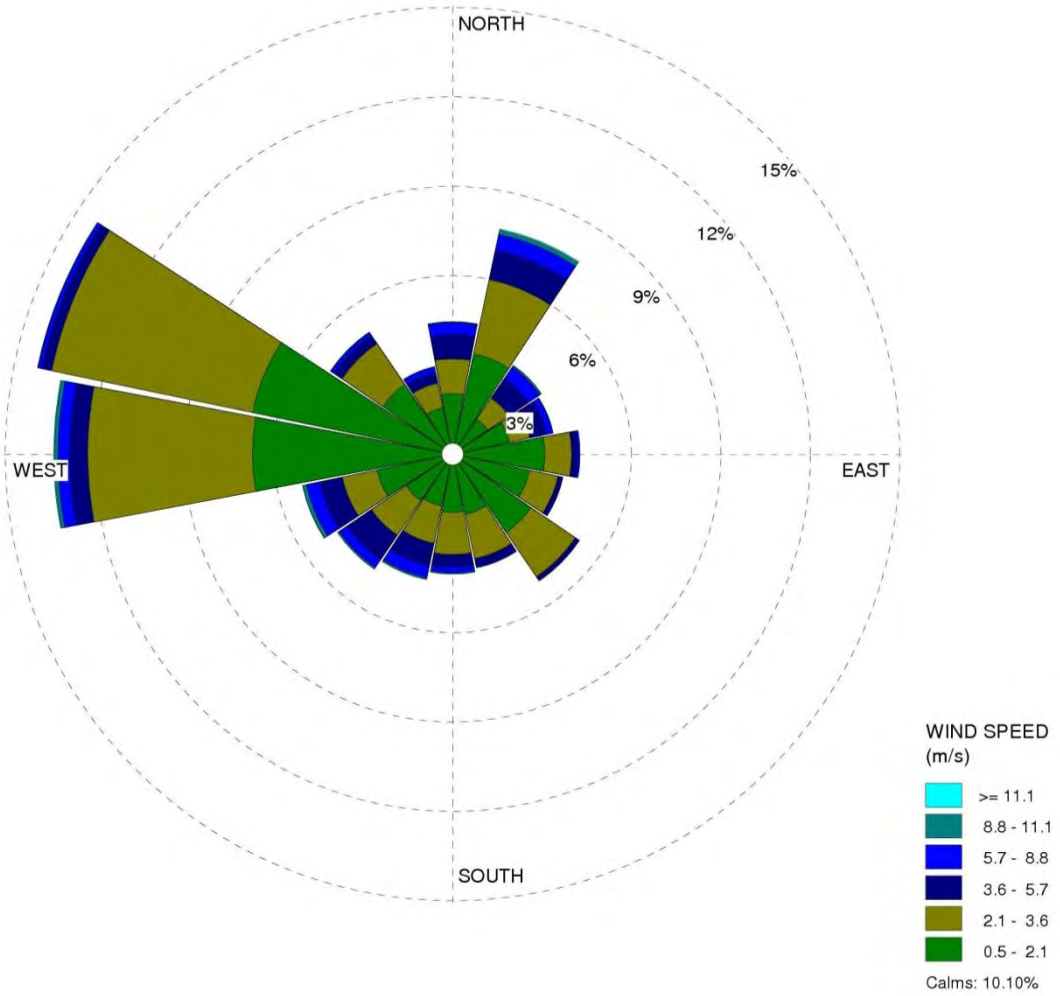
Finally, the AERMET processing program was utilized with all of the input data and produced two types of finished data files for each meteorological year for use by AERMOD; surface scalar parameters (*filename*.sss) and vertical profiles (*filename*.pfc). A profile base elevation of 1,470 m (4,823 ft.) was used with the meteorological data for the execution of AERMOD.

National Elevation Dataset (NED) data files were obtained containing information for the geographical area surrounding the facility. USGS 1/3 arc-second Geotiff files were downloaded in seamless data file format from the seamless.usgs.gov website. The NED data were based on the North American Datum of 1983 (NAD83). USEPA's AERMAP computer program was used to extract data from the DEM files and to calculate source base elevations and receptor elevations using the default algorithm (inverse distance squared of the nearest four terrain nodes). The most recent USEPA AERMAP version (09040) is being used to calculate elevations.

A wind rose for the project area is shown on Figure 3-1.

Figure 3-1

Wind Rose from Vernal Airport Data 2005-2009 (Vernal, UT)



4.0 SIGNIFICANCE CRITERIA

Potential impacts to near-field air quality that would result from the implementation of the River Bend Proposed Action were compared to the significance criteria listed below.

4.1 AIR QUALITY STANDARDS AND BACKGROUND DATA

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

The applicable ambient air quality standards and the Uinta Basin background concentrations are summarized in Table 4-1.

Under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act (CAA), incremental increases of specific pollutant concentrations are limited above a legally defined baseline level. Many national parks and wilderness areas are designated as PSD Class I. The PSD program protects air quality within Class I areas by allowing only slight incremental increases in pollutant concentrations. Areas of Utah not designated as PSD Class I are classified as Class II. For Class II areas, greater incremental increases in ambient pollutant concentrations are allowed.

The PSD increments for Class II areas are also shown in Table 4-1.

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

Table 4-1 Ambient Criteria Pollutant National and State Ambient Air Quality Standards, and PSD Increments				
Pollutant	**Averaging Period(s)**	**Uinta Basin Background Concentration [a] ($\mu g/m^3$)**	**NAAQS ($\mu g/m^3$)**	**PSD Class II Increment ($\mu g/m^3$)**
SO_2	Annual 24-hour 3-hour 1-hour	5 10 20 21.7[b]	-[e] -[e] 1,300 196[e]	20 91 512 -[e]
NO_2 NO_2	Annual 1-hour	9.0[b] 69.6[b]	100 188[d]	25 -[d]
PM_{10}	24-hour	18.0[b]	150	30
$PM_{2.5}$	Annual 24-hour	12.3[b] 21.6[b]	15 35	4[f] 9[f]
CO CO	8-hour 1-hour	3,910[b] 6,325[b]	10,000 40,000	None None
O_3	8-hour	105	147[c]	None

[a] Source: Utah Division of Environmental Quality - Division of Air Quality (UDAQ) unless otherwise noted.
[b] Based on data collected at the Ouray or Redwash Monitoring Stations (see AQIA, Greater Natural Buttes FEIS, AQTSD, March 2012. The 1-hour NO_2 value is the largest value in a range of 98th percentile values presented in the Greater Natural Buttes FEIS, AQTSD. [c] The 147 $\mu g/m^3$ value in the table is equivalent to the NAAQS of 0.075 ppm.
[d] NO_2 1-hour standard is based on the January 22, 2010 EPA update to the NAAQS standard (final rule effective April 12, 2010). The standard is the 3-year average of the 98th percentile. No PSD increment has been established.
[e] The USEPA published a 1-hour SO_2 standard, effective August 23, 2010, and eliminated the annual and 24-hour standard. The standard is the 3-year average of the 99th percentile. No PSD increment has been established.
[f] The USEPA published PSD increments for $PM_{2.5}$, effective October 20, 2011.

4.2 ACUTE AND CHRONIC HAP EXPOSURE THRESHOLDS

Hazardous Air Pollutants (HAPs) predicted to be released in significant quantities associated with the River Bend project include benzene, toluene, xylene, formaldehyde, and acrolein. Hydrogen sulfide (H_2S) is not expected to constitute a significant portion of the gas stream and therefore was not modeled. Since there are no applicable federal ambient air quality standards for the above pollutants, Reference Concentrations (RfC) for chronic inhalation exposure, and Reference Exposure Levels (REL) for acute inhalation exposures are applied as significance criteria. The RfCs represent an estimate of the continuous (i.e. annual average) inhalation exposure rate to the human population (including sensitive subgroups such as children and the elderly) without an appreciable risk of harmful effects. The RELs represent the acute (i.e. one-hour average) concentration at or below which no adverse health effects are expected; set by California EPA. Both the RfC and REL guideline values are for non-cancer effects.

Concentrations and exposure levels for the RfCs and RELs are provided in Table 4-2.

Table 4-2 HAP Reference Exposure Levels and Reference Concentrations		
Hazardous Air Pollutant (HAP)	**Reference Exposure Level [REL 1-hr Average] ($\mu g/m^3$)**	**Reference Concentration [1] [RfC Annual Average] ($\mu g/m^3$)**
Acrolein [2]	0.19	0.02

Table 4-2 HAP Reference Exposure Levels and Reference Concentrations		
Hazardous Air Pollutant (HAP)	**Reference Exposure Level [REL 1-hr Average] ($\mu g/m^3$)**	**Reference Concentration [1] [RfC Annual Average] ($\mu g/m^3$)**
Formaldehyde [2]	94	9.8
Benzene [2, 3]	1,300	30
Toluene [2]	37,000	5,000
Xylenes [2]	22,000	100

[1] EPA Air Toxics Database, Table 1 (EPA 2007a) http://www.epa.gov/ttn/atw/toxsource/summary.html
[2] EPA Air Toxics Database, Table 2 (EPA 2007a)
[3] REL for benzene is based on a 6-hr exposure (OEHHA 1999), predicted concentration is a 6-hr average.

The State of Utah has adopted Toxic Screening Levels (TSLs) which are applied during the air permitting process to assist in the evaluation of hazardous air pollutants released into the atmosphere (Utah Department of Environmental Quality- Division of Air Quality 2000). The TSLs are derived from Threshold Limit Values (TLVs) published in the American Conference of Governmental Industrial Hygienists (ACGIH) – "Threshold Limit Values for Chemical Substances and Physical Agents" (American Conference of Governmental Industrial Hygienists 2007). These levels are not standards that must be met, but screening thresholds which if exceeded, would suggest that additional information is needed to evaluate potential health and environmental impacts. The TSLs are compared against modeling concentrations for averaging periods of 1-hour (short-term) and 24-hour (chronic).

Table 4-3 lists the corresponding TSLs for each applicable HAP.

Table 4-3 Utah Toxic Screening Levels (TSLs)	
Pollutant and Averaging Time	**Toxic Screening Levels [b] ($\mu g/m^3$)**
Formaldehyde (1-hour)	36.8
Acrolein (1-hour)	22.9
Benzene [a] (24-hour)	53.2
Toluene (24-hour)	2,512
Xylenes (24-hour)	14,473

[a] Although there exists an acute TLV for benzene, the State of Utah does not apply a comparison to an acute TSL since the chronic TSL is more stringent.
[b] Source: Prey Utah Department of Environmental Quality - Air Quality Division (2008b).

4.3 INCREMENTAL CANCER RISK

To assess long-term exposure from carcinogenic HAP emissions, traditional risk assessment methods are applied and the risk for the maximally exposed individual (MEI) and most likely exposure (MLE) are compared to the generally acceptable risk range of one additional cancer per one million exposed persons (1×10^{-6}), to one additional cancer per ten thousand exposed persons (1×10^{-4}) (EPA 1993). For the MEI risk, it is assumed that a person is exposed continuously (24 hours per day, 365 days per year) for the life of project. For the MLE risk, an adjustment was made for the amount of time a family stays at a residence (nine years) and for the portion of time spent away from the home (64 percent of the day) (EPA 1997). It is further assumed that

households are exposed to one-quarter of the maximum concentration the remaining (36 percent) of the time. Exposure adjustment factors of 0.643 for the MEI (45/70) and 0.095 for the MLE [(9/70)*((0.64*1)+(0.36*0.25))] are applied to the estimated cancer risk to account for the actual time that an individual could be exposed during a 70-year lifetime.

The chronic inhalation cancer risk factors for benzene and formaldehyde and other HAPs are presented in Table 4-4.

Table 4-4 Carcinogenic Unit Risk Factors

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

Source: [1] EPA Integrated Risk Information System (IRIS) database (EPA 2008). A range of risk factors is available for benzene.

5.0 NEAR-FIELD DEVELOPMENT AND CONSTRUCTION IMPACTS

The major pollutants associated with development activities are particulate matter, characterized as PM_{10} and $PM_{2.5}$, generated by earth-moving and traffic activities. The major pollutants associated with production activities are NO_2, CO, and HAPs as presented in section 6.0 of this report).

1-Hour NO_2 and SO_2 Standards s

Since the new 1-hour NO_2 and SO_2 standards were promulgated after the initial Near-Field scoping and impact analyses were completed, potential project impacts for comparison to the 1-hour NO_2 and SO_2 standard were not explicitly included in this analysis. However, the Greater Natural Buttes FEIS (GNB FEIS, March 2012) modeled and assessed the potential impacts from cumulative development and construction impacts in the region, including the RBU Proposed Action sources. The potential impacts of the Proposed Action as discussed in the GNB FEIS are presented in Chapter 4 of the EA.

5.1 DEVELOPMENT AND CONSTRUCTION MODELING SETUP

For air quality modeling purposes, a scenario of 1 expanded well pad and 1 new well pad based on 20-acre spacing, and an attached segment of new road were used to simulate a likely development scenario in a single section of the well field for purposes of PM_{10} and $PM_{2.5}$ modeling. In order to alleviate some of the extensive AERMOD processing times associated with area source emissions, PM_{10} and $PM_{2.5}$ emissions are not being modeled based on a full field of development (i.e. maximum well pads developed per year), but rather under this scenario that includes a section of development that is estimated to result in the maximum emissions impact. The construction, drilling, and completion related air quality impacts were analyzed with this modeling setup for PM_{10} and $PM_{2.5}$.

A well pad and access road complex was characterized by an individual well pad and an access road right-of-way approximately 1,619-feet long by 22-feet wide. Project access roads were

modeled as a line of volume sources. Although a road could be oriented in any direction, the use of five years of meteorological data adequately characterizes the maximum short-term impacts regardless of orientation.

A buffer zone of 100-meters from the access road and the well pad was entered. The buffer zone criteria were based on minimum distances that heavy equipment operators would allow public access to construction. Receptors were spaced at 50-meter intervals along the 100-meter buffer zone (acting as a fenceline), at 100-meter intervals extending out 1.0 km from the center point of the two well pads, and at 250-meter intervals 2.5 km from the center point of the two well pads. Receptor elevations were entered into BEEST through the AERMAP modeling program.

5.2 DEVELOPMENT PARTICULATE MATTER EMISSIONS

Modeling for construction activities involved PM_{10} and $PM_{2.5}$ emissions from the operation of a backhoe, dozer and grader; in addition to fugitive dust generated by vehicles traveling on the existing roadways for transportation and hauling development purposes. Modeling for the drilling activities includes traffic-generated fugitive dust as well as PM_{10} and $PM_{2.5}$ emissions from a drill rig. Modeling for completion activities include vehicle-generated fugitive dust and well fracturing activity PM_{10} and $PM_{2.5}$ emissions. Development, construction and completion equipment and activity emissions are distributed to each well pad and the roadways based on emission factors which are specific to each proposed well pad or roadway segment.

Based on the proposed project schedule, a well pad and associated access road would be constructed in about 9 days. The time to drill a well would range from 14 days for shallower vertical drilling to 21 days for directional wells. A well would then be completed (well fracturing) in about 10 days. Well drilling, construction and completion activities are assumed to occur 10 hours per day.

PM_{10} and $PM_{2.5}$ emissions were predicted for comparison to applicable short-term and annual ambient air quality standards. For annual particulate impacts the 10-hour based particulate matter emission rates are calculated as if they were to be equally spread throughout the full annual period (e.g., a PM_{10} pounds per hour emission rate is multiplied by the total number of hours it would take to complete the activity, then divided by the 8,760-hour time period). Impacts for short-term (24-hour) particulate emissions are evaluated in AERMOD for full 24-hour periods; thus, the 10-hour based particulate matter emission rates are calculated as if they were to be equally spread throughout the full 24-hour period (e.g., a PM_{10} pounds per hour emission rate is multiplied by the total number of hours it would take to complete the activity, then divided by the 24-hour time period). Note, for drill rig emissions the emission rate is not re-calculated for the 24-hour short term impact because drill rig operations can occur throughout a whole 24-hour period.

Fugitive dust emissions from well pads were modeled as area sources with the release parameters listed in Table 5-1. Fugitive dust emissions from roads were modeled as volume sources with the parameters listed in Table 5-2. Drill rig and well fracturing pump and generator emissions were included as emissions releases through the well pad area sources.

Table 5-1 River Bend Development Area Source Release Parameters			
Source	Dimensions (meters)		Release Height [a] (meters)
	X-Dimension	Y-Dimension	
New Pad	101	101	6
Expanded Pad	45	45	6

[a] Typical values used in modeling fugitive dust range from 0 to 6 meters. Tailpipe emissions immediately rise and dust plumes from vehicles can rise from one to two times the vehicle height. Truck heights are generally higher than cars, hence 6 meters is being used.

Table 5-2 River Bend Development Volume Source Release Parameters			
Source	Dimensions (meters)		Release Height [a] (meters)
	X-Dimension	Y-Dimension	
New Road Segment	7.62	7.62	6

[a] Typical values used in modeling fugitive dust range from 0 to 6 meters. Tailpipe emissions immediately rise and dust plumes from vehicles can rise from one to two times the vehicle height. Truck heights are generally higher than cars, hence 6 meters is being used.

Because road construction usually precedes well pad construction, fugitive dust emissions from construction traffic was also added to the volume sources for the associated road. This is conservative because traffic associated with road construction is included.

Emission rates were derived according to the averaging period being modeled. For instance, NO_x emission rates were annualized for each activity because the NO_x emissions standard is an annual threshold. However, short-term fugitive dust emission rates reflect the maximum 24-hour emissions that could be observed during a single day.

The maximum predicted short-term emissions from well development are shown in Table 5-3.

Table 5-3 River Bend Proposed Action Short-Term Development Emission Rates

Activity	Duration	Maximum PM_{10} Emission Rate (lbs/hr)	Maximum $PM_{2.5}$ Emission Rate (lbs/hr)
Construction (per pad)	10 days		
Earth Moving		0.698	0.358
Vehicle Traffic (per volume)		0.033	0.003
Drilling (per well)	35 to 54 days		
Drill Rig		0.250	0.200
Vehicle Traffic (per volume)		0.033	0.0033
Completion (per well)			
Well Fracturing	6 hours	0.327	0.278
Vehicle Traffic (per volume)	14 days	0.033	0.0033

5.3 DEVELOPMENT EMISSION IMPACT RESULTS

5.3.1 Proposed Action Emission Impacts

Well development impacts as compared to the NAAQS for the Proposed Action are shown in Table 5-4.

Since well development activities are temporary and short-term in nature, comparisons to PSD increments are not appropriate. The annual results demonstrate that even if these activities lasted for an entire year in the same location, the effects would still be less than all applicable standards.

Table 5-4 Proposed Action Potential Development Impacts

Pollutant	Averaging Period	Ambient Air Concentration ($\mu g/m^3$)				
		Year of Maximum Impact	Predicted	Background [a]	Total	NAAQS
PM_{10}	24-Hour	1999	41.9	18.0	59.9	150
$PM_{2.5}$	24-Hour [b]	1995	18.4	21.6	40.0[b]	35
	Annual	1995	0.73	12.3	13.0	15

[a] Based on data collected at the Ouray or Redwash Monitoring Stations (see AQIA, Greater Natural Buttes FEIS, AQTSD, March 2012

[b] Although the modeled total impact appears to exceed the NAAQS, this is not case. The NAAQS is the 3-year average of the 98th percentile. The modeled impact presented herein is the maximum modeled concentration, not the 98th percentile. Accordingly, due to the conservative nature of the model assumptions, use of a background data value based on less than 3-years of data, and use of the maximum impact instead of the 98th percentile, actual impacts are expected to be less than the NAAQS.

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6.0 NEAR-FIELD OPERATIONS IMPACTS

The near-field impact assessment considers NO_X, CO, and HAP emissions during the operational phase of the River Bend project in the final year of full-field development (as the maximum amount of wells would be operational by the final year, and considering the possibility that the final year could be the maximum year of development). Since SO_2 concentrations within the gas are very minimal, these emissions were not included in the near-field modeling. All facilities were assumed to operate continuously throughout the year.

6.1 MODELING SETUP

Maximum impacts predicted to occur in the River Bend project infill area are analyzed by modeling the full project area with complete maximum development in the air quality modeling analysis. Criteria and HAP emissions that are based on development of all 484 wells are modeled through each well, and emissions that are based on the maximum year of well development are spread throughout a representation of 93 wells as a conservative estimate that the maximum year of development would occur during the final development year (i.e. the final year of project development is when maximum emission rates could occur).

Criteria pollutant emissions were modeled as point sources for the following development and operations:

- Gas well pads: drill rigs engines, well fracing engines, pumping unit engines, dehydrators and production heaters;
- Central Gas Plant: compressor engines and separator emissions;

HAP emissions were modeled for the following sources:

- Gas well pads: drill rigs engines, well fracing engines, pumping unit engines, dehydrators, production heaters and well site condensate tank flashing/working/breathing emissions;
- Central Gas Plant: compressor engine, central condensate tank flashing/working/breathing emissions, production heaters, dehydrator and dehydrator reboiler emissions.

Receptor spacing of 125-meters was utilized within all of the RBU facility property boundary. Preliminary modeling results show that maximum impacts occur within a center portion of the property, and not near the edge of the boundary (i.e. maximum impacts occur where development and operations are the densest in emission sources).

The release parameters for all point sources are described in Tables 6-1. Volume sources do not have release parameters. Table 6-2 summarizes the point source modeling emission rates calculated from the estimated annual emissions for the full-field operations.

Table 6-1 Operations Proposed Action Point Source Release Parameters				
Equipment	**Stack height (m)**	**Temperature (K)**	**Exit Velocity (m/sec)**	**Stack Diameter (m)**
Compressor Engine	6.1	730	50	0.3048
Generator Engine	6.1	730	50	0.3048
Separator or Dehydrator Reboiler	4.6	700	2.84	0.2286

[a] For large sources, sigma z = 2*release ht./2.15. (See the ISC Model User's Guide [EPA, 1995], pp 3-28 to 3-35 for further information)

Table 6-2 Operations Proposed Action Point Source Modeling Emission Rates (tons/year)			
Pollutant	**Central Station Compressor Engine**	**Central Station Heaters**	**Well site Heaters**
NOx	82.3	5.91	265
CO	15.6	4.97	223

6.2 OPERATIONS IMPACTS RESULTS

The predicted impacts are compared to applicable Utah and NAAQS standards and applicable PSD Class II increments presented in Section 4.0. All comparisons with PSD Class II increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during permitting, and are solely the responsibility of the State of Utah with EPA oversight. The Proposed Action is not subject to the PSD program. The maximum impact for NO_2 reflects an adjustment by a factor of 0.75, in accordance with standard EPA methodology (60:153 FR 40469, Aug 9, 1995) to convert from the modeled Nitrogen Oxides (NO_X) concentration to Nitrogen Dioxide (NO_2).

6.2.1 Proposed Action Results

Results of the near-field modeling are for each pollutant of interest, and based on the highest predicted value from the five years of meteorological data modeled, are presented in Table 6-3.

Table 6-3 Proposed Action Potential Development Impacts							
Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)					
		Year of Maximum Impact	Predicted	Background	Total	PSD Class II Increment	NAAQS
NOx	Annual	1999	19.2 [a]	9.0[b]	28.2	25	100
CO	8-hour	1999	338	3,910[b]	4,248	-	10,000
	1-hour	1996	658	6,325[b]	6,983	-	40,000

[a] NO_2 annual impacts are converted from modeled NOx to NO_2 using a 75% conversion rate.
[b] Based on data collected at the Ouray or Redwash Monitoring Stations (see AQIA, Greater Natural Buttes FEIS, AQTSD, March 2012).

6.3 HAP EMISSIONS

The gas plant and well pad sources were modeled as point sources with the release parameters listed in Table 6-4.

Table 6-4 River Bend HAP Point Source Release Parameters [a]				
Source	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Central Station (CS) Compressor Engine (Natural Gas)	7.0	730	50	0.3048
Drill and Fracing	6.0	800	50	0.1000
Dehydrator Reboiler (CS & Well pad)	4.6	700	2.84	0.2286
Separators (CS & Well pad)	4.6	700	2.84	0.2286
Storage Tanks (CS and Well Pad)	6.7	281	0.001	0.0508

[a] Data is a combination of previous installation and typical manufacturers' specifications.

Table 6-5 shows the estimated HAP emission rates from each emission category of emission sources.

Table 6-5 River Bend HAP Point Source Modeling Emission Rates [a]					
Source	Maximum Emission Rate (lbs/hr per pad or per central station)				
	Benzene	Toluene	Xylene	Formaldehyde	Acrolein
Central Station (CS) Compressor Engine, Heaters and Dehy	0.12501	0.31764	0.30893	0.12533	0.00934
Well Pad Dehy, Pump and Separator	0.19812	0.32782	0.20228	0.00811	0.00103
Well Pad Drilling, Fracing and Venting	0.00300	0.00305	0.00089	2.74E-08	2.28E-09
CS Storage Tanks	0.03265	0.03242	0.00982	-	-
Well Pad Storage Tanks	0.00891	0.00891	0.00274	-	-

[a] Emission rates are based on the maximum years production and operation.

6.4 OPERATIONS HAZARDOUS AIR POLLUTANT RESULTS

Modeled results were compared to the Utah screening levels, and the acute, chronic, and carcinogenic thresholds listed in Section 4.0 for each applicable HAP. Impacts from HAPs with the highest four predicted emissions, plus acrolein due to the dangers in small levels of exposure, were compared to all criteria. Short-term impacts from HAP exposure were assessed by comparing one-hour average impacts to the HAP-specific acute REL (reference exposure level) and annual average impacts to the HAP-specific RfC (reference concentration for continuous inhalation exposure). The REL is the acute concentration at or below which no adverse health effects are expected. The RfC is the average concentration, i.e., an annual average, at or below which no long-term adverse health effects are expected. Both of these guideline values are for non-cancer effects.

Screening level risk assessment involves application of a HAP specific unit risk factor. The unit risk factor is an upper-bound estimate of the probability of one additional person contracting cancer based on continuous exposure to 1 ug/m^3 of the substance over a 70-year lifetime. Annual average concentrations of carcinogenic HAPs were modeled and expressed as a long-term cancer risk (based on 70-year exposure) using the HAP specific unit risk factor. The risk from long-term exposure to carcinogenic HAP emissions is assessed by comparison to the generally acceptable risk range of one additional cancer per one million exposed persons (1×10^{-6}) to one additional cancer per ten thousand exposed persons (1×10^{-4}) (EPA 1993).

Exposure adjustment factors are calculated to adjust for actual exposure times. Cancer risk is estimated for two exposure scenarios: the most likely exposure (MLE) that individuals will experience, and the maximally exposed individual (MEI).

The MLE was assumed to apply to people living in the general vicinity of the RBU project area. For the MLE exposure adjustment factor, it is assumed a family stays at a residence an average of nine years and spends 64 percent of the day away from the home (EPA 1997). It is further assumed that households are exposed to one-quarter of the maximum concentration the remaining (36 percent) of the time. This results in an adjustment factor of 0.095 [(9/70)*((0.64*1)+(0.36*0.25))].

An example of an MEI could be a person assigned to project area pumping that visits well sites daily and lives near a well pad. For the MEI exposure adjustment factor, exposure is assumed to

occur continuously (24 hours per day, 365 days per year) for the life of project (assumed to be 45 years). This results in an adjustment factor of 0.643 [45/70].

EPA's first guidelines on carcinogen risk assessment assumed that risks exist at any dose (EPA 1986). More recent data show that there are some exceptions to this assumption however it is still the default when there is a lack of data (EPA 2007). Therefore carcinogenic risk was assessed for the known, probable, and possible human carcinogens (possible human carcinogen meaning known animal carcinogen) associated with the Proposed Action with existing unit risk factors (EPA 2007).

Table 6-6 presents the predicted results of emission impacts under the proposed action in comparison to the State of Utah TSLs for averaging periods of 1-hour (short-term) and 24-hour (chronic). None of the HAPs exceed Utah TSLs.

Table 6-6 River Bend Proposed Action Utah Toxic Screening Level (TSL) Impacts

Pollutant and Averaging Time	Predicted Maximum Impact ($\mu g/m^3$)	Maximum Impact Year	Toxic Screening Levels [b] ($\mu g/m^3$)	Percent of TSL
Formaldehyde (1-hour)	12.8	1996	36.8	34.8%
Acrolein (1-hour)	1.63	1996	22.9	7.12%
Benzene [a] (Annual)	26.9	1999	53.2	50.6%
Toluene (24-hour)	10.5	1996	2,512	0.40%
Xylenes (24-hour)	103	1999	14,473	0.70%

[a] Although there exists an acute TLV for benzene, the State of Utah does not apply a comparison to an acute TSL since the chronic TSL is more stringent. Thus, the annual Benzene impact is compared to the Benzene chronic TSL.
[b] Source: Utah Department of Environmental Quality – Division of Air Quality (2008).

Table 6-7 presents the acute RELs and RfCs for non-cancer effects for the Proposed Action. The predicted maximum concentrations of all HAPs are compared against the REL and RfC for each pollutant. Predicted concentrations of acrolein for the Proposed Action exceed both the acute REL and the RfC. The sources of acrolein for the Proposed Action include the compressor engines and pump unit engines. Acrolein is a very reactive compound with a half-life in air of 1 day. Exposure to lower levels of acrolein can cause eye, nose, and throat irritation, and can lower breathing rates. Higher levels of acrolein can damage the lungs and cause death (ATSDR 2007). For perspective, the annual average ambient urban background in California is 0.15 $\mu g/m^3$ with a 95th percentile of 0.3 $\mu g/m^3$. Acrolein levels measured in smoky bars and restaurants ranged from 2.3 to 275 $\mu g/m^3$ (OEHHA 2001). A public draft is available through the OEHHA website (dated November 7, 2007) increasing the acute REL to 2.3 $\mu g/m^3$, and increasing the chronic level to 0.1 $\mu g/m^3$ (OEHHA 2007). The ACGIH has set a threshold limit ceiling value that should never be exceeded in a work environment at 229 $\mu g/m^3$ (ACGIH 2007). EPA's website documentation for the acrolein RfC indicates EPA has medium confidence in the RfC as it is based on medium quality data. (http://www.epa.gov/iris/subst/0364.htm)

Table 6-7 River Bend Proposed Action Non-Carcinogenic Acute REL and RfC Impacts						
HAP	**REL [a] ($\mu g/m^3$)**	**Predicted Maximum 1-Hour Impact ($\mu g/m^3$)**	**% of REL**	**RfC [c] ($\mu g/m^3$)**	**Predicted Maximum Annual Impact ($\mu g/m^3$)**	**% of RfC**
Acrolein	0.19	1.63	858%	0.02	0.13	650%
Acrolein [d]		-	-	0.06	0.13	216%
Formaldehyde	94	12.8	13.6%	9.8	1.04	10.6%
Benzene [b]	1,300	187	13.0%	30	26.9	89.6%
Toluene	37,000	521	1.41%	5,000	43.3	0.87%
Xylenes	22,000	321	1.46%	100	26.2	26.2%

[a] California EPA Reference Exposure Level (REL) for no adverse effects EPA Air Toxics Database, Table 2 (EPA 2007a)
[b] REL for benzene is based on a 6-hr exposure (OEHHA 1999), predicted concentration is a 6-hr average.
[c] EPA Air Toxics Database, Table 1 (EPA 2007a)
[d] California EPA chronic REL

Table 6-8 presents the unit risk factor, exposure adjustment factor, and the estimated cancer risk for the MLE and MEI exposure scenarios for the Proposed Action known, probable, and possible carcinogenic HAPs. The unit risk factor is a slope factor that when multiplied by the ambient air concentration provides an estimate of the probability of one additional person contracting cancer based on continuous exposure over a 70-year lifetime. A range of unit risk factors is available for benzene. All estimated risks are within the acceptable range.

Table 6-8 River Bend Proposed Action Potential Carcinogenic HAP Risk					
Exposure Scenario	**HAP**	**Unit Risk Factor ($1/\mu g/m^3$)**	**Exposure Adjustment Factor**	**Modeled Annual Impact ($\mu g/m^3$)**	**Cancer Risk**
MLE	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.095	26.9	5.6×10^{-06} to 2.0×10^{-05}
	Formaldehyde	1.3×10^{-05}	0.095	1.04	1.3×10^{-06}
	TOTAL MLE RISK				**1.3×10^{-05}**
MEI	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.40	26.9	2.4×10^{-05} to 8.4×10^{-05}
	Formaldehyde	1.3×10^{-05}	0.643	1.04	8.7×10^{-06}
	TOTAL MEI RISK				**9.3×10^{-05}**

Example Benzene MLE Calculation: 0.0000022 unit risk factor * 0.095 adjustment factor * 26.9 impact = 0.0000056 cancer risk

MEI = maximally exposed individual
MLE = most likely exposure

There is uncertainty associated with adding cancer risk values together although it is commonly done for carcinogens having similar modes of action or target organs. However formaldehyde, a suspected human carcinogen, is suspected to cause leukemia and therefore it is reasonable to add benzene and formaldehyde risk numbers together.

7.0 VISIBILITY DEGRADATION ANALYSIS

A screening analysis to determine the impacts on visibility caused by the River Bend Unit project area at 50 km distances was performed. The VISCREEN model provided by the USEPA was used to determine the visual effect parameters (color difference parameter and plume contrast against a background) from the RBU project area emissions plumes from a given vantage point (i.e., a scenic vista). VISCREEN is recommended for use up to a maximum distance of 50 km from the source. Due to the distance from RBU to the nearest Class I area (greater than 150 km), analyzing the visibility impact (degradation) that RBU could have on a given location at 50 km is considered to be a conservative estimate.

Potential visibility degradation can be evaluated in terms of the change in deciview (Δdv) or a change in background extinction (B_{ext}). A 1.0 dv "Just Noticeable Change" is equivalent to a 10% change in B_{ext}. There are no applicable federal, state, tribal, or local visibility standards. However, predicted visibility impacts are compared to Levels of Acceptable Change (LAC) developed by Federal Land Managers (FLAG 2000). This threshold is based on the original development of the deciview scale (Pitchford and Malm 1994), and is supported by EPA's Final Regional Haze Regulation (EPA 1999) decision to use 1.0 Δdv as the significance level when preparing periodic reasonable progress reports. Therefore, a "Just Noticeable Change" threshold of a 10% change in the reference background extinction or 1.0 Δdv is being used as a threshold.

The VISCREEN model used for the visibility impact screening analysis calculates the contrast of a potential plume of pollutants emitted by the proposed project. The model uses 5 percent contrast as the significance criterion. Contrast is directly related to visual range, and most visual range calculations use a 2 percent contrast difference as being "barely noticeable". That is, if there is a 2 percent difference in contrast between the object being viewed and the background, the object would be barely noticeable and the distance at which the contrast decreases to 2 percent is the visual range. Accordingly, to be comparable to the deciview "Just Noticeable Change" criterion, a 2 plume percent contrast value was used as the significance criterion instead of the default VISCREEN criterion of 5 percent.

The VISCREEN model was run with an particulate matter ($PM_{2.5}$) emission rate of 77 tpy and a NO_X emission rate of 218 tpy. These emission rates are for maximum development, where maximum $PM_{2.5}$ emissions occur. This set of emissions was used since $PM_{2.5}$ has the greatest effect on visual air quality. The source-observer distance and minimum distance to the scenic vista was set at 50 kilometers and the maximum distance to the scenic vista was set at 50 kilometers. The 50 km distance was used since the VISCREEN model is designed to yield conservative (i.e., over predict) estimates of potential visibility impacts near a source. The model uses hypothetical worst case meteorology (e.g., 1 meter per second wind speed) and assumes straight line transport indefinitely. At a 1 meter per second wind speed, it will take nearly 14 hours to transport emissions 50 km. Therefore, using VISCREEN quantitatively for distances beyond 50 km is not reasonable. However, at distances beyond 50 km, the plume contrast will be much less than at 50 km due to plume dispersion and entrainment of background ambient air.

A background visual range of 170 kilometers was used for the surrounding area, as presented and recommended in Figure 4-3 of the VISCREEN manual. Although more recent visual air quality data indicate that some of the "best" days in the region of the Proposed Action may have visual ranges greater than 170 km, the VISCREEN model was developed with the hypothetical background visual range values incorporated into the model as defaults. Along with the default

background visual range, default particle size, particle density and worst-case meteorological conditions (F stability and 1 meter per second wind speed) were selected for the model to provide a worst-case scenario (i.e., Level-1 screening analysis) in accordance with the VISCREEN User's Manual.

Execution of the VISCREEN model with the inputs specified above resulted in visual impacts 50 km from RBU that are not considered objectionable or adverse (i.e., do not exceed screening criteria) at the distance of the theoretical scenic vista.

Appendix B presents the VISCREEN model inputs and results.

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APPENDIX A

AERMOD INPUT EXAMPLE FILE

APPENDIX B

VISCREEN INPUTS AND RESULTS

VISUAL EFFECTS SCREENING ANALYSIS FOR
SOURCE: RBU
CLASS I AREA: RBURECEPTOR

*** LEVEL-1 SCREENING ***
INPUT EMISSIONS FOR

PARTICULATES	77.00	TON/YR
NOX (AS NO2)	218.00	TON/YR
PRIMARY NO2	.00	TON/YR
SOOT	.00	TON/YR
PRIMARY SO4	.00	TON/YR

**** DEFAULT PARTICLE CHARACTERISTICS ASSUMED

TRANSPORT SCENARIO SPECIFICATIONS:

BACKGROUND OZONE: .04 PPM
BACKGROUND VISUAL RANGE: 170.00 KM
SOURCE-OBSERVER DISTANCE: 50.00 KM
MIN. SOURCE-CLASS I DISTANCE: 50.00 KM
MAX. SOURCE-CLASS I DISTANCE: 50.00 KM
PLUME-SOURCE-OBSERVER ANGLE: 11.25 DEGREES
STABILITY: 6
WIND SPEED: 1.00 M/S

R E S U L T S

ASTERISKS (*) INDICATE PLUME IMPACTS THAT EXCEED SCREENING CRITERIA

MAXIMUM VISUAL IMPACTS INSIDE CLASS I AREA
SCREENING CRITERIA ARE NOT EXCEEDED

BACKGRND	THETA	AZI	DISTANCE	ALPHA	DELTA E CRIT	DELTA E PLUME	CONTRAST CRIT	CONTRAST PLUME
SKY	10.	84.	50.0	84.	2.00	.896	.05	.013
SKY	140.	84.	50.0	84.	2.00	.497	.05	-.009
TERRAIN	10.	84.	50.0	84.	2.00	1.937	.05	.017
TERRAIN	140.	84.	50.0	84.	2.00	.176	.05	.003

MAXIMUM VISUAL IMPACTS OUTSIDE CLASS I AREA
SCREENING CRITERIA ARE EXCEEDED

BACKGRND	THETA	AZI	DISTANCE	ALPHA	DELTA E CRIT	DELTA E PLUME	CONTRAST CRIT	CONTRAST PLUME
SKY	10.	0.	1.0	169.	2.28	11.415*	.05	.173*
SKY	140.	0.	1.0	169.	2.00	2.459*	.05	-.079*
TERRAIN	10.	0.	1.0	169.	2.00	12.463*	.05	.131*
TERRAIN	140.	0.	1.0	169.	2.00	3.147*	.05	.080*

APPENDIX H-1

Ozone Impact Assessment for XTO Energy's River Bend Unit Natural Gas Development Project Environmental Assessment

Ozone Impact Assessment
for
XTO Energy's
River Bend Unit Natural Gas Development Project
Environmental Assessment

Prepared for: Bureau of Land Management
Vernal Field Office
Vernal, Utah

Prepared by: Alpine Geophysics, LLC
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May 2010

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1.0 Introduction

XTO Energy (XTO) has proposed to the United States Department of the Interior (USDOI) Bureau of Land Management (BLM) Vernal Field Office (VFO) to develop oil and natural gas resources within XTO's Federal leases located within the River Bend Unit Project Area (RBU Project Area).

The RBU Project Area is located approximately 34 miles south of Vernal. The RBU Project Area consists of 16,719 acres including parts of Township 9 South, Range 19 East; Township 10 South, Range 19 East; and Township 10 South, Range 20 East; Salt Lake Meridian, Uintah County, Utah. Surface ownership in the RBU Project Area consists of BLM land administered by the Vernal FO (12,002 acres), Uintah and Ouray Indian reservation administered by the Bureau of Indian Affairs (BIA) (4,075 acres), and State land administered by the School and Institutional Trust Lands Administration (SITLA).

The XTO River Bend Project Area currently contains active producing wells, with accompanying production related facilities, roads, and pipelines.

1.1 Project Description

XTO proposes to expand and fully develop gas production in the existing RBU Project Area through the use of vertical and directional drilling to attain 20-acre well spacing. Due to the extensive amount of pre-existing development via vertical drilling in the RBU Project Area, XTO has gained an intricate understanding of the sub-surface formations and associated pay zones. Based upon this knowledge, XTO is able to target additional pay zones via directional drilling in a technically and economically feasible manner, with lower risks for missing these targets. As such, full field development in the RBU Project Area would include the drilling of 484 wells.

The Proposed Action includes utilizing directional drilling from existing and proposed well pads in the RBU Project Area. This would include the construction of necessary infrastructure to directionally and vertically drill 484 wells, including the 128 wells previously approved (EA No. 1997-49). Development on State and Tribal leases is also included in the Proposed Action. Specific requirements would include the expansion of the existing, and installation of new, infrastructure including well pads, roads, pipelines, and supporting facilities such as tanks, dehydrators, and compressors.

The primary components of the Proposed Action were utilized for the development of a project specific emissions inventory for this ozone assessment. The Proposed Action primary components are as follows:

- Directional drilling of up to 378 natural gas wells from 169 existing well pads;
- Vertical drilling of up to 74 natural gas wells from 74 new well pads;
- Directional drilling of up to 32 wells from 19 of the 74 new well pads;
- Construction of 15.7 miles of new co-located road, gas lines, and produced water lines;

- Depending upon well production, installation of up to 120 miles of replacement gas lines that would transport gas produced from both existing and proposed wells to the main gathering lines. These replacement spur gas lines would be buried adjacent to the existing gas line ROWs; and
- Construction of one new compressor station, and expansion of eight existing compressor stations.

Emissions to the atmosphere from the proposed project would include the following criteria pollutants and precursors: nitrogen oxides (NO_x), particulates (PM_{10} and $PM_{2.5}$), Volatile Organic Compounds (VOC), and sulfur dioxide (SO_2). These pollutants would be emitted from the following activities and sources:

- Well pad and road construction: equipment producing fugitive dust while moving and leveling earth, vehicles generating fugitive dust on access roads;
- Drilling: vehicles generating fugitive dust on access roads, and drill rig engine exhaust;
- Completion: vehicles generating fugitive dust on access roads, frac pump engine and generator emissions, and completion venting emissions;
- Vehicle tailpipe emissions associated with all development phases;
- Well production operations: three-phase separator emissions, flashing and breathing emissions from stock tanks, dehydrator emissions, fugitive pneumatic device emissions, fugitive dust and tailpipe emissions from pumpers and trucks transporting produced condensate and water from storage tanks; and
- Central production facilities: compressor engines emissions, central glycol dehydration unit emissions, flare emissions for control of central facility VOC emissions, central flashing and breathing emissions from condensate tanks, fugitive pneumatic device emissions, and emissions associated with loading natural gas liquids (NGL) into trucks;

To reduce the emission of ozone forming precursors (NO_X and VOC) XTO has committed to implement the following Applicant Committed Environmental Protection Measures (ACEPMs):

- The use of Tier II or better diesel drill rig engines to reduce NO_X emissions;
- RMP compliant NO_X emissions limitation of 1.0 g/hp-hr for engines rated greater than 300 hp, and a NO_X emissions limitation of 2.0 g/hp-hr for engines rated less than 300 hp.
- The installation of low-bleed pneumatic controls, where technically feasible, on all new equipment to reduce potential VOC emissions;

This ozone impact analysis considered the emissions from the Proposed Action with applicant committed measures to reduce ozone precursor emissions.

Project emissions modeled in this assessment are shown below in Table1-1. A detailed project emission inventory is also available.

Table 1-1. XTO River Bend Unit Emissions

Alternative	Phase	Pollutant (ton/yr)			
		NO_x	CO	VOC	SO_2
Proposed Action	Development	206	171	301	1.0
	Operations	699	947	11,547	0.65
	Total	***905***	***1,118***	***11,848***	***1.65***

1.2 Modeling Approach

For more than a decade, EPA has been developing the Models-3 Community Multiscale Air Quality (CMAQ) modeling system with the overarching aim of producing a 'One-Atmosphere' air quality modeling system capable of addressing ozone, particulate matter (PM), visibility and acid deposition within a common platform (Byun and Ching, 1999, Pleim et al., 2003, Byun and Schere, 2006). The original justification for the Models-3 development emerged from the challenges posed by the 1990 Clean Air Act Amendments and EPA's desire to develop an advanced modeling framework for 'holistic' environmental modeling utilizing state-of-science representations of atmospheric processes in a high performance computing environment. EPA completed the initial stage of development with Models-3 and released CMAQ in mid-1999 as the initial operating science model under the Models-3 framework. This study used CMAQ version 4.6, publicly released October 2006.

CMAQ consists of a core Chemical Transport Model (CTM) and several pre-processors including the Meteorological-Chemistry Interface Processor (MCIP), initial and boundary conditions processors (ICON and BCON) and a photolysis rates processor (JPROC). EPA continues to improve and develop new modules for the CMAQ model and typically provides a new release each year. In the past, EPA has also provided patches for CMAQ as errors are discovered and corrected. More recently, EPA has funded the Community Modeling and Analysis Systems (CMAS) center to support the coordination, update and distribution of the Models-3 system. Byun and Schere (2006) describe the newest features implemented in the previously released CMAQ version 4.5.

2.0 CMAQ Modeling

The CMAQ modeling system is used for assessing the potential ozone impacts of the XTO RBU project in the surrounding area. The CMAQ analysis consists of the following model simulations:

- Run 1 is the *2006 actual* year simulation using actual emissions and also is used in the model performance evaluation;
- Run 2 is the *2006 typical* year, which uses typical emissions instead of actual emissions, and is used for comparison with the future case design value calculations. The only difference between the *actual* and *typical* runs are that the *actual* run uses Continuous Emission Monitoring (CEM) data for point sources whereas the *typical* run has point sources operating at more typical permitted levels;
- Run 3 is a *future baseline* year, which is 2018 – the year the XTO RBU project is projected to have maximum development activities and emissions;
- Run 4 is the simulation that includes the 2018 future baseline year and the anticipated emissions for XTO RBU project;

The "XTO RBU project-only" impacts are estimated by determining the difference between Runs 4 and 3.

The year 2006 is used for the CMAQ ozone modeling for the XTO RBU study. This selection is appropriate primarily because of data availability for 2006 from the IPAMS Uinta Basin Air Quality Study (UBAQS) and being a current year to take advantage of implementation of federal and local control programs.

The year 2018 was selected as the future baseline year based upon the predicted maximum development rate and associated emissions for the XTO RBU Proposed Action.

2.1 Modeling Domains

This section summarizes the model domain definitions for the XTO RBU ozone modeling, including the domain coverage, resolution, map projection, and nesting schemes for the high resolution sub-domain.

2.1.1 Horizontal Modeling Domain

Figure 2-1 displays the 36/12 km modeling domains that are used in the CMAQ/SMOKE air quality/emissions modeling. The 36-km continental United States (U.S.) horizontal domain for CMAQ air quality and SMOKE emissions modeling are identical to what is used by several Regional Planning Organizations (RPOs) for their regional haze modeling (e.g., WRAP, CENRAP and VISTAS). This 36-km modeling domain covers the continental U.S. as well as large portions of Mexico and Canada. The CMAQ 12-km modeling domain is shown in **Figure 2-2** and covers eastern Utah, western Colorado and portions of Wyoming, Arizona and New Mexico.

The CMAQ air quality and SMOKE emissions modeling 36/12 km modeling domains are aligned within the MM5 domains. The larger MM5 modeling domains provide a buffer around the CMAQ/emissions modeling domains by at least 6 grid cells in each direction. These grids are based on a Lambert Conformal Projection (LCP) using the same projection as adopted by the RPOs. The LCP parameters are listed in **Table 2-1**.

There is a possibility of boundary "noise" effects resulting from boundary conditions coming into dynamic balance with the MM5 algorithms. The WRAP 12-km MM5 domain, with the 12-km CMAQ domain in red, is presented in **Figure 2-3**. The larger MM5 domain is designed to sequester such errors from the air quality simulation. The buffer region used in the current study exceeds the EPA suggestion of at least 5 grid cell buffers at each boundary.

Table 2-2 lists the number of rows and columns (i.e., the number of grid cells in the east-west and north-south direction) and the definition of the X and Y origin (i.e., the southwest corner) for the 36/12 km domains used in the CMAQ and the SMOKE models for the current study.

2.1.2 Vertical Modeling Structure

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employs a terrain-following coordinate system defined by pressure, using multiple layers that extend from the surface to 100 millibars (mb), which is approximately 15 km above ground level (AGL). A layer-averaging scheme is adopted for CMAQ simulations to reduce the air quality computational time. The effects of layer averaging were evaluated by WRAP and VISTAS and found to have a relatively minor effect on the model performance metrics when both 34 layer and 19 layer CMAQ model simulations were compared to ambient monitoring data (Morris et al., 2004a). For the XTO RBU ozone modeling, 19 vertical layers are used. **Table 2-3** lists the mapping from the MM5 vertical layer structure to the CMAQ vertical layers. This MM5 structure was taken from the WRAP, VISTAS and CENRAP RPO configuration and the same CMAQ structure is also being used in the RPO modeling. Note that the MM5 and CMAQ models both use a terrain following "sigma" coordinate system so over elevated terrain the model heights will be compressed.

2.2 Model Input Preparation Procedures

2.2.1 Meteorological Inputs

This and the following subsections describe the procedures used in developing the meteorological, emissions, and air quality inputs to the CMAQ model for the XTO RBU ozone modeling study on the 36/12 km grids. The development of the CMAQ meteorological and emissions inputs are discussed together with the science options recommended for the CMAQ model. The procedures for developing the initial and boundary conditions and photolysis rates are also discussed along with the model application procedures.

The procedures set forth here are consistent with EPA guidance (e.g., EPA, 1991; 1999; 2005a; 2007), other recent 8-hour ozone modeling studies conducted for various State and local agencies using these or other state-of-science modeling tools (e.g., Tesche et al., 2003; Morris et al.,

2004a,b; Tesche et al., 2005a), as well as the methods used by EPA in support of the recent Clean Air Interstate Rule (EPA, 2005b) and the Clean Air Mercury Rule (EPA, 2005c).

Annual 36/12 km MM5 simulations for 2005 (McNally and Schewe 2006) and 2006 (McNally and Schewe, 2008) are used to provide meteorological inputs to the CMAQ and SMOKE models. The MM5 configuration is based on the WRAP 2002 simulation (Kemball-Cook et. al. 2004), which were based on an extensive review of available MM5 physical and dynamical options and have been the basis of many subsequent MM5 applications in the region. The WRAP did a fairly extensive study to determine the optimal configuration for the MM5 modeling system. One of the choices they made was to use the Betts-Miller Cumulus Parameterization. Betts-Miller was developed to parameterize tropical convection. However, using Betts-Miller improved the precipitation skill of the model.

2.2.2 Emission Inputs

In order to simulate atmospheric ozone levels, it is necessary to develop emissions estimates for all other emission sources (i.e., industrial, electric generation, motor vehicle, biogenic) in addition to the emissions from the XTO RBU project. The foundation datasets for the emissions development are based on the emissions data developed by the Western Regional Air Partnership (WRAP). Details on the emissions input preparation are presented in Chapter 3.0. The emissions are processed into CMAQ-ready files using SMOKE 2.4 for both the 36- and 12-km grids. SMOKE 2.4 is used because several of the WRAP-developed emissions files are not directly compatible with the newest version of SMOKE (i.e., Version 2.6). Further, this project would not have benefited from the enhancements in SMOKE Version 2.6.

2.2.3 CMAQ Science and Input Configurations

This section describes the model configuration and science options to be used in the XTO RBU ozone modeling effort. **Table 2-4** summarizes the CMAQ configuration that was used in the study. The latest version of CMAQ (Version 4.6) was used in the XTO RPU ozone modeling.

As indicated in the CMAQ model setup defined in **Table 2-4**, two grids were employed. CMAQ was initially run for the 2006 base case on the 36-km continental U.S. grid for calendar year 2006. CMAQ was then run for the 2006 base case on the 12-km grid utilizing the initial and boundary conditions from the 36-km CMAQ simulation.

CMAQ inputs were as follows:

> Meteorological Inputs: The MM5-derived meteorological fields were prepared for CMAQ using MCIP 3.3.
>
> Initial/Boundary Conditions (IC/BC's): The IC/BC's for the 36-km continental U.S. simulation were based on the latest available information. Currently, the RPOs use IC/BC's for the same domain based on a 2002 GEOS-CHEM global chemistry model simulation. Boundary and initial conditions for the 12-km nest will be generated from the 36-km CMAQ nest using the CMAQ ICON and BCON processors.

Photolysis Rates: The modeling team prepared the photolysis inputs as well as the albedo/haze/ozone/snow inputs for CMAQ based on Total Ozone Mapping Spectrometer (TOMS) data using the CMAQ JPROC processor.

Spin-Up Initialization: The model was run in quarters using a nominal 15-day spin-up from the previous quarter for the 36-km grid and a nominal 4 day spin-up from the previous quarter for the 12-km grid.

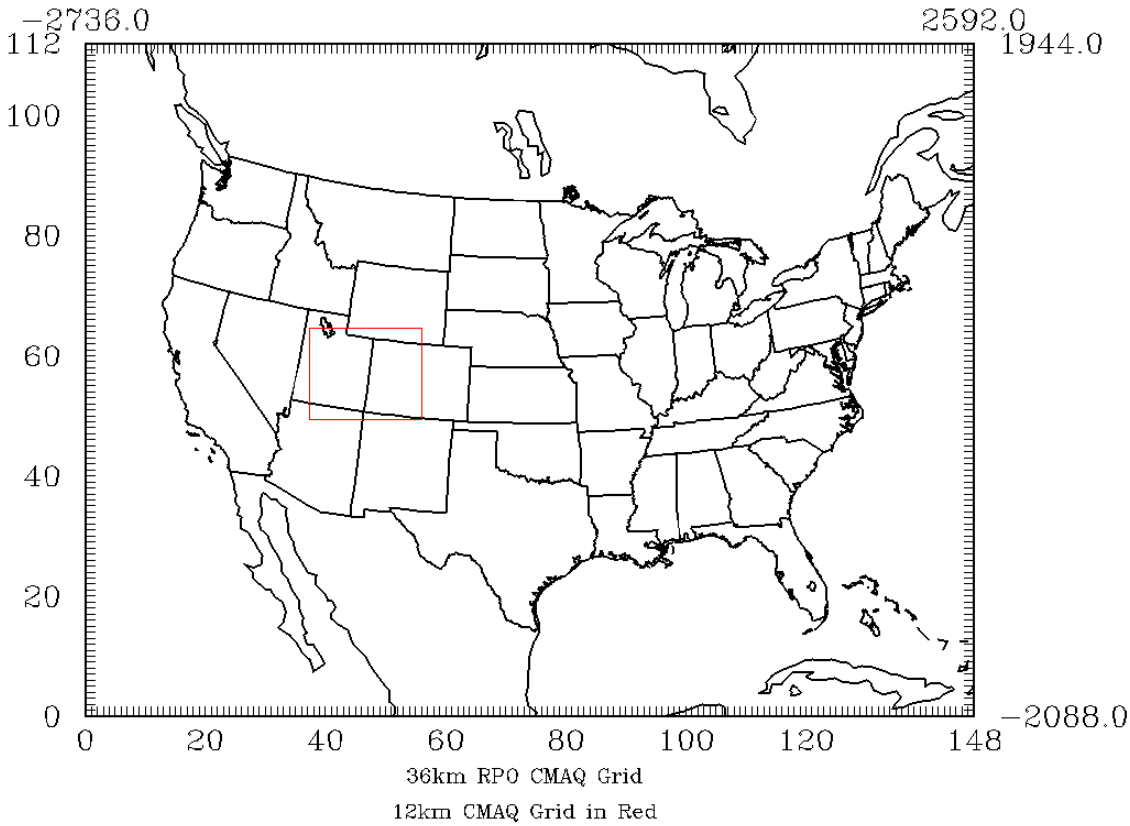


Figure 2-1. 36- and 12-km CMAQ Domains for XTO RBU Study. The 12-km domain is highlighted in red and is expanded in Figure 2-2.

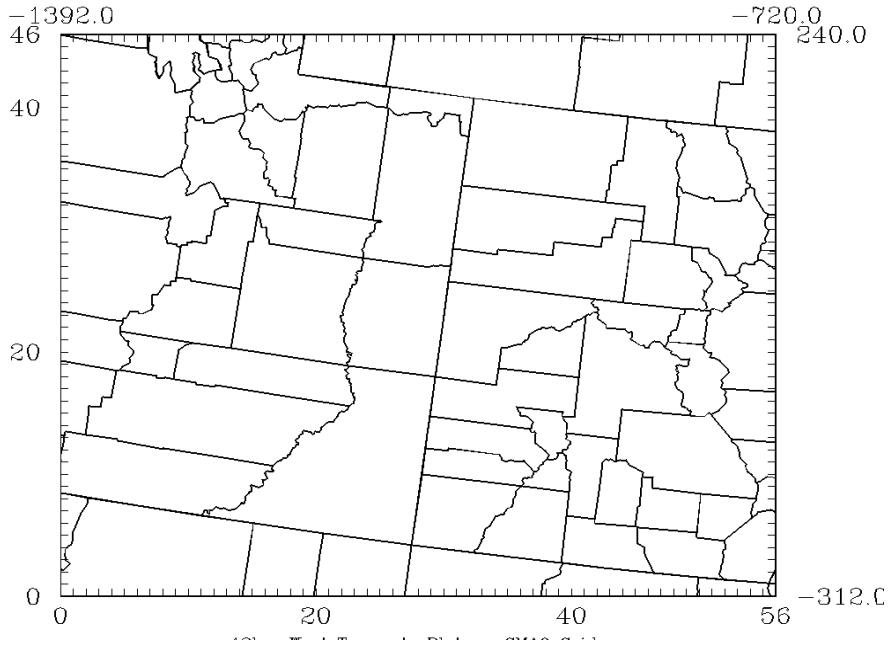


Figure 2-2. 12-km CMAQ Domain for XTO RBU Study.

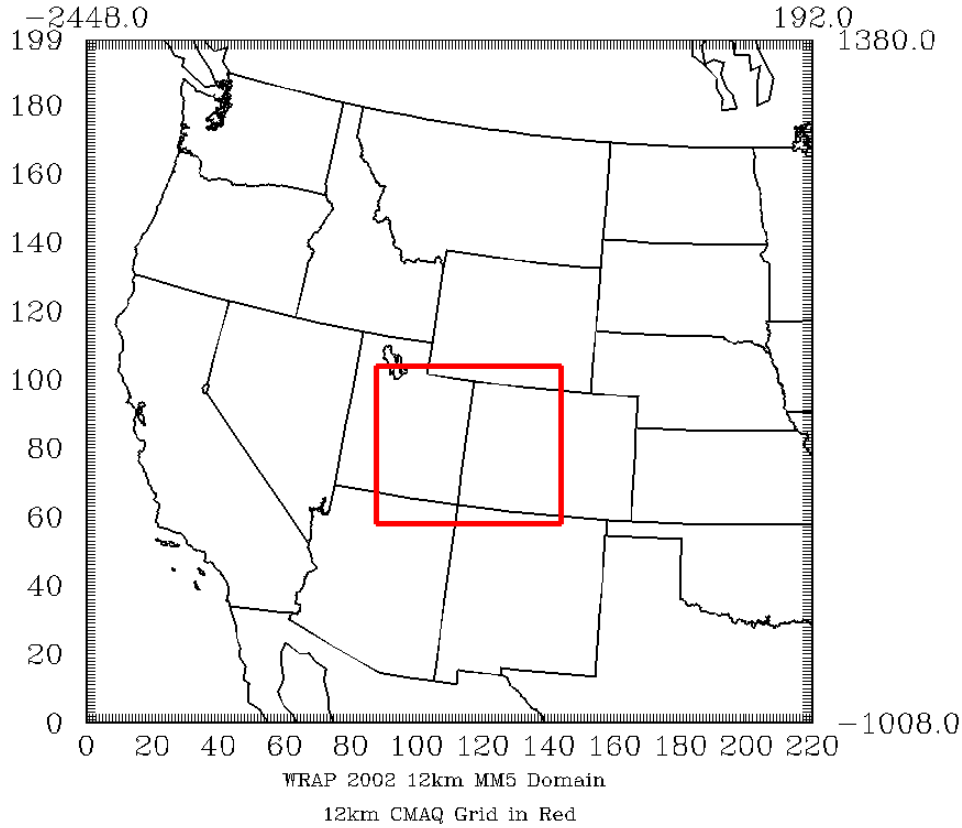


Figure 2-3. 12-km WRAP MM5 Domain with 12-km CMAQ Domain for XTO RBU Study

Table 2-1. Lambert Conformal Projection (LCP) Definition for the XTO RBU Modeling Grid	
Parameter	**Value**
Projection	Lambert-Conformal
1st True Latitude	33 degrees N
2nd True Latitude	45 degrees N
Central Longitude	-97 degrees W
Central Latitude	40 degrees N

Table 2-2. Grid Definitions for SMOKE and CMAQ				
Grid Resolution	**east-west grid cells**	**north-south grid cells**	**X-origin (km)**	**Y-origin (km)**
36-km grid	148	112	-2736.0	-2088.0
12-km grid	53	47	-1368.0	-288.0

Table 2-3. Vertical Layer Definition for MM5 Simulations (left most columns), and Approach for Reducing CMAQ Layers by Collapsing Multiple MM5 Layers (right columns)								
MM5					**CMAQ**			
Layer	**Sigma**	**Pres (mb)**	**Height (m)**	**Depth (m)**	**Layer**	**Pres (mb)**	**Height (m)**	**Depth (m)**
34 (top)	0.000	100	18123	2856	19	100	18123	9160
33	0.050	145	15267	2097				
32	0.100	190	13170	1659				
31	0.150	235	11510	1374				
30	0.200	280	10136	1173				
39	0.250	325	8963	1024	18	325	8963	3492
28	0.300	370	7938	909				
27	0.350	415	7030	817				
26	0.400	460	6213	742				
25	0.450	505	5471	680	17	505	5471	1890
24	0.500	550	4791	627				
23	0.550	595	4163	582				
22	0.600	640	3581	543	16	640	3581	1053
21	0.650	685	3038	509				
20	0.700	730	2528	386	15	730	2528	664
19	0.740	766	2142	278				
18	0.770	793	1864	269	14	793	1864	443
17	0.800	820	1596	174				
16	0.820	838	1421	171	13	838	1421	338
15	0.840	856	1251	167				
14	0.860	874	1083	164	12	874	1083	163
13	0.880	892	920	161	11	892	920	161
12	0.900	910	759	79	10	910	759	158
11	0.910	919	680	78				
10	0.920	928	601	78	9	928	601	155
9	0.930	937	524	77				
8	0.940	946	447	76	8	946	447	76
7	0.950	955	371	75	7	955	371	76
6	0.960	964	295	75	6	964	295	75
5	0.970	973	220	74	5	973	220	74
4	0.980	982	146	37	4	982	146	37
3	0.985	987	109	37	3	987	109	37
2	0.990	991	73	36	2	991	73	36
1	0.995	996	36	36	1	996	36	36
0 (ground)	1.000	1000	0	0	0	0	0	0

Table 2-4. CMAQ (version 4.6) Model Configuration		
Science Options	**Configuration**	**Details/Comments**
Model Code	CMAQ (version 4.6)	Pleim et al., (2003)
Horizontal Grid Mesh	36/12 km	36-km covering continental U.S; 12-km covering Eastern UT and Western CO
36-km grid	148 x 112 cells	RPO National Grid
12-km grid	53 x 47 cells	
Vertical Grid Mesh	19 Layers	First 8 layers synchronized with MM5
Grid Interaction	One-way nesting	
Initial Conditions	15 days full spin-up	Separately run 4 quarters of 2002
Boundary Conditions	GEOS-CHEM annual run	2002 GEOS-CHEM run.
Emissions		
Baseline Emissions Processing	See SMOKE (Ver 2.4) model configuration	MM5 Meteorology input to SMOKE, CMAQ
Dust Transport Fraction	Applied in emissions before SMOKE	
NH3 Inventory Adjustment	Applied in emissions before SMOKE	
Sub-grid-scale Plumes	No Plume-in-Grid (PinG)	
Chemistry		
Gas Phase Chemistry	CBM-IV	with Isoprene updates
Aerosol Chemistry	AE3/ISORROPIA	
Secondary Organic Aerosols	Secondary Organic Aerosol Model (SORGAM)	Schell et al., (2001)
Aerosol Mass Conservation Patch	Yes	
Cloud Chemistry	RADM-type aqueous chemistry	Includes subgrid cloud processes
N2O5 Reaction Probability	0.01 – 0.001	
Horizontal Transport		
Eddy Diffusivity Scheme	K-theory with K_h grid size dependence	Multiscale Smagorinsky (1963) approach
Vertical Transport		
Eddy Diffusivity Scheme	K-theory	
Diffusivity Lower Limit	Kzmin = 0.1	
Planetary Boundary Layer	No Patch [1]	
Deposition Scheme	M3dry	Directly linked to Pleim-Xiu Land Surface Model parameters

Table 2-4. CMAQ (version 4.6) Model Configuration		
Science Options	**Configuration**	**Details/Comments**
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) solver	Hertel et al (1993) EPI solver ~ 2x faster than MEBI
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	
Other		
Meteorological Processor	MCIP ver 3-3	
Simulation Periods	Annual 2005/2006	
Integration Time Step	Internally Computed	15 minute coupling time step
Time zone	GMT	
Platform	Dual Processor/Quad Core Intel Xeon	
Run-Time (expected)	7-10 days	Platform Dependent

[1]PATCH means applying a mosaic scheme based on land-use, which is not normally done for CMAQ. The terminology is not the same as used for a software fix.

3.0 CMAQ Emissions Input Procedures

The emissions inventories utilized for the XTO RBU Study were based on several sources. The ozone modeling required CMAQ-ready emissions estimates for 2006 and an additional future modeling year. 2018 was selected as the future year modeling inventory because it coincided with the projected Proposed Action maximum development activity and emissions rates.

3.1 2006 and 2018 Emissions Inventory Sources

Air emissions inventories are developed from the WRAP emissions inventories. The WRAP inventories are compiled using data provided by state and tribal regulatory agencies, as well as industry partners, and include data for point, area, non-road mobile, and on-road mobile sources. All or portions of five different WRAP inventories are used to develop emissions for the 2006 Baseline and 2018 Projected Baseline scenarios. These WRAP inventories include:

- 2002 Plan2D – Baseline 2002 WRAP inventory for area, point, on-road and non-road mobile source;
- 2018 PRP18a – original WRAP forecasted inventory for non-road mobile and on-road mobile sources;
- 2018 PRP18b – updated WRAP forecasted inventory for point and area sources;
- 2006 Phase III – 2006 base year inventory for oil and gas sources within the Uinta and Piceance basins only; and
- 2012 Phase III – 2012 forecasted inventory for oil and gas sources.

A summary of the emissions datasets used for each emissions source category is included in Table 3-1.

Table 3-1. Summary of 2006 and 2018 Emissions Inventory Data Sources.

Emissions Source Category	Inventory Used for 2005/2006 Baseline	Inventory Used for 2018 Projected Baseline
Oil and Gas – Uinta Basin	WRAP Oil and Gas Phase III 2006	Projected from WRAP Phase III Oil and Gas 2006 based on projected cumulative activity in 2018
Oil and Gas – Piceance Basin	WRAP Oil and Gas Phase III 2006	Projected from WRAP Phase III Oil and Gas 2006 and 2012
Oil and Gas – Southwest WY	Wyoming 5-County (SWWY) 2005/2006 O&G Inventory	Wyoming 5-County (SWWY) 2005/2006 O&G Inventory with projections
Point Sources – Non Oil and Gas	Interpolated from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a +Denver SIP	WRAP 2018 PRP18b
Area Sources – Non Oil and Gas	Interpolated from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a + Denver SIP	WRAP 2018 PRP 18b
Non-Road Motor Vehicle	Interpolated from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a +Denver SIP	WRAP 2018 PRP 18a
On-Road Motor Vehicle	Calculated with 2005 and 2006 meteorology and Interpolated VMT from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a	Calculated with 2005 and 2006 Meteorology and WRAP 2018 PRP 18a VMT
Biogenic	MEGAN with 2005/2006 meteorology	MEGAN with 2005/2006 meteorology (held steady from 2005/2006)
Wildfire	2005/2006 Wildfire Inventory	2005/2006 Wildfire Inventory (held steady from 2005/2006)

3.1.1 2006 Baseline Inventory

The 2006 Baseline CMAQ-ready emissions were developed from the WRAP2002 Plan2d and WRAP 2018 PRP18a inventory using the same methodology as followed for the UBAQS project. (Morris et al., 2009). For the 2006 Baseline, the draft 2006 WRAP Phase III oil and gas emissions for the Piceance and Uinta basins are used. For Wyoming, the 2006 Southwest Wyoming (also referred to as the 5-County) oil and gas inventory was used. (WDEQ, 2008). For the area, non-road, and non-Continuous Emission Monitor (CEM) point source emissions, the emission rates are directly interpolated from the 2002 and 2018 values. The 2006 on-road motor vehicle emissions are calculated using vehicle miles traveled (VMT) values interpolated from the 2002 and 2018 VMT totals combined with mobile source emissions factors and meteorological data specific for the 2006 episode. Day-specific emissions for the 2006 episodes are obtained for the CEM point sources and fire emissions and are calculated for the biogenic emissions. For all source categories in Colorado, the WRAP emissions were replaced by the 2006 emissions inventories developed for the Denver State Implementation Plan. (Morris, 2007)

3.1.2 2018 Future Year Inventory

The 2018 future year emissions estimates were based mainly on the WRAP 2018PRPa and PRPb inventories. (ERG, 2009) For non oil and gas related sources, the predicted emissions for the 2018 forecast year for non-road and on road mobile sources are directly from the WRAP 2018PRP18a inventory. The WRAP 2018PRPb inventory update was incorporated for area sources and point sources. Fire and biogenic source categories were maintained at 2006 levels, which is consistent with the WRAP Phase II 2018PRP18a development approach.

The Oil and Gas (O&G) portions of the 2018 future year emissions projections were done on a regionally specific basis, with the Uinta Basin, Piceance Basin, Wyoming 5-County region, and other Colorado (outside the Piceance Basin) emissions handled separately.

Colorado O&G sources outside the Piceance Basin were calculated using the same inventory growth and controls as used in the future year inventories developed for the Denver SIP. (Morris, 2009).

Emissions projection factors for the Wyoming 5-County O&G emissions have not been developed by the Wyoming DEQ, but large portions of the regions are covered by emissions offset requirements for new development. To accommodate these offset requirements, the 2018 5-County inventory was held to 2006 levels, with the exception of the vehicular traffic emissions required for well maintenance and support. The growth in well counts for this area was assumed to be in proportion to other active drilling areas (Piceance and Uinta basins) and the traffic emissions were grown accordingly.

In the Piceance basin the 2018 oil and gas emissions were estimated by developing a growth rate from the 2006 and 2012 WRAP III estimates for the basin, applying the growth rates by county and SCC code, and then accounting for control measures being adopted in Colorado. (Bar-Ilan, 2009a).

Table 3-2. Projection Parameter Data for Piceance Basin.

SCC	Description	Projection Parameter	Projection Factor
2310000100	Heaters	total well count	2.391
2310000220	Drill rigs	Spuds	1.686
2310000230	Workover rigs	total well count	2.391
2310000300	Pneumatic devices	Conv. Gas Well Count	2.391
2310000700	Unpermitted Fugitives	total well count	2.391
2310000801	Gas Well Truck Loading	Condensate Production	2.096
2310000802	Oil Well Truck Loading	Oil Well Oil Production	1.000
2310000820	Gas Plant Truck Loading	Condensate Production	2.096
2310001610	Venting - initial completions	Spuds	1.686
2310001620	Venting - recompletions	Spuds	1.686
2310001630	Venting - blowdowns	total gas production	2.476
2310002230	Condensate tank	Condensate Production	2.096
2310002240	Oil Tank	Oil Well Oil Production	1.000
2310003100	Exempt engines	total well count	2.391
2310003200	Pneumatic pumps	total well count	2.391
2310003500	Flaring	total gas production	2.476
20200201	Compressor Engines	total gas production	2.476
20200202	Compressor Engines	total gas production	2.476
20200203	Compressor Engines	total gas production	2.476
20200252	Compressor Engines	total gas production	2.476
20200253	Compressor Engines	total gas production	2.476
20200254	Compressor Engines	total gas production	2.476
31000101	Permitted Fugitives	total oil production	0.810
31000102	Oil Production, Miscellaneous Well: General	total oil production	0.810
31000123	Oil Production, Well Casing Vents	total oil production	0.810
31000130	Oil Production, Fugitives: Compressor Seals	total oil production	0.810
31000132	Oil Production, Atmospheric Wash Tank: Flashing Loss	total oil production	0.810
31000199	Oil Production, Processing Operations: Not Classified	total oil production	0.810
31000201	Natural Gas Production, Gas Sweetening	total gas production	2.476
31000202	Natural Gas Production, Gas Stripping Operations	total gas production	2.476
31000203	Compressor Engines	total gas production	2.476
31000205	Natural Gas Production, Flares	total gas production	2.476
31000207	Permitted Fugitives	total gas production	2.476
31000209	Natural Gas Production, Incinerators	total gas production	2.476
31000215	Natural Gas Production, Flares Combusting Gases >1000 BTU/scf	total gas production	2.476
31000216	Natural Gas Production, Flares Combusting Gases <1000 BTU/scf	total gas production	2.476
31000220	Natural Gas Production, All Equipt Leak Fugitives	total gas production	2.476
31000225	Natural Gas Production, Compressor Seals	total gas production	2.476
31000227	Glycol Dehydrator	total gas production	2.476
31000228	Glycol Dehydrator	total gas production	2.476
31000230	Natural Gas Production, Hydrocarbon Skimmer	total gas production	2.476

Table 3-2. Projection Parameter Data for Piceance Basin.

SCC	Description	Projection Parameter	Projection Factor
31000299	Natural Gas Production, Other Not Classified	total gas production	2.476
31000301	Glycol Dehydrator	total gas production	2.476
31000302	Glycol Dehydrator	total gas production	2.476
31000303	Glycol Dehydrator	total gas production	2.476
31000304	Glycol Dehydrator	total gas production	2.476
31000305	Natural Gas Processing Facilities, Gas Sweeting: Amine Process	total gas production	2.476
31000306	Natural Gas Processing Facilities, Process Valves	total gas production	2.476
31000309	Natural Gas Processing Facilities, Compressor Seals	total gas production	2.476
31000311	Natural Gas Processing Facilities, Flanges and Connections	total gas production	2.476
31000404	Process Heaters	total well count	2.391
31000405	Process Heaters	total well count	2.391
31000406	Process Heaters	total well count	2.391
31000502	Liquid Separator	total well count	2.391
31088801	Permitted Fugitives	total gas production	2.476
31088803	Permitted Fugitives	total gas production	2.476
31088804	Permitted Fugitives	total gas production	2.476
31088805	Permitted Fugitives	total gas production	2.476
31088811	Permitted Fugitives	total gas production	2.476
40400311	Tank Losses	total oil production	0.810
40400322	Tank Losses	total oil production	0.810

In the Uinta basin, the 2018 oil and gas emissions are projected based on predicted growth in key operating activity parameters by county from 2006 to 2018. (Bar-Ilan, 2009b) These growth rates are applied to specific oil and gas sources by Source Classification Codes (SCC) and control efficiencies are applied for control measures being adopted by operators under federal rule or consent decree.

3.1.3 Projected Activity Parameters and 2018 Scaling Ratios in the Uinta Basin

The 2018 projected baseline is estimated based on the growth of five operating parameters in each of the five counties within the Uinta Basin. The level of each of these parameters is based on the reasonably foreseeable development demonstrated by pending or proposed projects filed with the Bureau of Land Management.

These projects and associated well counts are summarized in Table 3-3. These parameters include:

- Total well count – total number of operating wells for all operators in each county;
- Spud count – number of wells drilled by all operators in each county;
- Total gas production – total gas produced by all operators in each county;
- Total condensate production – total condensate produced by all operators in each county; and
- Total oil production – total oil produced by all operators in each county.

Table 3-3. Summary of New Well Development for Proposed Projects in the Uinta Basin				
	Proposed Natural Gas Wells by 2018	**Uinta County**	**Duchesne County**	**Carbon County**
Anadarko Greater Natural Buttes EIS	3,675	3,675	--	--
BBC West Tavaputs Plateau EIS	807	20	23	764
Berry Petroleum ANF South Unit EIS	140	--	140	--
Enduring Resources Big Pack EA	490	490	--	--
Enduring Resources Southam Canyon EA	225	25	--	--
EOG Greater Chapita Wells EIS	3,725	3,725	--	--
EOG North Alger EA	44	44	--	--
Gasco Uinta Basin EIS	900	301	599	--
Newfield Monument Buttes EIS	700	272	428	--
XTO Hill Creek Unit EA	144	144	--	--
XTO Little Canyon EA	510	510	--	--
XTO River Bend Unit Infill EA	484	484	--	--

In reviewing proposed projects, no reasonably foreseeable future development is anticipated for Grand or Emery counties; therefore, these counties will be maintained at their 2006 uncontrolled emissions levels for the purposes of this analysis. Uncontrolled emissions of criteria pollutants for 2018 are calculated for each source category as the product of the 2006 emissions and the ratio of 2018 predicted activity level to the historic 2006 level for that parameter. The list of the source categories and the relevant activity parameter are summarized in Table 3-3. New development for the XTO RBU is calculated in the project specific alternatives, and therefore the XTO RBU well data is not included in the 2018 projection calculations.

A control efficiency is applied to the predicted uncontrolled emissions for certain source categories based on implementation of more stringent federal emission standards or installation of additional controls required by consent decree. Determination of these control efficiencies is discussed in detail in Section 3.1.4.

Table 3-4. Activity Parameters Used for Emissions Scaling by Source Category Code		
SCC	**Description**	**Scaling Parameter**
2310000100	Heaters	Total well count
2310000220	Drill rigs	Spud count
2310000230	Workover rigs	Total well count
2310000300	Pneumatic devices	Total well count
2310000330	Artificial lift	Total oil production
2310000700	Unpermitted fugitives	Total well count
2310000800	Truck loading of condensate	Total condensate production
2310000801	Truck loading of oil	Total oil production
2310000820	Gas plant truck loading	Total condensate production

2310001610	Venting - initial completions	Spud count
2310001611	Initial completion flaring	Spud count
2310001620	Venting - recompletions	Spud count
2310001630	Venting - blowdowns	Total gas production
2310001640	Venting - compressor startup	Total gas production
2310001650	Venting - compressor shutdown	Total gas production
2310002230	Condensate tank	Total condensate production
2310002231	Condensate tank flaring	Total condensate production
2310002240	Oil tank	Total oil production
2310003100	Miscellaneous engines	Total well count
2310003200	Pneumatic pumps	Total well count
2310020600	Compressor engines	Total gas production
2310021410	Dehydrator	Total gas production
2310021411	Dehydrator Flaring	Total gas production

Additional conventional well counts are taken from the proposed projects listed in Table 3-1 and are spatially allocated to each county on an annual basis based on the fraction of the project area in each county and the estimated start date, drilling rate, and schedule. This information was taken from pending EA or EIS documents for each project and is accumulated with recorded total well counts for each county for 2009 from the IHS, Inc. Exploration and Production Information database

Spud counts are estimated based on the change in total wells (conventional and CBM) from 2017 to 2018 in each county. An additional 5 percent spud to well rate is assumed to account for unsuccessful holes and ancillary drilling activities including monitoring and injection wells.

Gas production in 2018 from each county is predicted using a county-specific estimated well production decline over time. The number of wells at each given age is estimated as the number of new wells in each year based on projected and historical data. Gas production in each year is the product of the number of new wells and the assigned gas production rate for a well of that age; the total 2018 gas production is the sum of these products. For year 2018, only one half of the incremental production is considered due year round drilling and completion schedules.

For Uintah and Duchesne counties, condensate production in 2018 is predicted using a county-specific estimated well condensate production decline over time. The number of wells at each given age is estimated as the number of new wells in each year based on projected and historical data. Condensate production in each year is the product of the number of new wells and the condensate production for a well of that age; the total 2018 gas production is the sum of these products. For year 2018, only one-half of the production is considered due to well completion. For Carbon County, condensate production data was not available. Therefore, condensate production in Carbon County is predicted based on the historical ratio of the change in condensate production to the change in gas production of 0.0012.

The Newfield Monument Butte EIS indicates there will be 3,250 oil wells installed in Uintah and Duchesne counties over the life of the project; however, no data are available to predict oil production based on well schedule. Therefore, oil production in these counties is linearly forecast

based on historical data. For each county, the linear increase is based on the growth rate from the last upturn in production (2001 for Uintah County and 2002 for Duchesne County). Projected oil production for the remaining counties in the Uinta Basin is held at their 2006 levels

Table 3-5 summarizes the historical 2006 activity parameter data and the projected 2018 activity levels. The ratio of 2018 to 2006 levels is used to develop a scaling ratio for uncontrolled emissions to predict 2018 emissions by source category for each county.

Table 3-5. Summary of Projection Parameter Data in Uinta Basin.

	Well Count			Spud Count			Total Gas Production		
County	**2006**	**2018**	**Ratio**	**2006**	**2018**	**Ratio**	**2006**	**2018**	**Ratio**
Uinta	4,035	12,207	3.03	685	677	.99	203,391	595,651	2.93
Carbon	730	1,615	2.21	58	0	0	20,497	121,803	5.94
Duchesne	1474	2,981	2.02	277	156	.56	22,526	40,025	1.77
Grand	368	368	1	27	27	1	6855	6,855	1
Emery	56	56	1	23	23	1	951	951	1

Table 3-5 Continued. Summary of Projection Parameter Data in Uinta Basin.

	Total Condensate Production			Total Oil Production		
County	**2006**	**2018**	**Ratio**	**2006**	**2018**	**Ratio**
Uinta	1,554	5,842	3.76	3,399	4,828	1.42
Carbon	43	148	3.43	0.3	0.3	1
Duchesne	163	455	2.79	6,402	15,093	2.36
Grand	9	9	1	116	116	1
Emery	4	4	1	4	4	1

3.1.4 Baseline Emissions Control Efficiency from Federal Rule and Consent Decree

Several existing federal rules will require more stringent emission standards on existing sources. Furthermore, some operators have entered into consent decrees with the U.S. Department of Justice that require them to install additional controls. This analysis reviewed and determined emissions reductions to baseline emissions for selected source categories based on these rules or agreements. For rules that affect only new sources, these controls are applied only to the portion of emissions above 2006 levels. Control efficiencies derived from retroactive rules or requirements are applied to all emissions for the relevant source category.

Federally enforceable emissions reductions occur with the stationary and nonroad engine requirements under 40 CFR Part 60, Subpart JJJJ and 40 CFR 89, respectively. VOC reductions from dehydrators at area sources under 40 CFR Part 63, Subpart HH are not likely to be required since these standards apply to area sources with a gas throughput of 3 MMscf/day. Based on the decline curve, the average production of a new well under the proposed project is 215 MMscf/yr (0.59 MMscf/day). Therefore, there is no expected applicability or enforceability of these reductions at area sources, and thus, reductions from this rule are not considered.

The U.S. District Court recently entered into the following 3 Consent Decrees with 7 operators in the Uinta Basin requiring controls on selected dehydrators, compressor engines, selected condensate tanks, and pneumatic devices:

• U.S. v. Wind River Resources Corporation and Bill Barrett Corporation;
• U.S. v. Dominion Exploration and Production, Inc. and XTO Energy, Inc.; and
• U.S. v. Miller, Dyer, & Co., LLC, Chicago Energy Associates, and Whiting Oil and Gas Corporation.

The only requirement under these consent decrees to have measurable and enforceable impact to baseline emissions is the installation of low-bleed pneumatics. Since low bleed pneumatics reduce the maximum release of actuating gas by 50 percent or more, emissions of VOC are assumed to be reduced by 50 percent for this source category. The total control efficiency for a county for pneumatic controls and devices is then calculated as the product of this 50 percent control and the fraction of operator control of future assets.

3.1.5 Summary of Emissions Inventory Data

The results of the emissions inventory 2006 base year and 2018 future year development are summarized by major source category in Table 3-6. These totals are average day emissions, before temporal adjustments are applied. The totals are over the 12-km modeling domain only.

Table 3-6. 12-km Emissions Modeling Domain Grid Totals.
Average Tons/day

	2018 Emissions Totals			2006 Emissions Totals		
	CO	NOx	VOC	CO	NOx	VOC
Area	211.3	31.1	264.3	93.3	17.5	113.5
NonRoad	574.4	31.4	85.2	775.0	102.8	83.5
Motor Vehicle	1787.0	70.0	69.0	2587.9	192.7	143.6
Point	362.8	505.4	120.3	225.2	662.6	50.6
Total Non-O&G	2935.5	637.9	538.8	3681.3	975.6	391.2
Piceance Basin O&G	11.0	10.0	42.0	0.2	17.3	59.7
Uinta Basin O&G	29.0	38.0	531.0	23.9	28.8	192.0
SWWY O&G	8.4	22.5	347.5	8.2	22.4	347.4
Other O&G	68.3	94.2	279.1	21.1	33.0	38.7
Total O&G	116.7	164.7	1199.6	53.4	101.5	637.8
Total	3052.2	802.6	1738.4	3734.7	1077.1	1029.0

3.2 Development of CMAQ Ready Emissions Inventories

Emissions inventory development for CMAQ ozone and haze modeling addressed several source categories including: (a) stationary point sources, (b) area sources, (c) on-road mobile sources, (d) non-road mobile sources, (e) biogenic sources and (f) fire sources. For this analysis, CMAQ ready emissions input files were created using SMOKE 2.4 for the 2006 and 2018 annual periods over the 36- and 12-km grids.

CMAQ requires emission input files containing hourly emission estimates, distributed both vertically and horizontally in the modeling domain. For ozone modeling alone, hourly emissions

are required for NO, NO_2, CO, several classes of VOCs and other chemicals as available. The VOC classes used depend upon the chemical mechanism selected, which for the current study was CB-05 with updates to the isoprene chemistry.

CMAQ was also configured to provide particulate matter (PM) estimates, as well as visibility and deposition results. Thus, additional PM precursor species were needed as emissions inputs, which included SO_2, NH_3, SO_4, NO_3, EC, OMC, other primary $PM_{2.5}$ and coarse PM ($PM_{2.5\text{-}10}$).

3.3 Set-up of SMOKE for the XTO RBU Domain

SMOKE was configured to generate point, area, non-road, highway, and biogenic source emissions. In addition, certain subcategories, such as fires and electricity generator units (EGU) were maintained in separate source category files in order to allow maximum flexibility in producing alternate emissions modeling strategies. Domain specific oil and gas-related emissions were also maintained as a separate source category. With the exception of biogenic and highway mobile source emissions, that were generated using the MEGAN and MOBILE6 modules in SMOKE, respectively, pre-computed annual emissions were processed using the month, day, and hour-specific temporal profiles of the SMOKE model.

Producing 365 day-specific input files for all source categories places a burden on available computing facilities, data management systems, and would adversely affect the project schedule. Selecting representative model days for some or all of the source categories reduces the processing and file handling requirements to a more manageable level, and in most cases, does not compromise the accuracy of the emissions files. Other current or recent projects undertaken by EPA, WRAP and LADCO have used representative weekday/Saturday/Sunday emissions estimates for all source categories except biogenics either for each month or each season to model.

In an attempt to better represent the level of temporal and spatial detail available for each source category, a more detailed strategy was adopted. Biogenic emissions were modeled for each episode day, using the daily meteorology. Point sources, including CEM and fire emissions, were modeled for each episode day to take advantage of the available day-specific emissions and meteorology. All sources were treated by SMOKE as potentially elevated. No plume-in-grid sources were modeled. Wildfire emissions were handled as point sources. In the past, wildfire emissions were often handled as area source releases. However, since wildfires do have plume rise, techniques have been developed using plume rise calculations to place emissions into appropriate vertical layers. This technique was used in the WRAP and VISTAS CMAQ modeling.

Area sources, including non-road mobile and dust emissions, which do not utilize meteorological data, were temporally allocated by monthly, daily and hourly profiles that are contained in SMOKE. Review of these temporal profiles indicated that maximum temporal definition was achieved by selecting representative Thursday, Friday, Saturday, Sunday and Monday profiles for each month. Though motor vehicle emissions are influenced by meteorological variability, the processing requirements for daily motor vehicle emissions were prohibitive under the project schedule. Instead, a single week per month was selected to model emissions from on-road

mobile sources. This week was selected from mid-month, to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would have required atypical processing. The area source modeling dates were also selected from these weeks to simplify data handling procedures. The selected weeks for area source and on-road mobile source emissions modeling were as follows:

2006 On-Road Mobile Sources Represented by the Following Weeks:

January 15-21	February 11-17
March 12-18	April 6-22
May 14-20	June 11-17
July 16-22	August 13-19
September 17-23	October 15-21
November 12-18	December 17-23

3.4 Development of Point Source Emissions

Stack parameter data are frequently incorrectly reported, especially in some of the current regional modeling inventories, and careful QA is required to assure that the point source emissions are properly located both horizontally and vertically on the modeling grid. To screen for simple, but potentially serious inventory errors such as these, the study team has modified procedures originally developed by EPA to quality assure, augment, and where necessary, revise the stack parameters to examine the accuracy of the point source emissions, as well as standardize procedures to identify and correct stack data errors. SMOKE has a number of built-in QA procedures designed to catch missing or out-of-range stack parameters. These procedures were invoked in the processing of the point source data.

Point source emissions were separated into Electric Generating Units (EGU) and non-EGU categories. The non-EGU category did not have any day or hour-specific emissions. All non-EGU point source emissions were temporally allocated to month, day, and hours using annual emissions and source category code (SCC) based allocation factors. These factors were based on the cross-reference and profile data supplied with the SMOKE 2.4 and were supplemented with relevant data that were developed during the WRAP and VISTAS modeling projects.

To temporally allocate the EGU point sources, the heat input data were derived from the 2002 Continuous Emissions Monitoring (CEM) datasets, and were used to develop facility-level temporal distributions. The day-specific and facility-specific temporal profiles were used in conjunction with the emissions data to estimate hourly EGU emissions by facility.

All point sources were spatially allocated in the domain based on the stationary source geographic coordinates. If a point source was missing its latitude/longitude coordinates, the source was placed in the center of its respective county.

3.5 Development of Area and Non-Road Source Emissions

All area and non-road source emissions were temporally allocated to month, day, and hour using annual emissions and source category code (SCC) based allocation factors. These factors were based on the cross-reference and profile data supplied with the SMOKE 2.4 and supplemented with relevant data developed during the WRAP and VISTAS studies. Area and non-road sources were spatially allocated in the domain based on SCC-based spatial surrogate allocation factors. If an area or non-road source SCC did not have an existing cross-reference profile assigned to it, the county-level emissions were allocated by population density in the respective county.

A crustal PM transport factor was applied to fugitive dust emission sources that were identified in U.S. EPA modeling to have only a portion of its mass transported from the source of the emissions generation. The EPA's studies indicated that 60 to 90 percent of PM emissions from fugitive dust sources are rapidly deposited to near-source locales; hence, do not participate in the physicochemical processes on the spatial scales that are typically used in air quality modeling simulations. For this reason, the county-specific fugitive dust emissions transport factors were applied to these sources to adjust PM emissions prior to the SMOKE modeling.

3.6 Development of On-Road Mobile Source Emissions

The MOBILE6 module of SMOKE was used to develop the base year on-road mobile source emissions estimates for CO, NOx, PM, and VOC emissions. The MOBILE6 parameters, vehicle fleet descriptions, and VMT estimates were combined with gridded, episode-specific temperature data to calculate the gridded, hourly emission estimates. Of note, whereas the on-network emissions estimates were spatially allocated based on link location and subsequently summed to the grid cell level, the off-network emissions estimates were spatially allocated based on a combination of the FHWA version 2.0 highway networks and population. For the XTO RBU 36/12 km modeling, no link based data were used. The MOBILE6 emissions factors were based on episode-specific temperatures predicted by the meteorological model. Further, the MOBILE6 emissions factors model accounted for the following:

- Hourly and daily minimum/maximum temperatures;
- Facility speeds;
- Locale-specific inspection and maintenance (I/M) control programs, if any;
- Adjustments for running losses;
- Splitting of evaporative and exhaust emissions into separate source categories;
- VMT, fleet turnover, and changes in fuel composition and Reid vapor pressure (RVP).

The primary input to MOBILE6 was the MOBILE shell file. The MOBILE shell contained the various options (e.g., type of inspection and maintenance program in effect, type of oxygenated fuel program in effect, alternative vehicle mix profiles, RVP of in-use fuel, operating mode) that direct the calculation of the MOBILE6 emissions factors.

3.7 Development of Biogenic Source Emissions

Biogenic emissions are generated using MEGAN, which uses high resolution GIS data on plant types and biomass loadings and the Fifth Generation National Center for Atmospheric Research/Penn State Mesoscale Model (MM5) surface temperature fields, and solar radiation (modeled or satellite-derived) to develop hourly emissions for biogenic species on the 36/12 km grids. MEGAN generates gridded, speciated, temporally allocated emission files as well as biogenic VOC precursor emission species for the new secondary organic aerosol (SOA) module in CMAQ. MEGAN was selected over BEIS as the biogenics model of choice in order to maintain consistency with the Uinta Basin Air Quality Study emissions inventory development.

3.8 Wildfires and Prescribed Burns

Wildfire and prescribed burn emissions were handled separately from the standard area source input files. The study team had nation-wide fire emissions for the 2002 year, developed for WRAP and VISTAS. Spatial and temporal distributions of the fire emissions were calculated based on this information rather than relying on standard distribution profiles. Also, the study team calculated the vertical distribution of the fire emissions, based on fire size and biomass involvement. SMOKE 2.4 can model fire plume rise if provided with the following variables:

PTOP – Top of the fire plume profile (meters above ground level)
PBOT – Bottom of the fire plume profile (meters above ground level)
Lay1 – The percent of the emissions entrained in the first modeling layer

The WRAP Fire Emissions Joint Forum Emissions Inventory Report (WRAP/FEJF, 2002) documented an approach to estimate these plume descriptors. In this method, the fires were assigned to one of 5 size categories, based on the total burn acreage, and the biomass fuel loading. These categories were then used to calculate representative hourly plume profiles. These profiles were used by SMOKE 2.4 to distribute the vertical emissions for the fires.

3.9 Products of the Emissions Inventory Development Process

In addition to the CMAQ-ready input files generated for each hour of the days modeled in the annual run, a number of quality assurance (QA) files were prepared and used to check for gross errors in the emissions inputs. Importing the model-ready emissions into the Package for Analysis and Visualization of Environmental Data (PAVE) and looking at both the spatial and temporal distribution of the emissions provided insight into the quality and accuracy of the emissions inputs. PAVE allowed for the following quality assurance checks on the emissions estimated using SMOKE 2.4:

Visualizing the model-ready emissions with the scale of the plots set to a very low value, areas where emissions were omitted from the raw inventory and erroneously located emissions (such as area source industrial emission in water cells) were corrected.

Normalizing the emissions by population for each state illustrated where the inventories may have been deficient and provided a reality check of the inventories vis-à-vis a spatial evaluation of the population weighted emissions estimates.

Spot checked vertical allocation of point source emissions estimates.

State inventory summaries were prepared prior to the emissions processing to compare against SMOKE output report totals generated after each major step of the emissions generation process.

To check the vertical allocation of the emissions estimates, reports were created by source, hour, and layer for randomly selected states in the domain.

Quantitative QA analyses often reveal significant deficiencies in the input data or the model setup. Sometimes it is necessary to tailor these procedures to track down the source of each problem. As such, the basic quantitative QA steps that were performed in an attempt to reveal the underlying problems with the inventories or processing are described. Some of the reports that may be generated to review the processed emissions estimates include the following:

- State and county totals from inventory for each source category
- State and county totals after spatial allocation for each source category
- State and county totals by day after temporal allocation for each source category for representative days
- State and county totals by model species after chemical speciation for each source category
- State and county model-ready totals (after spatial allocation, temporal allocation, and chemical speciation) for each source category and for all source categories combined
- If elevated source selection is chosen by user, the report indicating which sources have been selected as elevated and plume-in-grid will be included.
- Totals by source category code (SCC) from the inventory for area, mobile, and point sources
- Totals by state and SCC from the inventory for area, mobile, and point sources
- Totals by county and SCC from the inventory for area, mobile, and point sources
- Totals by SCC and spatial surrogates code for area and mobile sources
- Totals by speciation profile code for area, mobile, and point sources
- Totals by speciation profile code and SCC for area, mobile, and point sources
- Totals by monthly temporal profile code for area, mobile, and point sources
- Totals by monthly temporal profile code and SCC for area, mobile, and point sources
- Totals by weekly temporal profile code for area, mobile, and point sources
- Totals by weekly temporal profile code and SCC for area, mobile, and point sources
- Totals by diurnal temporal profile code for area, mobile, and point sources
- Totals by diurnal temporal profile code and SCC for area, mobile, and point sources

3.10 Project Emissions

Study-specific emission inventories for the simulation, described in Section 1.1, were developed for the Proposed Action without controls beyond mandates and a simulation with ACEPMs to reduce NO_X and VOC emissions beyond mandates. These inventories included the construction and operations emissions. The emissions were calculated for the predicted year of maximum

development activity and emissions; 2018. Because emissions related to the Proposed Action are expected to peak in 2018, use of the WRAP 2018 inventory was possible thus allowing for the application of the best available emissions estimates for the future year.

4.0 2005/2006 Base Case Modeling Results

The CMAQ modeling database used in this study was the Uinta Basin Air Quality Study (UBAQS) developed by the Independent Petroleum Association of Mountain States (IPAMS) (IPAMS, 2009). Presented below is the technical summary of the ozone performance evaluation. The UBAQS report provides more detail on the model performance.

Table 4-1 compares the UBAQS CMAQ 2005 and 2006 base case simulation ozone model performance across CASTNet monitoring sites in the 12-km domain with EPA's hourly ozone model performance goals for bias (≤±15%) and error (≤35%) (EPA, 1991). Presented in Table 4-1 are the fractional bias (FB), normalized mean bias (NMB) and mean normalized bias (MNB) ozone performance metrics (and similar metrics for error) that are calculated using hourly predicted and observed ozone pairs for which the observed value is above a 60 parts per billion (ppb) threshold (EPA, 1991) for each Quarter of 2005 and 2006. Bias and error performance statistics in Table 4-1 are only presented for Quarters when there is a minimum of at least 100 predicted and observed hourly ozone pairs available. For Q1 and Q2 in 2005 and 2006 with at least 100 predicted and observed hourly ozone pairs, the UBAQS CMAQ base case ozone performance consistently achieved EPA's ozone performance goal. During Q3 of both 2005 and 2006, the CMAQ ozone bias performance metrics were just at the -15% ozone performance goal (≤±15%) with some of the bias metrics achieving the goal, whereas others are just outside of the goal. However, the CMAQ error ozone performance metrics achieved the ≤35% ozone performance goal by a wide margin (over a factor of two all the time).

Table 4-1. Ozone model performance bias and error statistical performance measures across the five CASTNet monitoring sites in the UBAQS 12-km modeling domain and 2005 and 2006 by Quarter (statistics based on a minimum of 100 predicted/observed hourly ozone pairs, N≥100).

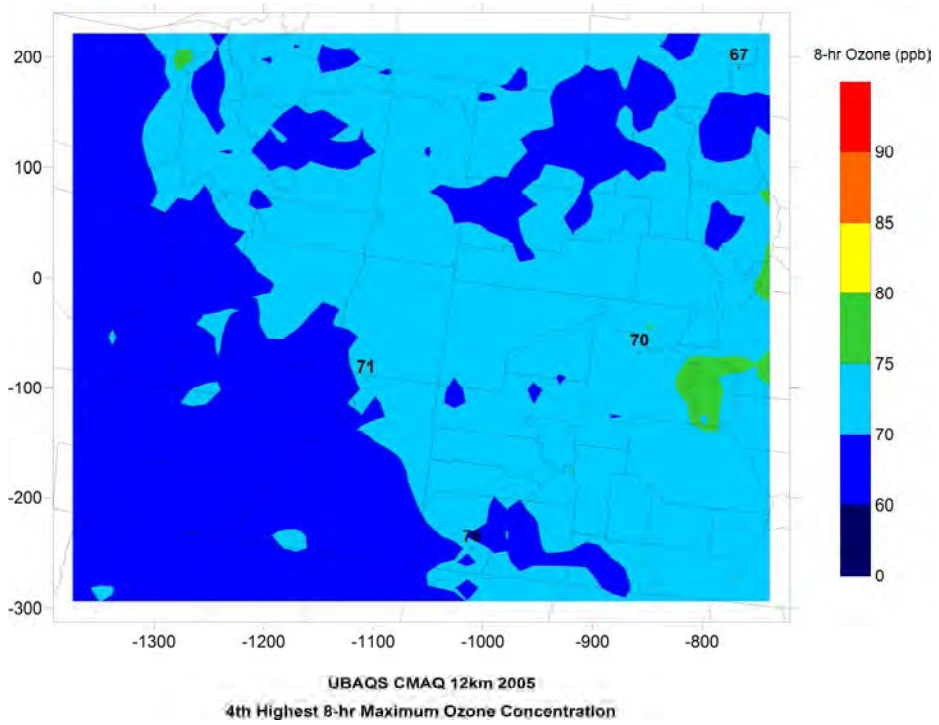
	Bias Metrics			**Error Metrics**			
Site	**FB**	**NMB**	**MNB**	**FE**	**NMGE**	**MNGE**	**N**
EPA Goal	*≤±15%*	*≤±15%*	*≤±15%*	*≤35%*	*≤35%*	*≤35%*	
2005 Quarter 2	-5.80	-5.16	-4.82	11.16	10.65	10.51	2015
2005 Quarter 3	-16.75	-15.04	-14.89	17.52	15.82	15.70	1388
2006 Quarter 1	-5.00	-4.52	-4.43	8.56	8.18	8.14	278
2006 Quarter 2	-4.06	-3.66	-3.40	9.14	8.87	8.77	3174
2006 Quarter 3	-16.48	-14.83	-14.71	16.86	15.21	15.11	1179

The UBAQS CMAQ base case simulations also satisfied EPA's daily maximum 8-hour ozone concentration performance goal that requires predicted daily maximum 8-hour ozone concentration "near the monitor" to be within ±20% of the observed value most of the time (EPA, 1999). Even using the most stringent definition of "near the monitor", which is based on the predicted 8-hour ozone concentration at the monitor, the CMAQ base case predicted daily maximum 8-hour ozone concentration were within ±20% of the observed value 90% and 83% of the time for the 2005 and 2006 modeling years, respectively.

The 8-hour ozone NAAQS is expressed as the three-year average of the fourth highest daily maximum 8-hour ozone concentrations. Thus, an important ozone performance issue when

analyzing the future year CMAQ absolute modeling results is the fourth highest daily maximum 8-hour ozone concentration. Figure 4-1 compares the CMAQ estimated fourth highest daily maximum 8-hour ozone concentration with the observed values for 2005 and 2006. The modeled fourth highest daily maximum 8-hour ozone concentrations are comparable to the observed values. The modeled fourth highest daily maximum 8-hour ozone concentrations at the locations of the ozone monitors are usually higher than the observed value resulting in an over-prediction bias that is greater in 2006 than 2005. This ozone over-prediction bias must be accounted for when interpreting the future year absolute model ozone predictions.

2005



2006

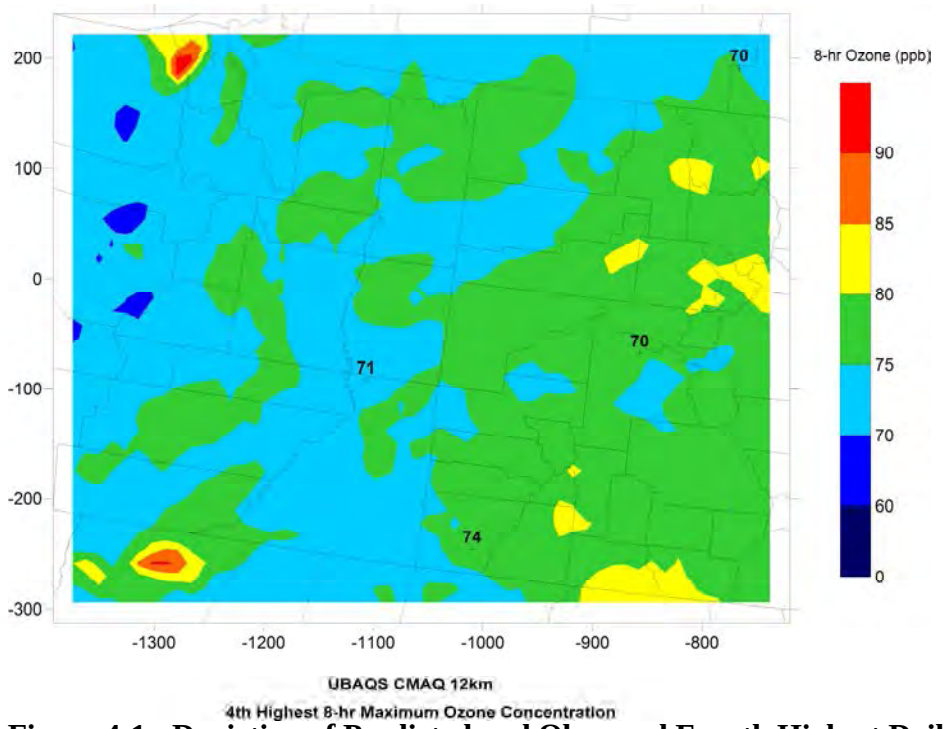


Figure 4-1: Depiction of Predicted and Observed Fourth Highest Daily Maximum 8-hour Ozone Concentrations for 2005 and 2006.

5.0 CMAQ Ozone Impact Assessment

The following subsections present the ozone impacts of the 2018 Future Year Base Case and 2018 Proposed Action cases using both the USEPA guidance relative approach (USEPA 2007) and an absolute impact approach. Considerable caution must be taken in interpreting the project impacts. In traditional CMAQ ozone modeling applications, the model is applied in regions with sufficient ozone and precursor observations (monitoring) to judge the adequacy of the model for use in ozone forecasting. In this application, the closest rural monitor with a sufficiently long data record for attainment designation, Canyonlands, is approximately 150 km from the project area. Ozone observations closer to the project (Vernal and Dinosaur National Park) were operated for shorter time periods that did not correspond to the 2005/2006 period being modeling and were not able to be used for the performance evaluation. Without sufficient local monitored ozone data, the base and future year model estimated ozone levels cannot be validated; however, the comparative modeled ozone levels among the alternatives are considered a reliable evaluation.

5.1 Results Using EPA Guidance Ozone Projection Approach

EPA guidance for projecting future 8-hour ozone concentrations recommends using the photochemical grid model in a relative sense to scale current observed 8-hour ozone design values (EPA, 2007).

The EPA metrics for determining attainment of the ozone standard are based on the modeled ozone concentrations at a monitor location. For this analysis, the study area has very few available ozone measurements, so it is desirable to examine the ozone impacts both at the monitors, and also at areas removed from monitors. This section treats each in-turn.

5.1.1 EPA Guidance 8-Hour Ozone Projection Procedures

USEPA guidance for projecting future 8-hour ozone concentrations recommends using the photochemical grid model in a relative sense to scale current observed 8-hour design values (USEPA 2007). A design value is defined as a 3-year average of the fourth highest daily maximum 8-hour ozone concentrations at a monitor. Model scaling factors, referred to as relative response factors (RRFs), are used to scale the observed design values in order to predict future year design values. RRFs are the ratio of the future year (or the control case) to the current-year modeled 8-hour ozone concentrations near a monitor site. USEPA has defined "near the monitor" to be approximately 15 km from the monitor location. The future-year design value (DVf) is obtained from the current-year design value (DVc) using the relation:

$$DVf = DVc \ x \ RRF$$

The RRFs are calculated for all days in which the current-year modeled 8-hour ozone value is above a threshold. This is done so that the model response to future changes in emissions is considered only on high ozone days of comparable conditions to the days used to produce the DVc. USEPA recommends a threshold between 70 and 85 ppb.

To perform the 8-hour projections, USEPA has developed the Modeled Attainment Test Software (MATS) tool that uses modeling results, 8-hour ozone design values and follows USEPA guidance (USEPA 2007) to project 8-hour ozone concentrations that reflect the change in emissions from the base case to an alternative emissions scenario.

EPA recommends using a DVc based on an average of three year 8-hour ozone Design Values that span 5 consecutive years centered on the modeling year (i.e., a weighted average of 5 years of fourth highest daily maximum 8-hour ozone concentrations). For example, for the 2006 baseline modeling year used in this analysis, this would mean the DVc at a given monitor would be the weighted average of the fourth highest 8-hour daily maximum ozone at that monitor from the years 2004, 2005, 2006, 2007 and 2008 using weights of 1, 2, 3, 2 and 1, respectively. To develop RRFs, EPA guidance recommends using current and future modeling results for all days in which the current year daily maximum 8-hour ozone concentration near the monitor exceeds an ozone threshold value. For a 12-km grid, as in the XTO RBU CMAQ modeling, the maximum modeled daily maximum 8-hour ozone concentration in a 3 x 3 array of grid cells centered on the monitor is used. EPA recommends using an 8-hour ozone threshold concentration of 85 ppb and also recommends that RRFs be based on a minimum of 5 days, although a total of 10 days or more is preferred. EPA allows a reduction of the threshold value to 70 ppb to meet the minimum 5-10 days requirement. These procedures were developed mainly for urban ozone nonattainment areas where there are typically many more days of elevated ozone concentrations than are observed in the rural Uinta Basin study area.

There are several issues with using the MATS tool in its standard configuration for the XTO RBU ozone analysis. The most serious is that the monitoring network is relatively dense in the Salt Lake but sparse throughout the rest of Utah, with no monitors in the Uinta Basin that have a sufficiently long data record to allow inclusion in the MATS tool (Figure 5-1). Therefore, use of the MATS tool as is would result in the DVCs in Uintah County, Utah being based on interpolation of DVCs from monitors hundreds of kilometers away in the Salt Lake City area, San Juan County, Utah (Cayonlands) and the Gothic, Colorado and Centennial, Wyoming CASTNet sites. This results in the interpolation of high Salt Lake City ozone values typical of an urban area across the Wasatch Range into the rural Uinta Basin region. Note that the Uinta Basin is not part of the Salt Lake City airshed. In addition, restricting sites used in MATS to those with a minimum of 5 days of DVc greater than 70 ppb means that MATS cannot project future ozone in the middle of the Uinta Basin and leaves this area blank in plotting future year design values in the Unmonitored Area Analysis. The most effective way to remedy this problem is to include monitors that record ozone data according to EPA standard methods, but are not included in the default MATS tool because they have fewer than five years of data available.

For this analysis a MATS assessment was performed in which all available data were used. While this may not be acceptable to NAAQS attainment designation, this approach leads to a more informative analysis. The 5 year data requirement to construct DVc was relaxed so that sites with a minimum of 1 year of data were included as DVc in the analysis. DVc for sites with multiple years of record were based on the three year 8-hour ozone Design Value that spanned 2004-2008. In the enhanced MATS Unmonitored Area Analysis grid cells are included in the RRF calculation if they had 1 or more days over both a 70 ppb and a 60 ppb threshold.

The most important difference in the Uinta Basin is the addition of DVc associated with the Vernal, Utah ozone monitor and the monitor at Dinosaur National Monument. The Vernal monitor lies within the Uinta Basin and was active in 2007 and the fourth highest daily maximum 8-hour ozone concentration was used for the DVc. The DVc for the Dinosaur National Monument was based on three years of monitoring data (2006-2008) with the three-year average fourth highest daily maximum 8-hour ozone concentrations used as the DVc.

The 8-hour ozone projections are performed twice times for each meteorological year. The first projection is performed using the 2006 typical simulation and the Future Year Base Case. Projections are then run comparing the Proposed Action case to the 2006 typical simulation. The project impacts are the differences in the future design values between the Proposed Action simulations and the Future Year Base case simulation.

5.1.2 Impact Assessment at Monitors

Monitor station 2006 design values (DVc), 2018 future year design values (DVf) and the RRF for the 2018 Future Year Base Case and 2018 Proposed Action for all stations in the domain analyzed over the entire 2018 period run with 2005 and 2006 meteorology with a minimum ozone threshold of 70 ppb are presented in Tables 5-1 and 5-2, respectively. EPA Guidance (EPA, 2007) suggests truncating ozone concentrations to the parts per billion level when performing attainment testing. However, for this analysis the results are presented to the tenth of a ppb to better resolve potential project impacts.

For the 2005 meteorological year (Table 5-1) the Proposed Action scenario increases ozone design values by 0.1 ppb at 2 monitors. The CMAQ model indicated greater impacts from the project using the 2006 meteorology. For the 2006 meteorological year (Table 5-2) the Proposed Action scenario increases ozone by 0.1 ppb at 2 monitors and by 0.2 ppb at the Dinosaur NM monitor. Tables 5-1 and Table 5-2 show that for all three future scenarios all monitors in the modeling domain are predicted to be in attainment of the 75 ppb ozone NAAQS.

Analogous tables with the MATS analysis run with a minimum threshold of 60 ppb are presented in Tables 5-3 and 5-4 for the 2005 and 2006 meteorologies, respectively. The impact results are very similar to, but somewhat lower than, the impacts with the 70 ppb threshold. For the 2005 meteorology (Table 5-3) the maximum impact is 0.1 ppb, which occurs at 3 stations for the Proposed Action case. For the 2006 meteorology (Table 5-4) the Proposed Action case shows an impact of 0.1 ppb at 2 monitors.

5.1.3 Impact Assessment Removed from Monitors

To assess the project impacts in areas removed from monitor locations, EPA guidance calls for an unmonitored area analysis. For this application, the MATS tool is used to prepare spatial fields of the projected future year ozone design values throughout the 12-km domain. EPA does not determine attainment of the 8-hour standard based on the unmonitored area analysis. Rather the unmonitored analysis is used as more of a weight of evidence analysis (EPA, 2007).

Figure 5-1 presents the 2006 MATS estimated ozone design values using the 2005 and 2006 meteorologies. For both meteorological years the highest values are estimated to occur in the Salt Lake City area. For the 2005 meteorology in the XTO RBU project area the estimated design values are sub 70 ppb. For the 2006 meteorology the majority of the values are sub 70 ppb with one grid cell in the range of 70 to 73 ppb. No grid cells in the vicinity of the project area are estimated to have design values in excess of the 75 ppb ozone NAAQS.

Figures 5-2 through 5-4 present the results of the MATS analysis with a minimum threshold of 70 ppb. Figure 5-2 presents the 2018 projected project Future Year Base Case design values. For both years of meteorology the CMAQ model is generally estimating a decrease in the design value across the domain. Figure 5-3 presents the 2018 design values which include the XTO RBU Proposed Action emissions. The results are near indistinguishable from the 2018 project Future Year Base Case figures. The model is not estimating ozone concentrations in excess of the 75 ppb standard in the project area for any simulations.

To focus on the differences in the 2018 design values, difference plots between the various simulations were prepared. Figure 5-4 presents the differences in the design values between the project Future Year Base Case and the project Proposed Action simulations. The project emissions show more impact in the 2006 meteorology than the 2005. The maximum increase with the 2005 meteorology is 0.2 ppb occurring southwest of the project and only three grid cells showing impacts of 0.2 ppb. With the 2006 meteorology the maximum increase is 0.7 ppb in the project area with the project emissions showing a 0.2 ppb or greater impact over portions of Uintah County and into Colorado.

Figures 5-5 through 5-7 present the results of the MATS analysis with a minimum threshold of 60 ppb. Figure 5-5 presents the 2018 projected project Future Year Base Case design values. For both years of meteorology the CMAQ model is generally estimating a decrease in the design value across the domain. Figure 5-6 presents the 2018 design values which include the XTO RBU Proposed Action emissions. The results are near indistinguishable from the 2018 project Future Year Base Case figures. The model is not estimating ozone concentrations in excess of the 75 ppb standard in the project area for any simulations.

To focus on the differences in the 2018 design values, difference plots between the various simulations were prepared. Figure 5-7 presents the differences in the design values between the project Future Year Base Case and the project Proposed Action simulations with the 60 ppb threshold. The project emissions show more impact in the 2006 meteorology than the 2005. The maximum increase with the 2005 meteorology is 0.2 ppb occurring at two grid cells just east of the project area. With the 2006 meteorology the maximum increase is 0.7 ppb in the project area with the project emissions showing a 0.2 ppb or greater impact over portions of Uintah County and into Colorado.

5.2 Ozone Projections Using Absolute Modeling Results

As was stated previously, the USEPA preferred approach for use of photochemical models to assess ozone attainment is to use air quality model results in a relative sense. However, another approach is to use the model in an absolute sense. Again, the lack of observations in the vicinity

of the XTO RBU study area make it impossible to assess whether the CMAQ model is able to replicate the ozone levels in the base year and hence reduces the credibility of the model to estimate future ozone concentrations.

The fourth highest ozone concentrations for 2018 project Future Year Base Case with the 2005 and 2006 meteorology are presented in Figure 5-8. With the 2005 meteorology the project area is estimated to have sub 70 ppb ozone concentrations. With the 2006 meteorology the study area is estimated to have sub 76 ppb ozone concentrations. The model is not simulating a fourth high ozone concentration of 76 ppb or greater in the vicinity of the project area with either year of meteorology.

Fourth high ozone concentrations for the Proposed Action case are presented in Figure 5-9. The spatial patterns are very similar to the project baseline, with only a few grid cells near the XTO RBU project area showing difference. No grid cells in the study area exceed 76 ppb.

As was performed for the unmonitored area analysis, differences between the different alternatives were prepared to highlight the differences. Figure 5-10 presents differences between the Proposed Action and the project Future Year Base Case using the 2005 and 2006 meteorologies. For the 2005 meteorology the maximum ozone increase is 0.8 ppb with the impact area being generally oriented southwest to northeast. For the 2006 meteorology the maximum increase is 1.1 ppb.

5.3 Ozone Impact Assessment Summary

The project impacts for the 2018 Future Year Base Case and the Proposed Action scenario were examined using both the USEPA recommended relative approach and an absolute approach. Using the relative approach at the monitors, the criteria used by USEPA to show attainment of the NAAQS, indicates that all monitors are simulated to be below the 75 ppb NAAQS for all scenarios. The maximum predicted impact at a monitor for the Proposed Action case is 0.1 ppb.

Using the USEPA recommended relative non-monitored area analysis, no areas in the vicinity of the XTO RBU project area are simulated to exceed the 75 ppb ozone standard with either the 2005 or 2006 meteorologies with or without the project emissions. The maximum predicted impact from the Proposed Action case is 0.7 ppb. The areas of predicted maximum impact are occurring in areas simulated to be below the 75 ppb ozone standard.

Using the more uncertain absolute impact approach, none of the project alternative cases predict any regions in the XTO RBU project area to be in excess of the 75 ppb standard. On an absolute basis the project emissions are predicted to increase ozone by a maximum of 1.1 ppb.

Table 5-1. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317
80770020	CO	Palisade-Water	70.0	64.3	0.9187	64.3	0.9190
80771001	CO	Colorado NM	69.0	62.7	0.9094	62.7	0.9095
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642
490350003	UT	SaltLake0003	80.0	72.5	0.9074	72.5	0.9074
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258
490353008	UT	SaltLake3008	78.0	66.5	0.8529	66.5	0.8529
490370101	UT	SanJuan0101	71.0	62.2	0.8763	62.2	0.8764
490471002	UT	Dinosaur NM	65.0	59.2	0.9110	59.2	0.9115
490490002	UT	Utah0002	73.0	64.7	0.8867	64.7	0.8868
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991
490495010	UT	Utah5010	76.0	65.9	0.8677	65.9	0.8677
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554
Black_CnNP	CO	Black_CnNP	74.0	67.2	0.9090	67.2	0.9090
Cent_WY	WY	Cent_WY	68.0	63.0	0.9265	63.0	0.9265
EnCanaCyn	CO	EnCanaCyn	68.0	62.5	0.9195	62.5	0.9200
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332
USFS_Bell	CO	Garfield	70.5	63.0	0.8947	63.0	0.8950
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258
Vernal	UT	Vernal	68.9	64.1	0.9304	64.1	0.9304

Table 5-2. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032
490471002	UT	Dinosaur NM	65.0	59.4	0.9152	59.6	0.9173
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240
Cent_WY	WY	Cent_WY	68.0	64.3	0.9461	64.3	0.9464
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521
Vernal	UT	Vernal	68.9	63.6	0.9244	63.7	0.9258

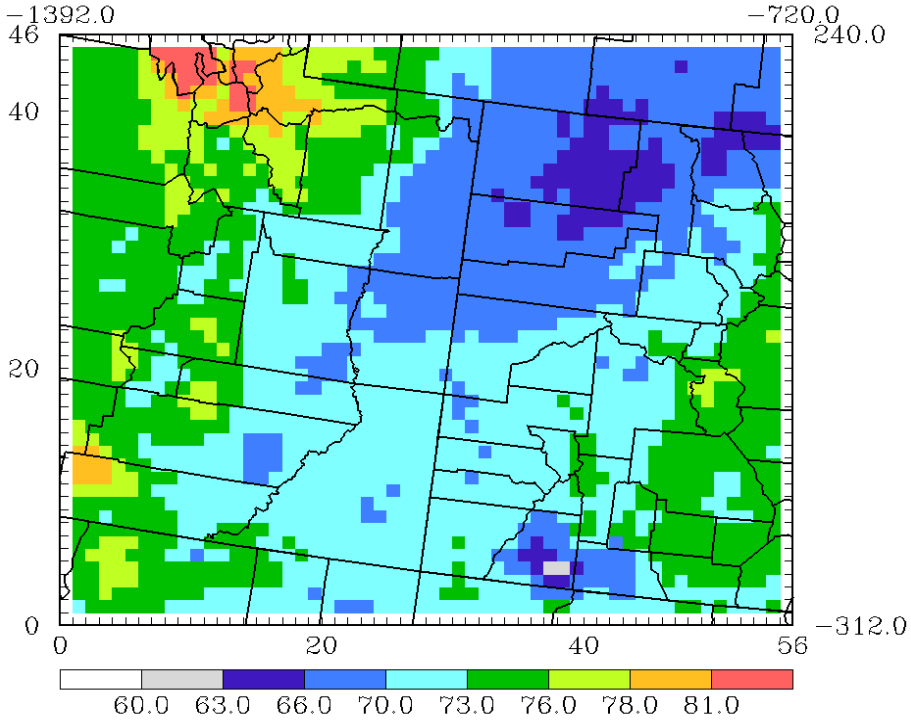
Table 5-3. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.

			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317
80770020	CO	Palisade-Water	70.0	64.7	0.9254	64.7	0.9256
80771001	CO	Colorado NM	69.0	62.4	0.9049	62.4	0.9050
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642
490350003	UT	SaltLake0003	80.0	72.5	0.9066	72.5	0.9066
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258
490353008	UT	SaltLake3008	78.0	69.1	0.8862	69.1	0.8862
490370101	UT	SanJuan0101	71.0	64.7	0.9120	64.7	0.9121
490471002	UT	Dinosaur NM	65.0	59.8	0.9201	59.8	0.9212
490490002	UT	Utah0002	73.0	64.7	0.8874	64.7	0.8874
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991
490495010	UT	Utah5010	76.0	66.9	0.8811	66.9	0.8811
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554
Black_CnNP	CO	Black_CnNP	74.0	68.4	0.9253	68.4	0.9253
Cent_WY	WY	Cent_WY	68.0	64.2	0.9443	64.2	0.9443
EnCanaCyn	CO	EnCanaCyn	68.0	62.8	0.9243	62.8	0.9246
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332
USFS_Bell	CO	Garfield	70.5	65.0	0.9225	65.0	0.9226
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258
Vernal	UT	Vernal	68.9	63.4	0.9214	63.4	0.9214

Table 5-4. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.

			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032
490471002	UT	Dinosaur NM	65.0	59.6	0.9173	59.7	0.9194
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240
Cent_WY	WY	Cent_WY	68.0	62.1	0.9133	62.1	0.9135
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521
Vernal	UT	Vernal	68.9	63.4	0.9206	63.4	0.9216

2005



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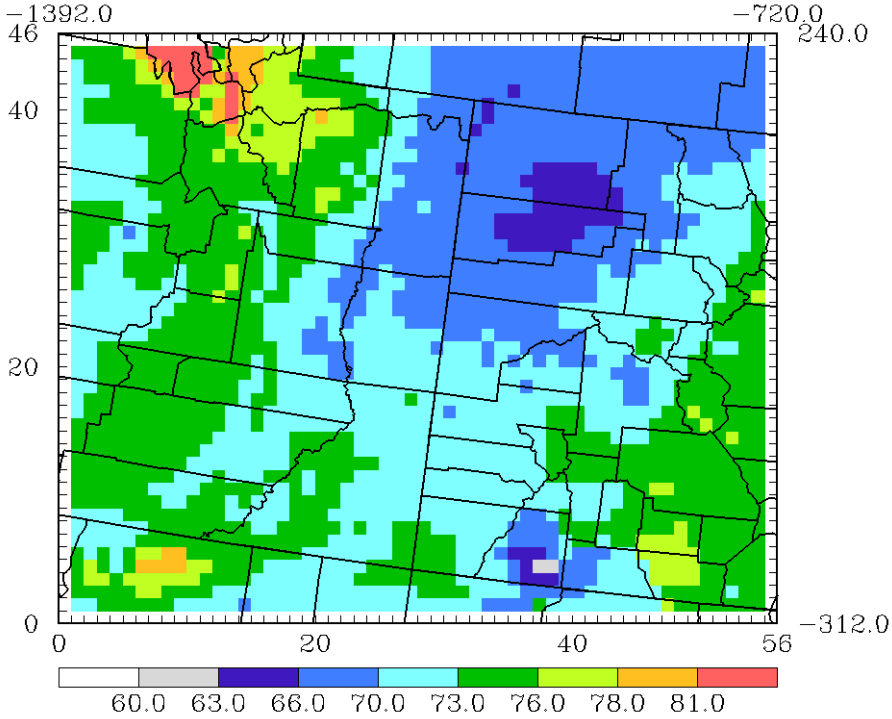
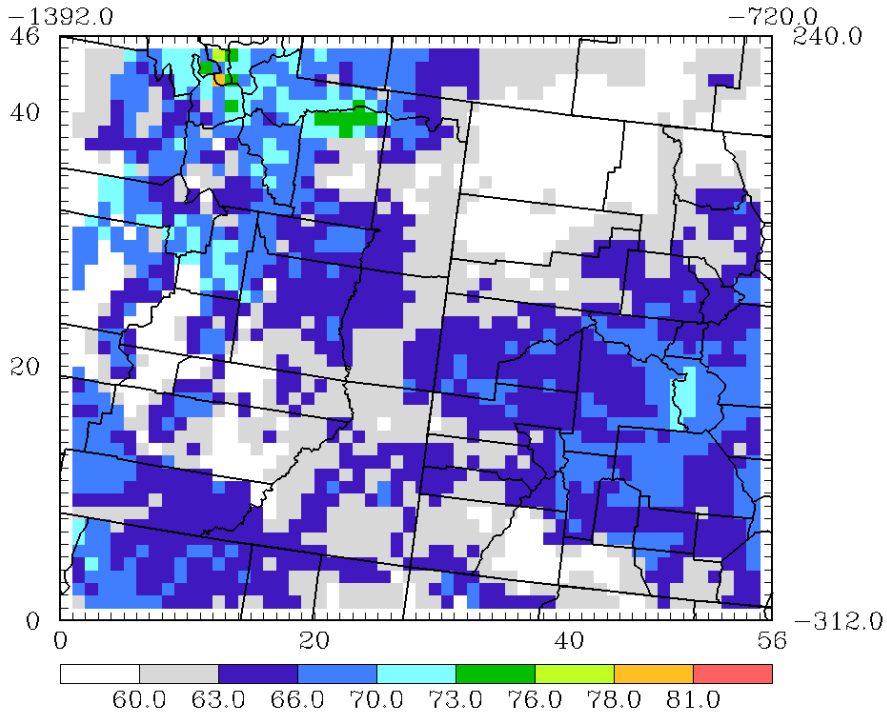


Figure 5-1: Baseline 8-hour Ozone Design Values

2005



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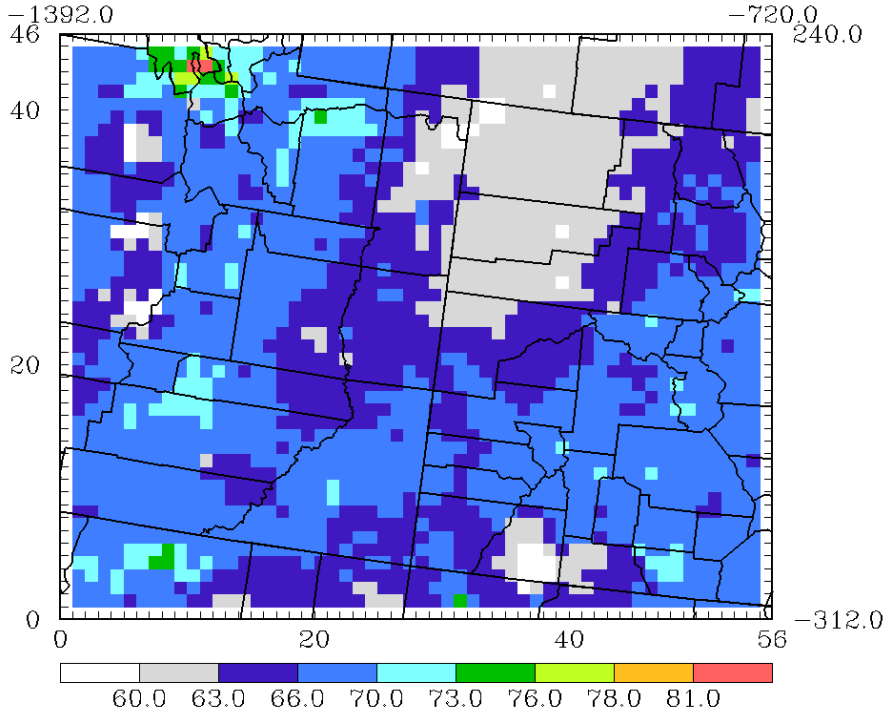
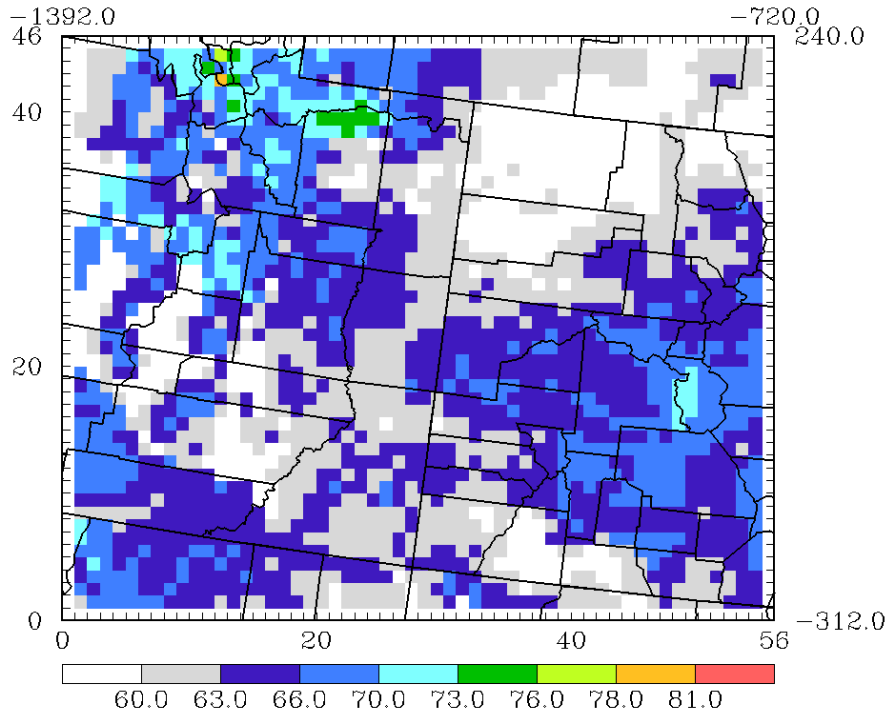


Figure 5-2: Annual 8-hour Ozone Future year Design Values for 2018 Future Year Base Case Projected Baseline with 70 ppb minimum threshold

2005



2006

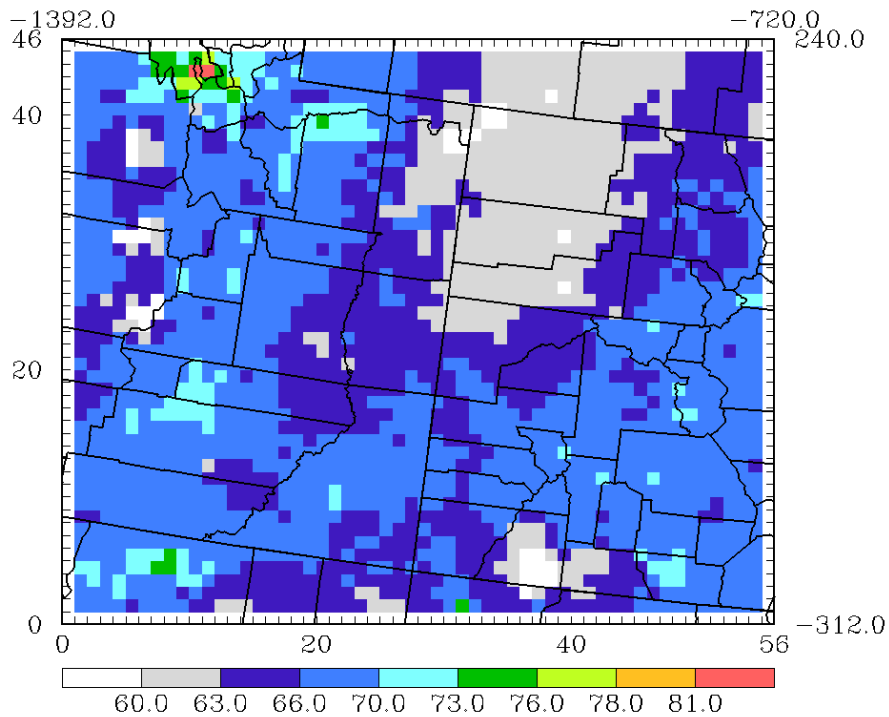
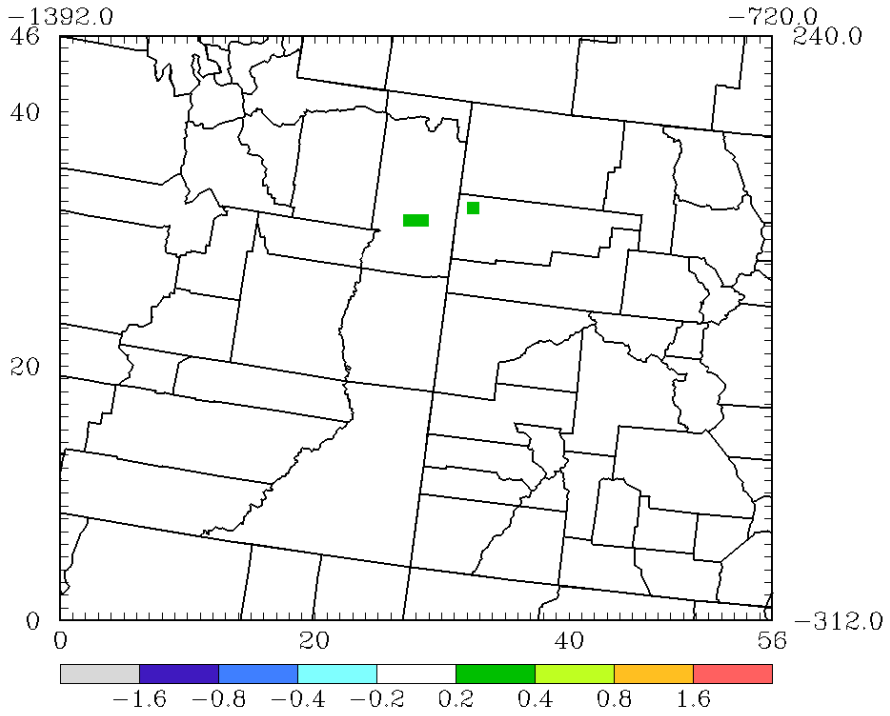


Figure 5-3: Annual 8-hour Ozone Future year Design Values for 2018 Proposed Action with 70 ppb minimum threshold

2005



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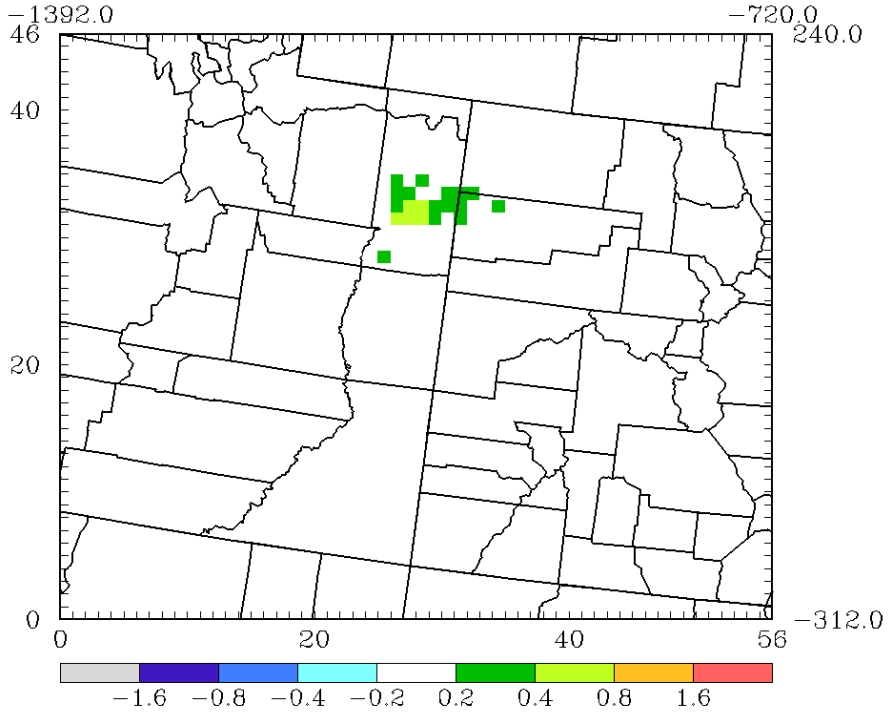
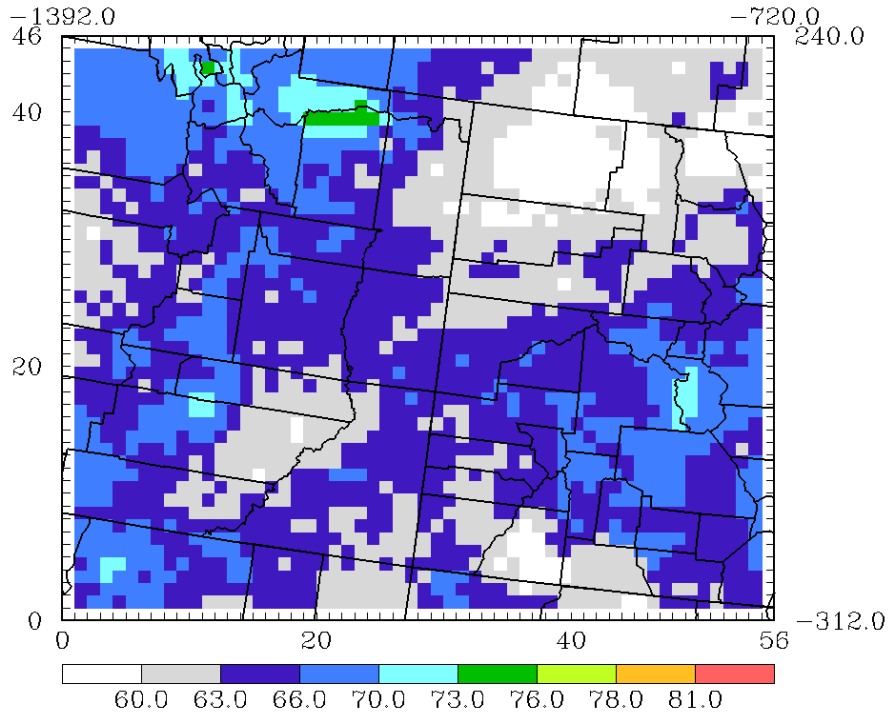


Figure 5-4: Annual 8-hour Ozone Future Design Value Differences for Proposed Action Minus 2018 Future Year Base Case with 70 ppb minimum threshold

2005



2006

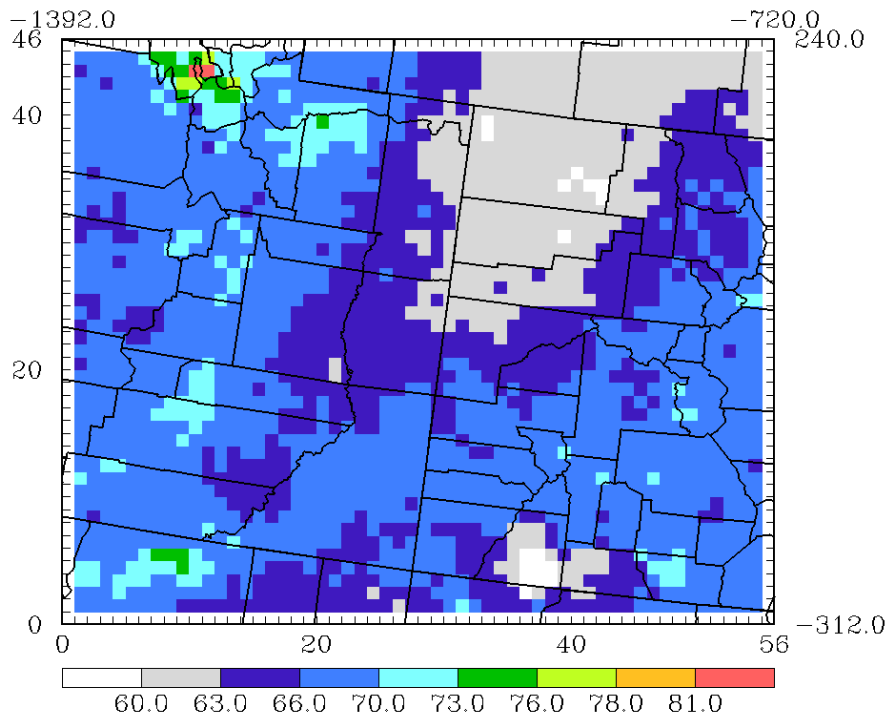
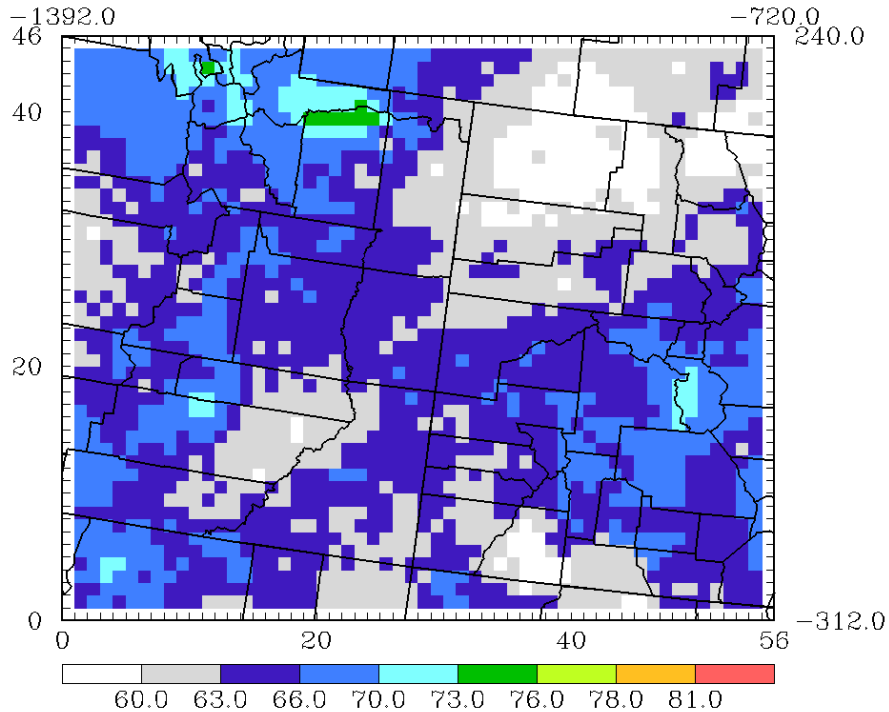


Figure 5-5: Annual 8-hour Ozone Future year Design Values for 2018 Future Year Base Case Projected Baseline with 60 ppb minimum threshold

2005



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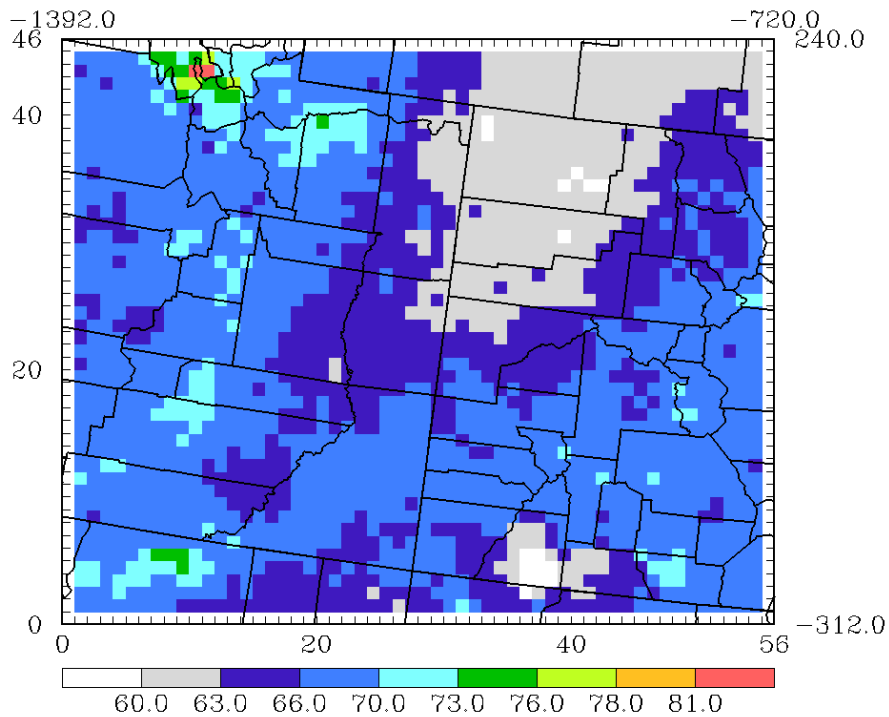
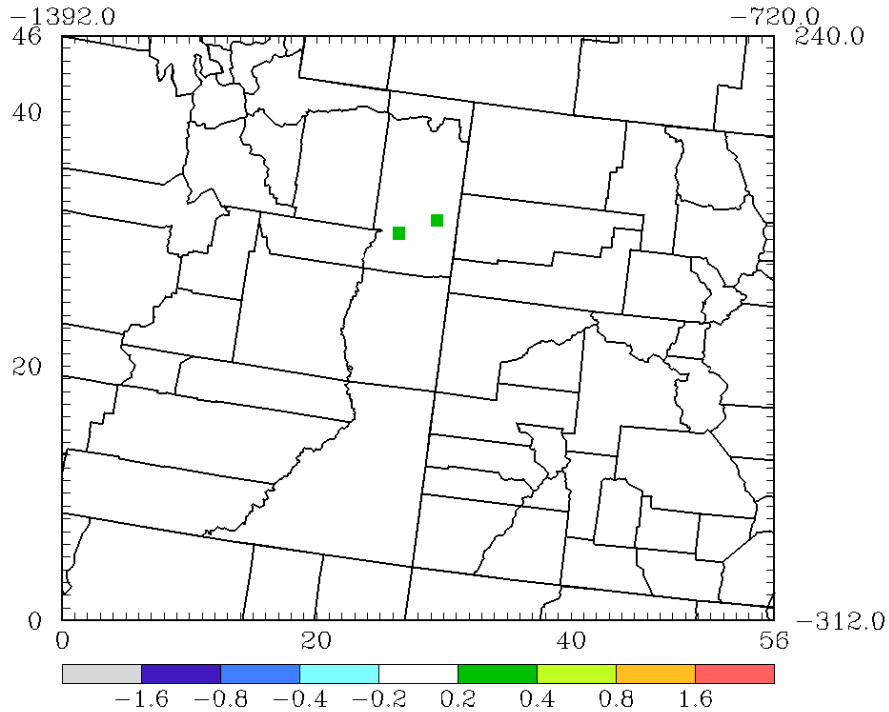


Figure 5-6: Annual 8-hour Ozone Future year Design Values for 2018 Proposed Action with 60 ppb minimum threshold

2005



2006

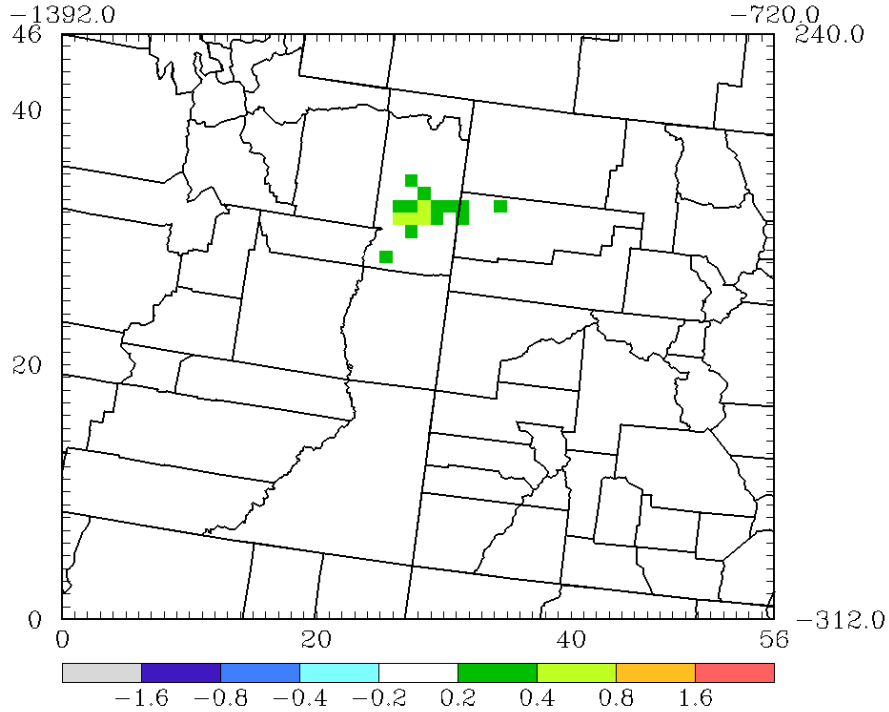
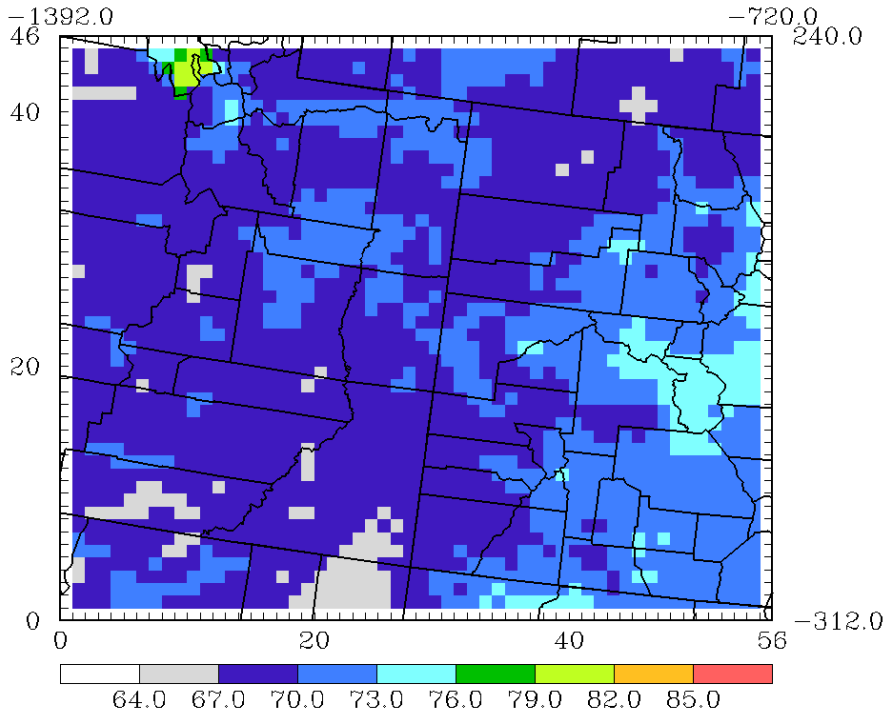


Figure 5-7: Annual 8-hour Ozone Future Design Value Differences for Proposed Action Minus 2018 Future Year Base Case with 60 ppb minimum threshold

2005



2006

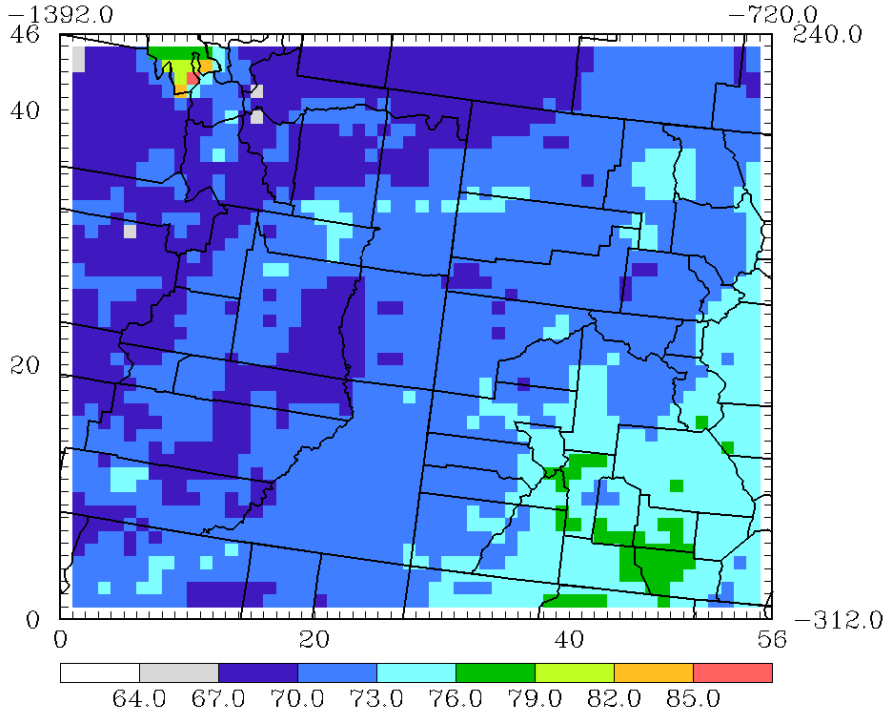
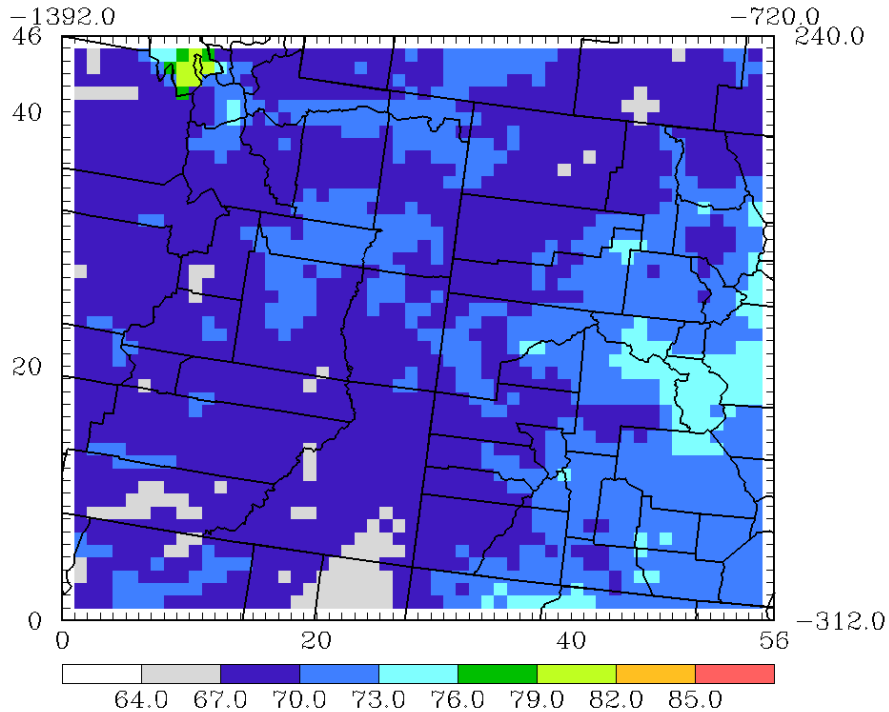


Figure 5-8: Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration for 2018 Future Year Base Case

2005



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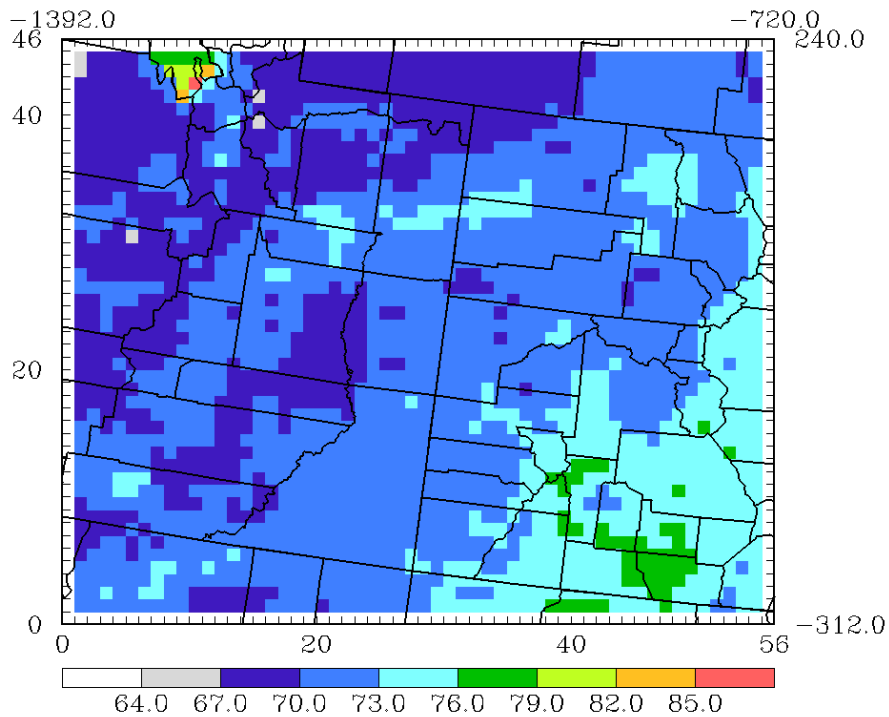
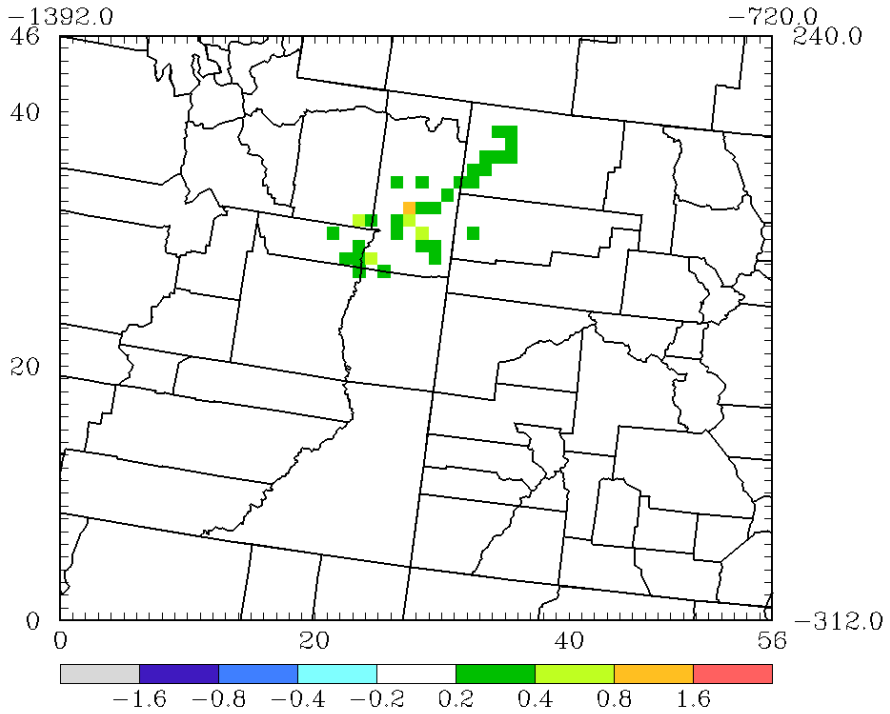


Figure 5-9: Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration for 2018 Proposed Action

2005



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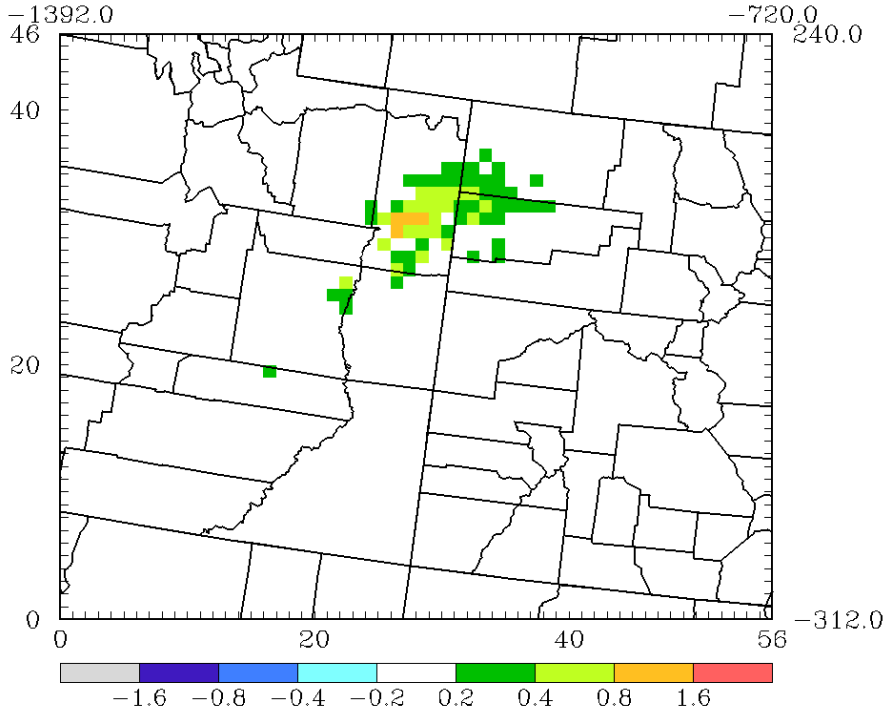

Figure 5-10: Difference in Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration (ppb) for Future Year Base Case Minus 2018 Proposed Action

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APPENDIX H-2

Memorandum to Update the Ozone Impact Assessment for XTO Energy's River Bend Unit Natural Gas Development Project

Alpine Geophysics, LLC

Memo

To: Daniel Pring, Doug Henderer

From: Dennis McNally

CC: Cyndi Loomis

Date: July 8, 2012

Re: XTO RBU August 2011 Modeling Results

At the request of Kleinfelder, Alpine Geophysics has completed a reanalysis of the XTO River Bend Unit (RBU) project impacts under an alternative emissions scenario. The modeling approach, save the emissions rates, and analyses are contained in the "Ozone Impact Assessment for XTO River Bend Unit Natural Gas Development Project Environmental Impact Statement" report dated May 2010.

For this analysis the emission rates were altered to reflect a higher level of applicant committed measures. The NOx emissions were adjusted from 935.97 tons/year to 585.74 tons/year and the VOC emissions were reduced from 12,173.94 tons/year to 5,174.46 tons/year.

Table **Error! No text of specified style in document.**-1. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for the 2018 Future Year Base Case case, 2018 Proposed Action, and August 2011 scenarios for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157	60.4	0.9155
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700	56.8	0.8699
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317	66.4	0.9316
80770020	CO	Palisade-Water	70.0	64.3	0.9187	64.3	0.9190	64.3	0.9188
80771001	CO	Colorado NM	69.0	62.7	0.9094	62.7	0.9095	62.7	0.9094
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185	61.8	0.9184
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150	70.4	0.9149
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300	66.0	0.9299
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642	69.1	0.8641
490350003	UT	SaltLake0003	80.0	72.5	0.9074	72.5	0.9074	72.5	0.9074
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877	63.0	0.7876
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986	69.1	0.8985
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258	64.4	0.8257
490353008	UT	SaltLake3008	78.0	66.5	0.8529	66.5	0.8529	66.5	0.8529
490370101	UT	SanJuan0101	71.0	62.2	0.8763	62.2	0.8764	62.2	0.8763
490471002	UT	Dinosaur NM	65.0	59.2	0.9110	59.2	0.9115	59.2	0.9112
490490002	UT	Utah0002	73.0	64.7	0.8867	64.7	0.8868	64.7	0.8867
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991	67.4	0.8990
490495010	UT	Utah5010	76.0	65.9	0.8677	65.9	0.8677	65.9	0.8677
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554	66.7	0.8553
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554	67.5	0.8553
Black_CnNP	CO	Black_CnNP	74.0	67.2	0.9090	67.2	0.9090	67.2	0.9089
Cent_WY	WY	Cent_WY	68.0	63.0	0.9265	63.0	0.9265	63.0	0.9265
EnCanaCyn	CO	EnCanaCyn	68.0	62.5	0.9195	62.5	0.9200	62.5	0.9198
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310	63.2	0.9308
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443	63.9	0.9441
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160	64.1	0.9158
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332	71.8	0.9331
USFS_Bell	CO	Garfield	70.5	63.0	0.8947	63.0	0.8950	63.0	0.8948
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258	61.0	0.9257
Vernal	UT	Vernal	68.9	64.1	0.9304	64.1	0.9304	64.0	0.9303

Table5-2. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for the 2018 Future Year Base Case case, 2018 Proposed Action, and August 2011 scenarios for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067	59.8	0.9065
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211	51.8	0.9210
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126	63.8	0.9125
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079	62.6	0.9078
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070	65.5	0.9069
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162	73.2	0.9161
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909	71.2	0.8908
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843	68.0	0.8842
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537	66.5	0.8536
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188	71.6	0.9187
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032	64.1	0.9030
490471002	UT	Dinosaur NM	65.0	59.4	0.9152	59.6	0.9173	59.5	0.9164
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931	65.1	0.8930
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839	67.1	0.8838
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069	70.7	0.9068
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069	71.6	0.9068
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240	68.3	0.9239
Cent_WY	WY	Cent_WY	68.0	64.3	0.9461	64.3	0.9464	64.3	0.9463
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135	62.1	0.9134
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093	61.8	0.9092
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331	63.1	0.9330
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247	64.7	0.9246
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108	64.2	0.9107
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521	62.8	0.9520
Vernal	UT	Vernal	68.9	63.6	0.9244	63.7	0.9258	63.7	0.9251

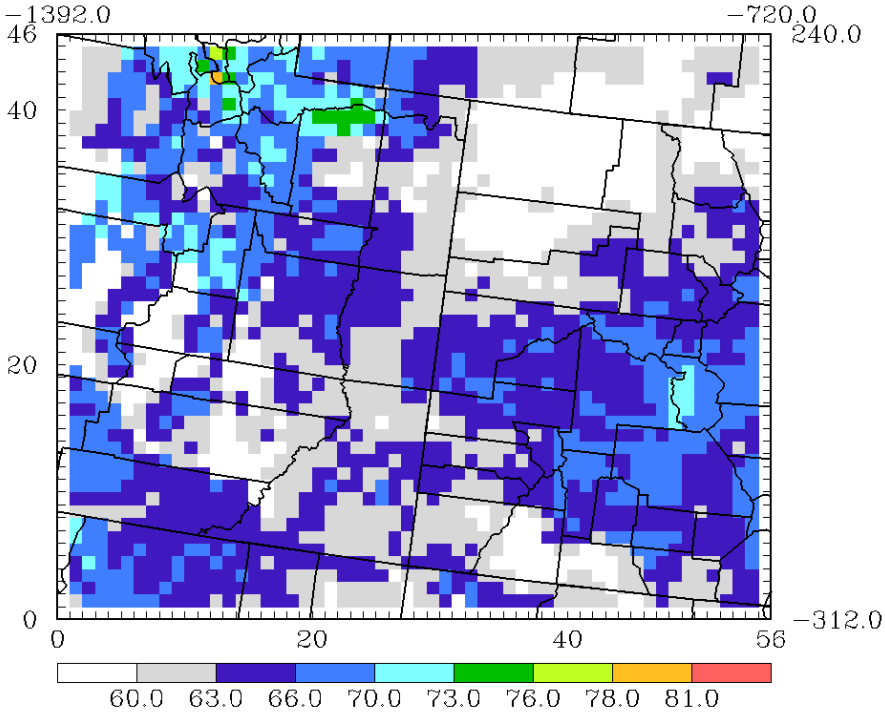
Table 5-3. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for the 2018 Future Year Base Case case, 2018 Proposed Action, and August 2011 scenarios for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157	60.4	0.9155
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700	56.8	0.8699
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317	66.4	0.9316
80770020	CO	Palisade-Water	70.0	64.7	0.9254	64.7	0.9256	64.7	0.9255
80771001	CO	Colorado NM	69.0	62.4	0.9049	62.4	0.9050	62.4	0.9049
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185	61.8	0.9184
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150	70.4	0.9149
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300	66.0	0.9299
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642	69.1	0.8641
490350003	UT	SaltLake0003	80.0	72.5	0.9066	72.5	0.9066	72.5	0.9066
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877	63.0	0.7876
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986	69.1	0.8985
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258	64.4	0.8257
490353008	UT	SaltLake3008	78.0	69.1	0.8862	69.1	0.8862	69.1	0.8862
490370101	UT	SanJuan0101	71.0	64.7	0.9120	64.7	0.9121	64.7	0.9120
490471002	UT	Dinosaur NM	65.0	59.8	0.9201	59.8	0.9212	59.8	0.9205
490490002	UT	Utah0002	73.0	64.7	0.8874	64.7	0.8874	64.7	0.8874
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991	67.4	0.8990
490495010	UT	Utah5010	76.0	66.9	0.8811	66.9	0.8811	66.9	0.8811
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554	66.7	0.8553
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554	67.5	0.8553
Black_CnNP	CO	Black_CnNP	74.0	68.4	0.9253	68.4	0.9253	68.4	0.9253
Cent_WY	WY	Cent_WY	68.0	64.2	0.9443	64.2	0.9443	64.2	0.9443
EnCanaCyn	CO	EnCanaCyn	68.0	62.8	0.9243	62.8	0.9246	62.8	0.9244
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310	63.2	0.9308
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443	63.9	0.9441
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160	64.1	0.9158
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332	71.8	0.9331
USFS_Bell	CO	Garfield	70.5	65.0	0.9225	65.0	0.9226	65.0	0.9225
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258	61.0	0.9257
Vernal	UT	Vernal	68.9	63.4	0.9214	63.4	0.9214	63.4	0.9213

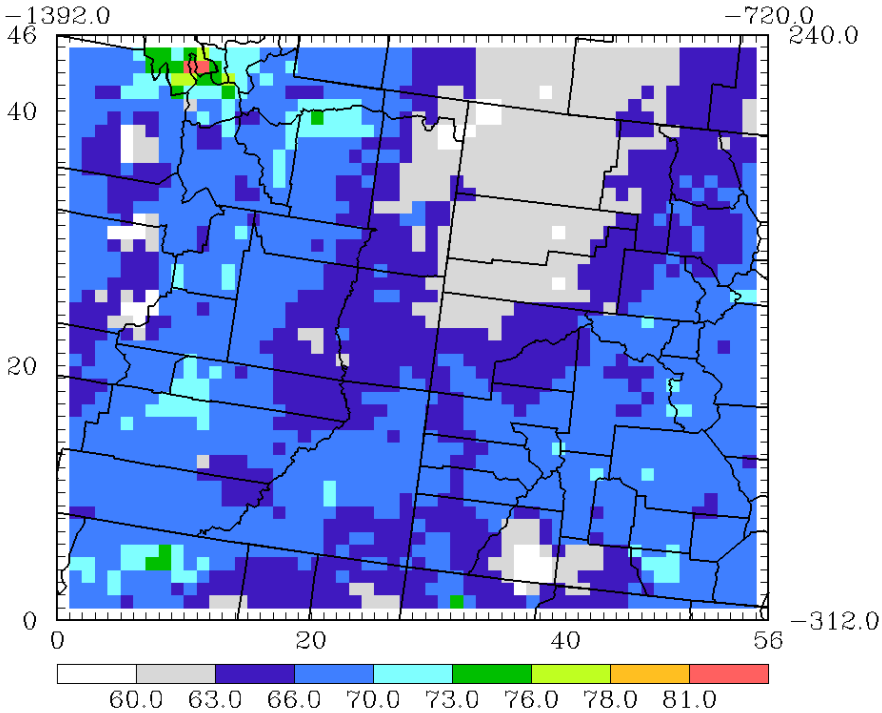
Table 5-4. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067	59.8	0.9065
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211	51.8	0.9210
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126	63.8	0.9125
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079	62.6	0.9078
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070	65.5	0.9069
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162	73.2	0.9161
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909	71.2	0.8908
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843	68.0	0.8842
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537	66.5	0.8536
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188	71.6	0.9187
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032	64.1	0.9030
490471002	UT	Dinosaur NM	65.0	59.6	0.9173	59.7	0.9194	59.6	0.9184
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931	65.1	0.8930
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839	67.1	0.8838
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069	70.7	0.9068
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069	71.6	0.9068
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240	68.3	0.9239
Cent_WY	WY	Cent_WY	68.0	62.1	0.9133	62.1	0.9135	62.1	0.9133
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135	62.1	0.9134
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093	61.8	0.9092
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331	63.1	0.9330
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247	64.7	0.9246
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108	64.2	0.9107
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521	62.8	0.9520
Vernal	UT	Vernal	68.9	63.4	0.9206	63.4	0.9216	63.4	0.9211

2005

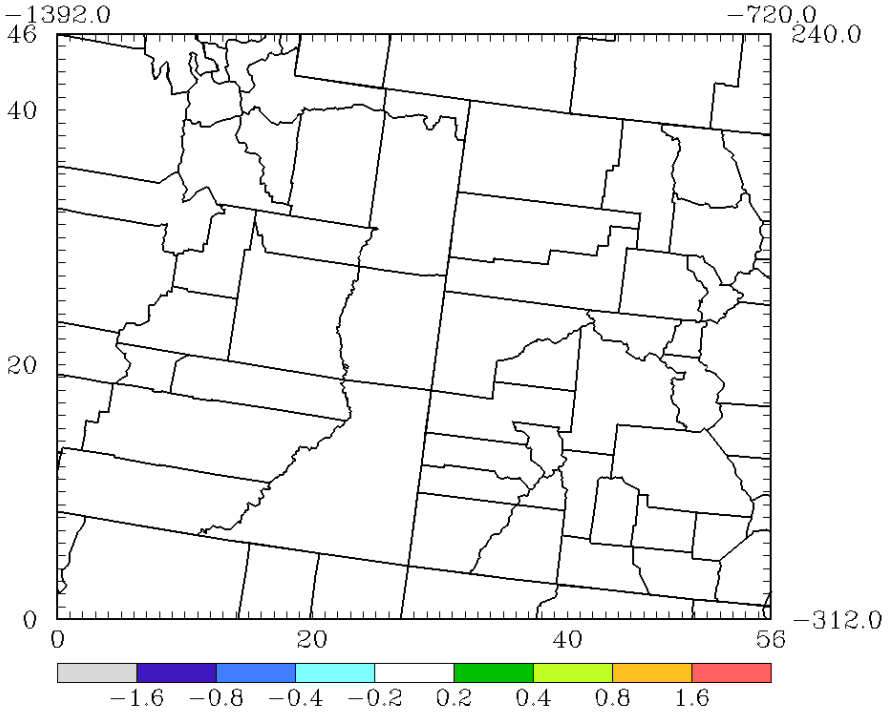


2006

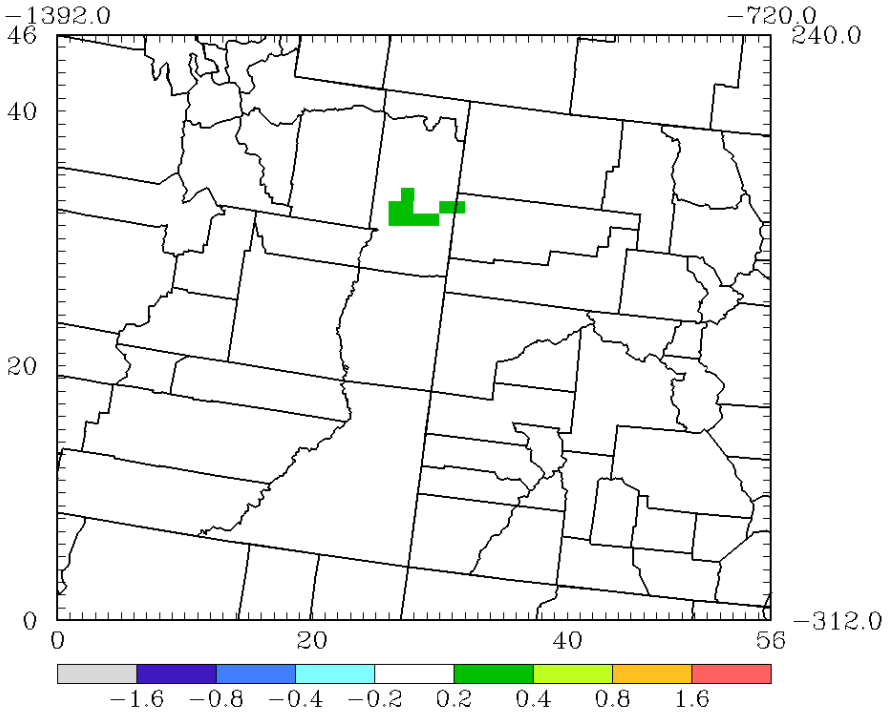


Annual 8-hour Ozone Future year Design Values for 2018 August 2011 scenario with 70 ppb minimum threshold. Analogous to Figure 5-3 in report.

2005

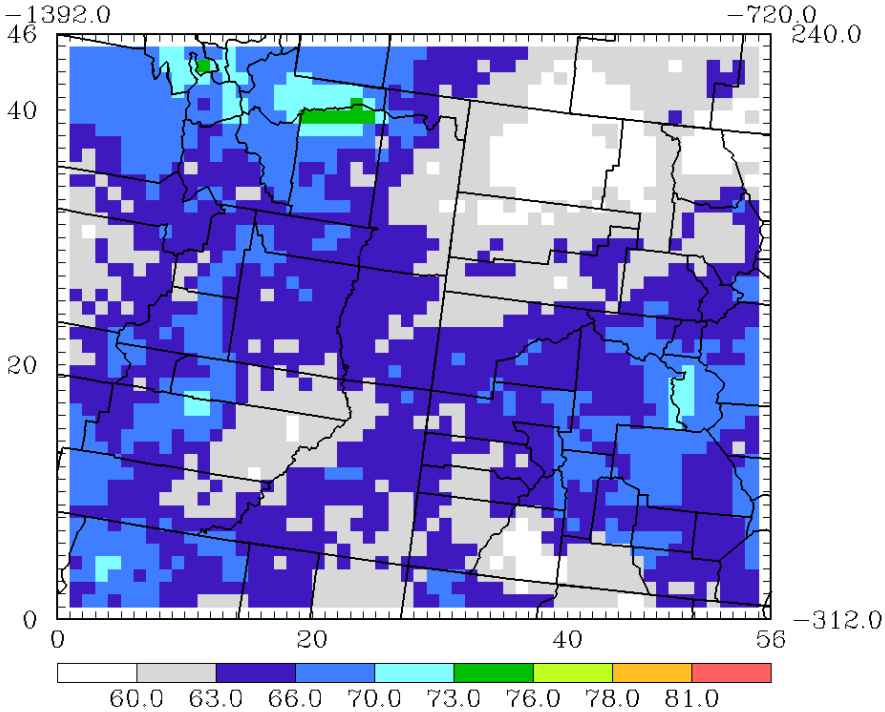


2006

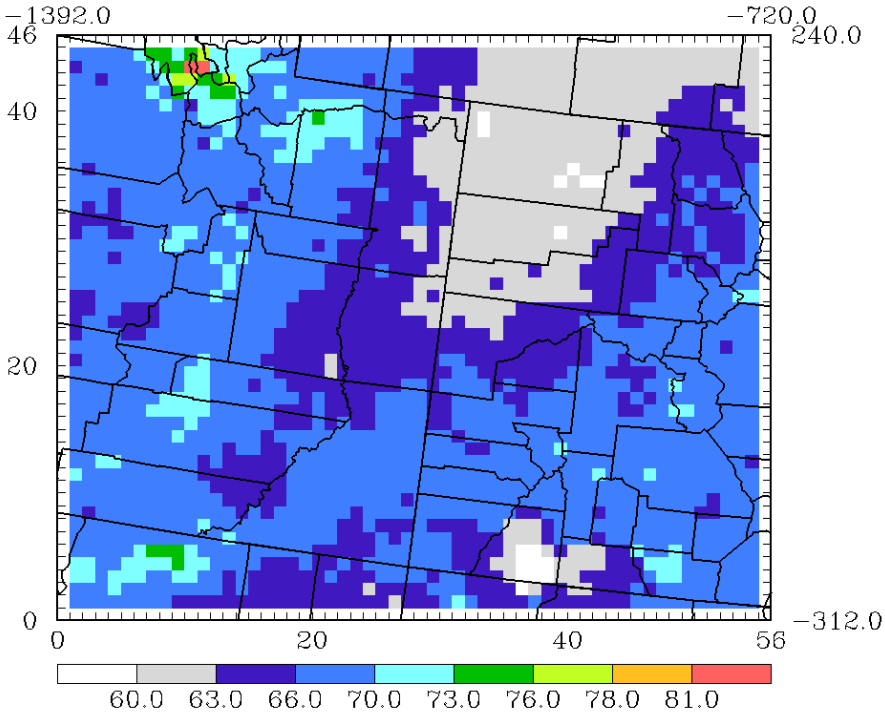


Annual 8-hour Ozone Future Design Value Differences for August 2011 scenario Minus 2018 Future Year Base Case with 70 ppb minimum threshold. Analogous to Figure 5-4 in report.

2005

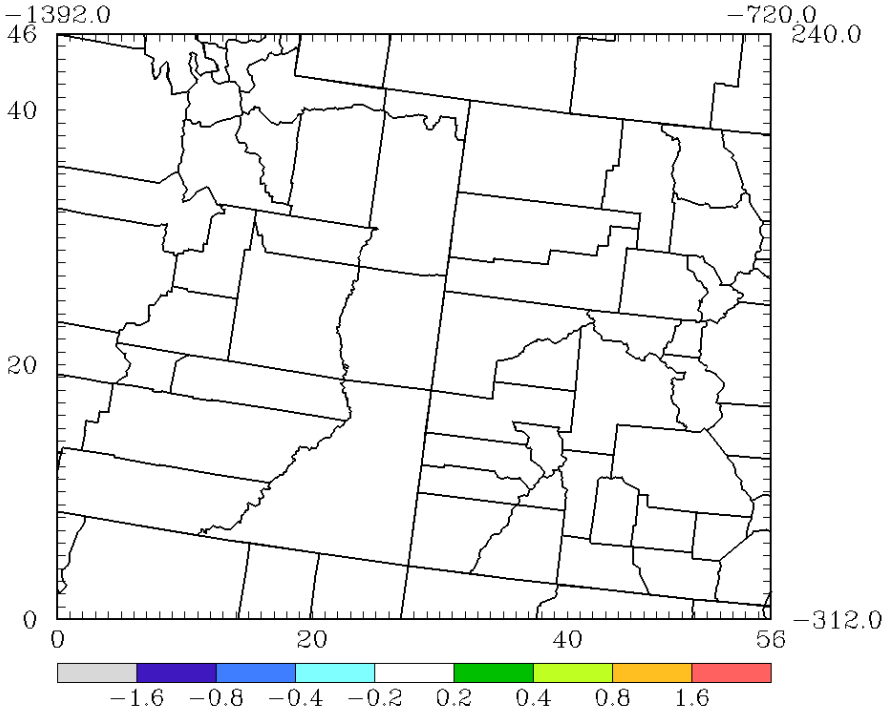


2006

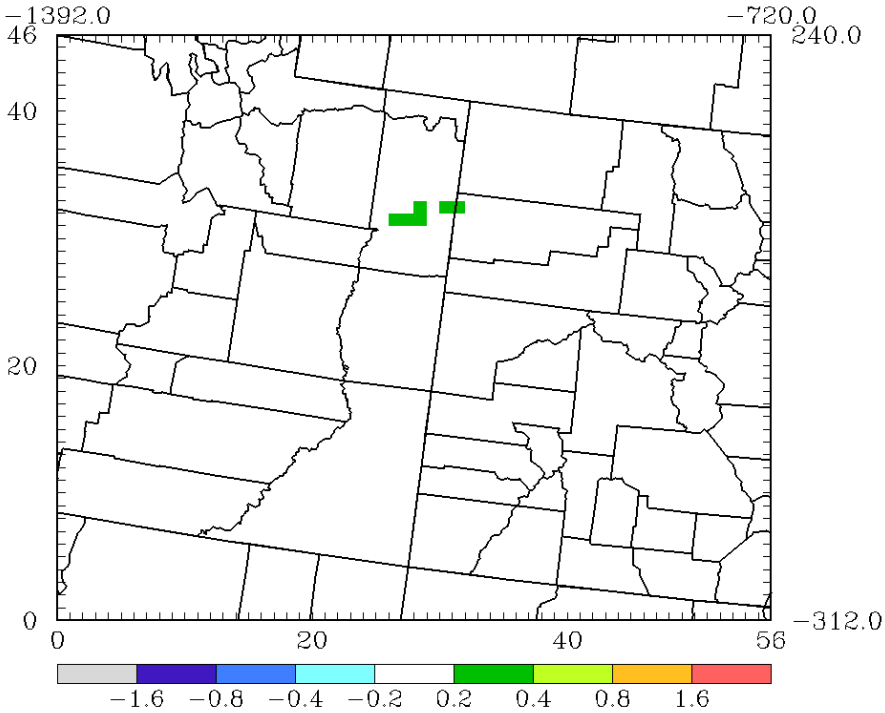


Annual 8-hour Ozone Future year Design Values for 2018 August 2011 Scenario with 60 ppb minimum threshold. Analogous to Figure 5.6 in the report.

2005

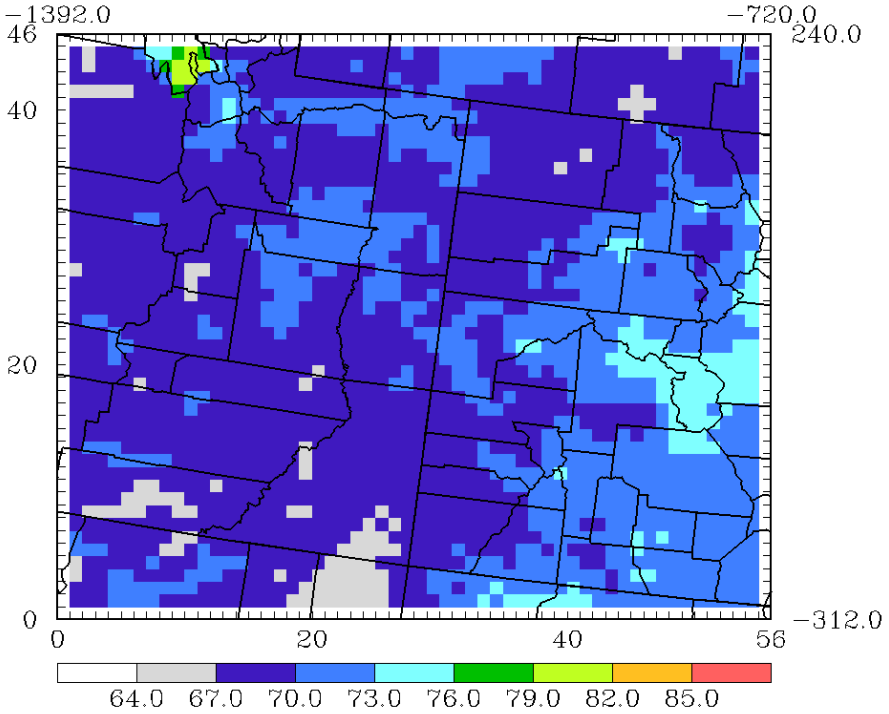


2006

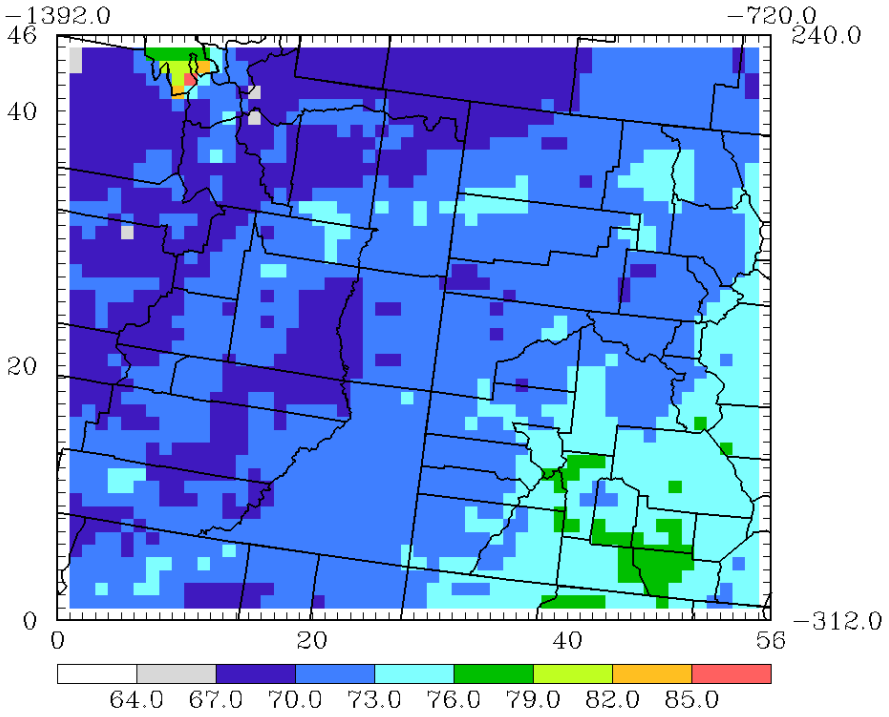


Annual 8-hour Ozone Future Design Value Differences for August 2011 scenario Minus 2018 Future Year Base Case with 60 ppb minimum threshold.

2005

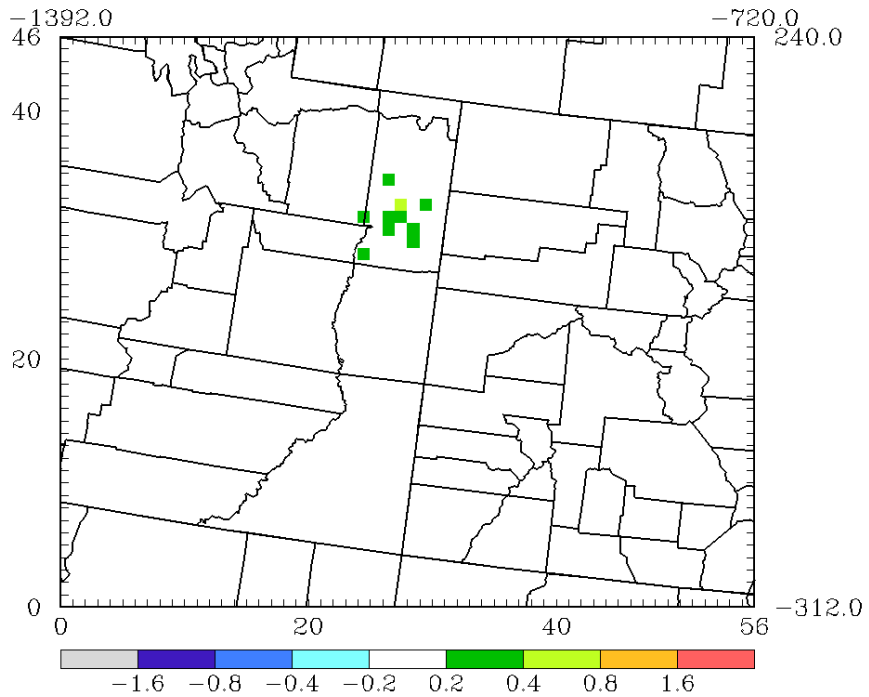


2006

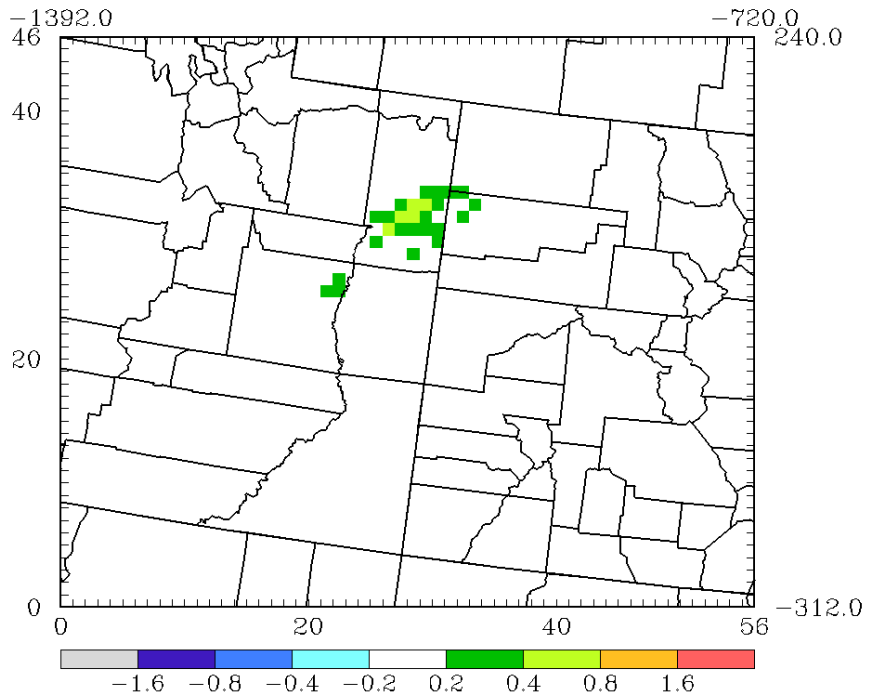


Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration for 2018 August 2011 scenario. Analogous to Figure 5-9 in the report.

2005



2006



Difference in Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration (ppb) for Future Year Base Case Minus 2018 August 2011 scenario. Analogous to Figure 5-10 in report.

Comparison of Difference in Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration (ppb) for Proposed Action and August 2011 Scenario.

Meteorological Year	Proposed Action	August 2011	Difference
2005	0.8	0.6	-0.2
2006	1.1	0.5	-0.6

APPENDIX I

Signed USFWS Biological Opinion

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District
Vernal Field Office
170 South 500 East
Vernal, UT 84078
http://www.blm.gov/ut/st/en/fo/vernal.html

IN REPLY REFER TO:
3160, 6841 (UTG010)

NOV 06 2012

Memorandum

To: Larry Crist
Utah Supervisor, Utah Field Office, Ecological Services,
U.S. Fish & Wildlife Services, Salt Lake City, Utah

From: for Michael G. Stiewig
Field Manager

Subject: Request to Initiate Formal Consultation on the XTO's Riverbend Unit Infill Development

Attached is the Biological Assessment (BA) for the XTO Energy's (XTO) Riverbend Unit (RBU) Infill Development EA. Pursuant with Section 7 of the Endangered Species Act (ESA) of 1973, and in conformance with 50 CFR Part 402.12, we are requesting initiation of Formal Section 7 consultation on federally listed species within the project area.

Background

XTO has proposed to expand gas production in the existing RBU Project Area through the use of vertical and directional drilling.

The EA has analyzed four alternatives: the No Action Alternative (Alternative B), the project proponent's Proposed Action Alternative (Alternative A), a **Moderate Recovery Alternative (Alternative C)**, and a Resource Protection Alternative (Alternative D). Alternative C has been designated as the Agency Preferred Alternative.

The Agency Preferred Alternative proposes the drilling of 250 new wells from 70 new well pads and 180 existing pads. Disturbance would include associated access roads, construction and production facilities, pipelines and electrical power lines. New surface disturbance under this alternative would be 923 acres.

Impacted Species

The following federally listed plant and animal species have been identified as being potentially impacted by the Agency Preferred Alternative:

Clay reed-mustard (*Schoenocrambe argillacea*) – **May Affect, Is Not Likely to Adversely Affect**
Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) – **May Affect, Is Likely to Adversely Affect**
Bonytail chub – **May Affect, Is Likely to Adversely Affect**
Colorado pikeminnow – **May Affect, Is Likely to Adversely Affect**
Humpback chub – **May Affect, Is Likely to Adversely Affect**
Razorback sucker – **May Affect, Is Likely to Adversely Affect**

Identified direct and indirect impacts, mitigation measures, and determinations are described within the Biological Assessment.

If you have any questions or need additional information, please contact Aaron Roe, Botanist, at (435) 781-4481 or Stephanie Howard, Environmental Coordinator, at (435) 781-4469.

Attachments: Biological Assessment

bcc: Central Files
Reading Files
Project File
UTG010: Aroe: ar: 10/31/12: 4481

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

In Reply Refer To:
FWS/R6
ES/UT
08-F-0026

January 29, 2013

Memorandum

To: Field Office Manager, Vernal Field Office, Bureau of Land Management, Vernal, Utah

From: for Utah Field Supervisor, Ecological Services, U.S. Fish and Wildlife Service, West Valley City, Utah

Subject: Final Biological Opinion for XTO Riverbend Unit Infill Development

In accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), this transmits our final biological opinion for impacts to the threatened *Sclerocactus wetlandicus*, and the endangered Colorado pikeminnow *(Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and bonytail (*Gila elegans*); including their designated critical habitat. We refer to your correspondence and biological assessment (BA) that we received on November 13, 2012, in which you requested formal consultation for this project.

Schoenocrambe argillacea was also analyzed within the BA. We concur that this project may affect, but is not likely to adversely affect this species based on the applicant-committed conservation measures included in the final BA. In particular, our concurrence is based on the fact that no development will occur within 300 feet of occupied habitat or avoidance areas. The only planned development in the Agency Preferred Alternative near potential habitat for *S. argillacea* is one well pad expansion, but this well pad is more than 300 feet away from potential habitat.

As stated below in our consultation history section for the Colorado River Fish Recovery Program, federal action agencies have come to anticipate Recovery Program activities and a requirement of a financial contribution (for new depletions greater than 100 acre-feet) and include paying this fee as part of their applicant committed conservation measures. This financial contribution is imperative in order to have the Recovery Program serve as the

Reasonable and Prudent Alternative for applicants' activities to avoid jeopardizing the 4 federally listed Colorado River fish species. Because payment of a water depletion fee is a required component to offset impacts to federally listed fish species, we recommend the applicant pay the water depletion fee expeditiously. Until the water depletion fee is paid in full, the Riverbend Unit Infill Development is not authorized to deplete water from the Green River Basin.

Consultation History

This section summarizes significant steps in the consultation process:

Colorado River Fish Recovery Program

On January 21-22, 1988, the Secretary of the Department of the Interior; the Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration signed a Cooperative Agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin"1 (Recovery Program). Since that time, the cooperators extended the Recovery Program with newly signed agreements twice: first in 2001, extending the Recovery Program until September 30, 2013[1]; and more recently in 2009, extending the Recovery Program to September 30, 2023[1]. The objective of the Recovery Program is to recover the listed species while water development continues in accordance with federal and state laws and interstate compacts.

In order to further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the Recovery Program, the cooperators developed a section 7 Agreement (Agreement) and a Recovery Implementation Program Recovery Action Plan (RIPRAP)[2]. The Agreement establishes a framework for conducting all future section 7 consultations on depletion impacts related to new projects and all impacts associated with historic projects in the Upper Basin. Procedures outlined in the Agreement are used to determine if sufficient progress is being accomplished in the recovery of the endangered fishes to enable the Recovery Program to serve as a reasonable and prudent alternative (RPA) to avoid jeopardy. The RIPRAP was finalized on October 15, 1993, and has been reviewed and updated annually[2].

In accordance with the 1993 Agreement, we annually assesses progress of the implementation of recovery actions to determine if progress toward recovery has been sufficient for the Recovery Program to serve as a RPA for projects that deplete water from the Colorado River. In the last review we determined that the Program has made sufficient progress to offset water depletions from individual projects up to 4,500 acre-feet/year[3]. Therefore, it is appropriate for the Recovery

1 Original Document and extensions are available online at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/cooperative-agreement.html
2 Originals and annual reviews are available online at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-action-plan.html
3 Sufficient progress determinations, including the 2009 determination, are available at: http://coloradoriverrecovery.org/documents-publications/section-7-consultation/sufficient-progress-letters.html

Program actions to serve as Conservation Measures in the project description for projects up to 4,500 acre-feet/year.

After many years of successful implementation of the Recovery Program and Agreement, federal action agencies have come to anticipate Recovery Program activities and a requirement of a financial contribution (for new depletions greater than 100 acre-feet) toward these activities serving as RPAs that must be included in their project planning to avoid jeopardy to listed species. Thus, the RPA has essentially become part of the proposed action. The Recovery Program activities will now serve as conservation measures within the proposed action and minimize adverse effects to listed species or critical habitat. The following excerpts summarize portions of the Recovery Program that address depletion impacts, section 7 consultation, and project proponent responsibilities:

> "All future section 7 consultations completed after approval and implementation of this program (establishment of the Implementation Committee, provision of congressional funding, and initiation of the elements) will result in a one-time contribution to be paid to the Service by water project proponents in the amount of $10.00 per acre-foot based on the average annual depletion of the project . . . This figure will be adjusted annually for inflation [the current figure is $19.82 per acre-foot] . . . Concurrently with the completion of the federal action which initiated the consultation, e.g., . . . issuance of a 404 permit, 10 percent of the total contribution will be provided. The balance . . . will be . . . due at the time the construction commences . . . ."

It is important to note that these provisions of the Recovery Program were based on appropriate legal protection of the instream flow needs of the endangered Colorado River fishes. The Recovery Program further states:

> ". . . it is necessary to protect and manage sufficient habitat to support self-sustaining populations of these species. One way to accomplish this is to provide long term protection of the habitat by acquiring or appropriating water rights to ensure instream flows. Since this program sets in place a mechanism and a commitment to assure that the instream flows are protected under State law, <u>the Service will consider these elements under section 7 consultation as offsetting project depletion impacts</u>."

<u>Chronology of recent events between Bureau of Land Management (BLM) and US Fish and Wildlife Service (Service) with regard to this section 7 consultation:</u>

- January 14, 2013; we received an email from the BLM with updated conservation measures for *Schoenocrambe argillacea.*
- November 13, 2012; we received the final BA.
- August 14, 2012; we met with the BLM to discuss the draft EA and we made a few minor comments that were incorporated in the BLM botanists' comments.

- April 7, 2008; we attended a BLM NEPA meeting to further discuss the project and impacts.
- December 3, 2007; we attended a BLM NEPA meeting to discuss the project and impacts.

A complete administrative record for this project is on file in our office.

Biological Opinion

I. DESCRIPTION OF PROPOSED ACTION

XTO proposes to develop natural gas resources in the River Bend Unit (RBU) project area. The project area is approximately 16,719 acres located within Uintah County, Utah (Figure 1). Surface ownership in the project area consists of 12,002 acres of BLM land, 4,075 acres of BIA land, and 642 acres of State land. Under the proposed action (agency-preferred Alternative C of the BA), XTO proposes to construct, drill, complete, and produce 250 new wells from 70 new well pads and 180 existing pads over 4 years. Disturbance will include associated access roads, pipelines, and power lines. New surface disturbance under this alternative will be 923 acres. The life of the project is expected to be up to 39 years.

Action Area

Our regulations define the action area as all areas directly or indirectly affected by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this consultation, we define the action area to encompass all of the project area proposed for well development including a 300 foot buffer surrounding these areas, and waterways downstream of the project area including the Green River within and outside of the project area.

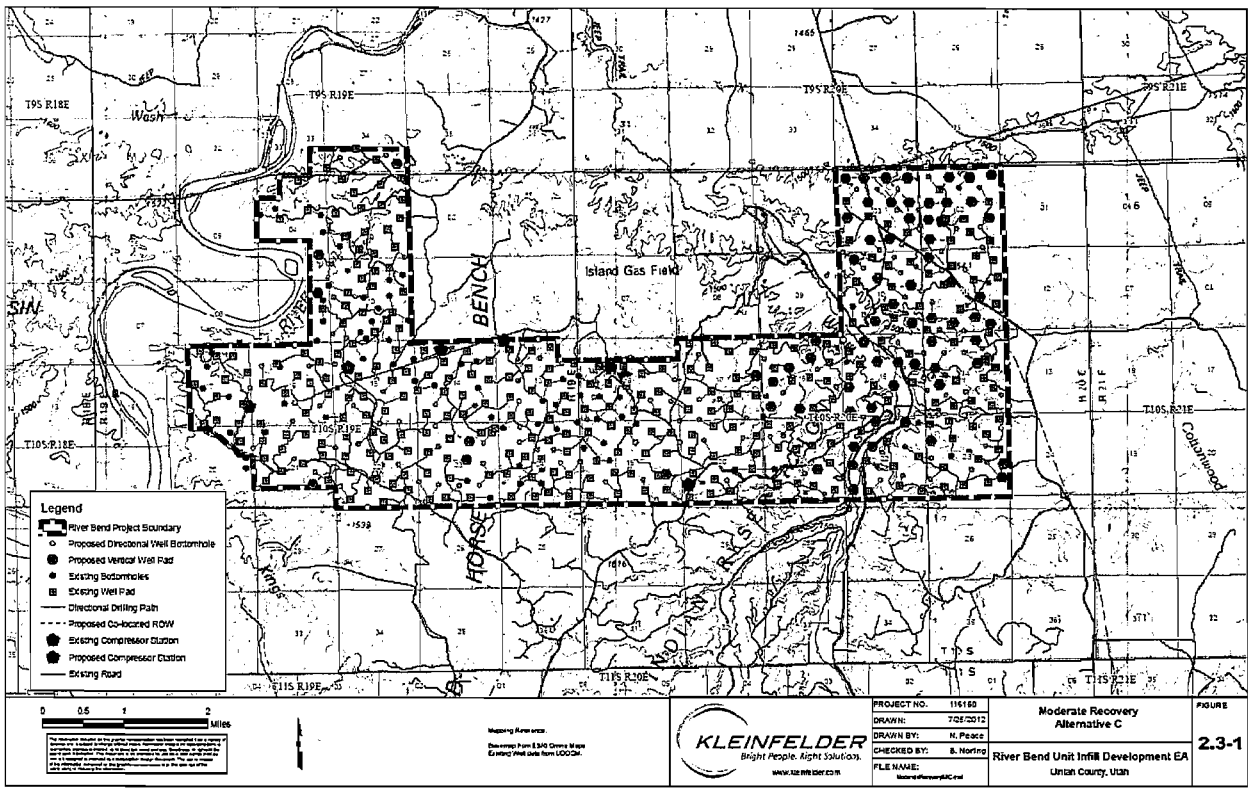


Figure 1. Figure 2.3-1 from the BA showing project area and proposed action.

Applicant Committed Conservation Measures

Conservation measures are actions that the action agency and applicant agree to implement to further the recovery of the species under review. The beneficial effects of conservation measures are taken into consideration for determining both jeopardy and incidental take analyses. The following sections list the applicable conservation measures for the federally-listed fish and plant species.

Sclerocactus wetlandicus

The following applicant-committed conservation measures in sections 2.1.11.2 and 4.1.1 will help minimize the impacts of the Proposed Action to *Sclerocactus wetlandicus*:

- Under the proposed action, no new surface disturbance[4] will occur within USFWS proposed level 1 or 2 core conservation areas for *Sclerocactus wetlandicus*. In addition, a

4 There will be no new surface disturbance within level 1 core conservation areas and there will be no new well pads within level 2 core conservation areas. New surface disturbance within level 2 core conservation areas will be limited to expansion of 3 well pads.

minimum 300-foot buffer will be maintained between the edge of new surface disturbance and identified populations of *S. wetlandicus*.

- As required by the Endangered Species Act of 1973 (ESA), as amended, no activities will be permitted that will jeopardize the continued existence of threatened or endangered plant species.
- Prior to any surface-disturbing activities on federal and non-federal lands that contain potential habitat for the Uinta Basin hookless cactus and clay-reed mustard, a BLM-approved botanist will survey proposed development sites plus a 300-foot avoidance buffer. If individuals of these species are present, XTO will implement appropriate avoidance or mitigation measures, including relocation of the proposed well pad construction/expansion or pipeline and/or design modifications to limit the potential impacts to these plants and their habitat. Specific details regarding avoidance and mitigation measures are included in **Appendix B** – Conservation Measures for Special Status Plant Species. All surveys will be conducted within the proper seasonal timeframe, as determined by the AO of the appropriate SMA and USFWS.
- Removal and disturbance of vegetation will be kept to a minimum through construction site management (e.g., using previously disturbed areas and existing easements where feasible, placing pipelines adjacent to roads, limiting well pad expansion, etc.). In addition, all areas not utilized for the operational phase of the project will be reclaimed.
- In an effort to ensure that project activities do not increase the existence of invasive or noxious weeds in the RBU Project Area, XTO will prepare a Weed Control Plan. Specific components of the plan will include:

    a. Conducting individual noxious weed inventories on a well by well basis prior to construction activities. The inventories will include examination of all proposed surface disturbance (i.e., roads, pipelines, and well pads) associated with each well. The results of these inventories will include GPS locations indicating the type and size of each infestation. This data will be formulated into a report and submitted with the associated APD.

    b. Preparing a Pesticide Use Proposal.

    c. Following the construction phase and drilling phase for each well, all disturbed surfaces will be monitored annually for the presence of noxious weeds. If monitoring shows increases in presence of noxious weeds, XTO will be responsible for treating these areas. Noxious plant control measures (mechanical, cultural, chemical) will be conducted before seed set annually. Monitoring and treatment will be conducted annually until reclamation and weed ratification was deemed successful by the AO of the appropriate SMA.

    d. All herbicide chemical control will be in conformance with national and local guidance, including approved chemicals, rates, and appropriated best management practices.

    e. To prevent further spread of noxious weeds, all vehicles and equipment will be power washed at designated washing locations to remove seed and plant materials before entering the RBU Project Area from outside of the Uinta Basin.
- Removal and disturbance of vegetation will be kept to a minimum through construction site management (for example, using previously disturbed areas and existing easements

where feasible). In addition, all areas not utilized for the operational phase of the project will be reclaimed.

- Preparation of a weed control plan, including noxious weed inventories and a pesticide use proposal.
- All surface disturbance will be monitored annually and treated as necessary for the presence of noxious weeds.

Colorado River Endangered Fishes

The following applicant-committed conservation measures, found in section 2.1 and 2.1.11.1 of the BA, will help minimize the impacts of the Proposed Action to the four Colorado River endangered fishes:

- No new surface disturbance will occur within mapped 100-year floodplains.
- To avoid entrainment pumping will occur from an off-channel location – one that does not connect to the river during high spring flows. The infiltration gallery will be constructed in a Service-approved location.
- Pump heads located in the river channel will be located in areas of high water velocity, avoiding low-flow or no-flow area as these habitats tend to concentrate larval fishes.
- Pumping will be limited to the greatest extent possible during that period of the year when larval fish may be present (April 1 to August 31). Pumping will be limited to the greatest extent possible during the midnight hours (10pm to 2 am), to avoid impacts to larval fish populations, and conducted at dusk as larval drift abundance is lowest during this time.
- All pump intakes will be screened with 3/32 inch mesh material.
- Approach velocities for intake structures will follow the National Marine Fisheries Service's document "Fish Screening Criteria for Anadromous Salmonids", and will not exceed 0.33 feet per second (ft/s).
- Any fish impinged on the intake screen or entrained into irrigation canals will be reported to the Service (801-975-3330) and the Utah Division of Wildlife Resources:

  Northeastern Region
  152 East 100 North
  Vernal, UT 84078
  Phone: (435) 781-9453
- To prevent the potential contamination of fish habitat from spills of petroleum products, XTO will utilize closed-loop drilling techniques for all proposed wells located in the 100-year floodplain of Willow Creek and in all named drainages within five miles of the Green River.

XTO also agrees to have the Upper Colorado River Recovery Program (Recovery Program) serve as a conservation measure within the proposed action. The following paragraphs further clarify the Recovery Program's role:

In determining if sufficient progress has been achieved under the Recovery Program, we consider--a) actions which result in a measurable population response, a measurable improvement in habitat for the fishes, legal protection of flows needed for recovery, or a reduction in the threat of immediate extinction; b) status of fish populations; c) adequacy of flows; and, d) magnitude of the Project impact. In addition, we consider support activities (funding, research, information, and education, etc.) of the Recovery Program if they help achieve a measurable population response, a measurable improvement in habitat for the fishes, legal protection of flows needed for recovery, or a reduction in the threat of immediate extinction. We evaluate progress separately for the Colorado River and Green River Subbasins; however, it gives due consideration to progress throughout the Upper Basin in evaluating progress toward recovery.

Water depletion impacts can be offset by: a) the water project proponent's one-time contribution to the Recovery Program in the amount of $19.82 per acre-foot of the Project's average annual depletion; b) appropriate legal protection of instream flows pursuant to State law; and, c) accomplishment of activities necessary to recover the endangered fishes as specified under the RIPRAP. We believe it is essential that protection of instream flows proceed expeditiously, before significant additional water depletions occur. As the project's peak annual new depletion of 175acre-feet is below the current sufficient progress threshold of 4,500 acre-feet, Recovery Program activities will serve as the conservation measures to minimize adverse effects to the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail and destruction or adverse modification of critical habitat caused by the project's new depletion.

With respect to (a) above (i.e., depletion charge), XTO will make a one-time payment which has been calculated by multiplying the Project's peak annual depletion (175 acre-feet) by the depletion charge in effect at the time payment is made. For Fiscal Year 2013 (October 1, 2012, to September 30, 2013), the depletion charge is $19.82 per acre-foot for the average annual depletion which equals a total payment of **$3,468.50** for this Project. The total payment will be provided to the Service's designated agent, the National Fish and Wildlife Foundation (Foundation), at the time of issuance of the federal approvals from the BLM, with the rest to be paid when construction commences. Fifty percent of the funds will be used for acquisition of water rights to meet the instream flow needs of the endangered fishes (unless otherwise recommended by the Implementation Committee); the balance will be used to support other recovery activities for the Colorado River endangered fishes. All payments should be made to the National Fish and Wildlife Foundation.

National Fish and Wildlife Foundation
1133 15th Street, NW
Suite 1100
Washington, DC 20005

The payment is to be accompanied by a cover letter that identifies the Project and biological opinion that requires the payment, the amount of payment enclosed, check number, and any

special conditions identified in the biological opinion relative to disbursement or use of the funds (there are none in this instance). A copy of the cover letter and of the check is to be sent directly to our office. The cover letter shall identify the name and address of the payer, the name and address of the federal agency responsible for authorizing the project, and the address of the Service office issuing the biological opinion. This information will be used by the Foundation to notify the payer, the lead federal agency, and the Service that payment has been received. The Foundation is to send notices of receipt to these entities within 5 working days of its receipt of payment.

II. STATUS OF THE SPECIES/CRITICAL HABITAT

The purpose of this section is to summarize the best available information regarding the current range wide status of the listed fish and plant species. Additional information regarding listed species may be obtained from the sources of information cited for these species[5].

Sclerocactus wetlandicus

Sclerocactus glaucus (Uinta Basin hookless cactus), which included three identified subpopulations, was listed as a threatened species in 1979 (44 FR 58870). The decision to separate *S. glaucus* into three species is supported by recent genetic studies (Porter et al. 2000), common garden experiments (Welsh et al. 2003), and a reevaluation of morphological characteristics (Heil and Porter 2004). We currently recognize *S. glaucus* as three distinct species: *S. brevispinus* (Pariette cactus), *S. glaucus* (Colorado hookless cactus), and *S. wetlandicus* (Uinta Basin hookless cactus). These three species retain their threatened status (74 FR 47112, September 15, 2009).

Below we discuss the status of *Sclerocactus wetlandicus* and new biological information as it pertains to the proposed project. Additional information on this species' life history, population dynamics, status, and distribution is described in detail within the "Recovery Plan for the Uinta Basin Hookless Cactus" (Service 1990a) and the more recent recovery outline (Service 2010a).

Sclerocactus wetlandicus is typically found on coarse soils derived from cobble and gravel stream terrace deposits, or rocky surfaces on mesa slopes at 1,350 to 1,900 meters (4,400 to 6,200 feet) elevation (Service 1990a; Heil and Porter 2004). Other habitat types recognized for this species include desert pavement, white or gray shale, and tan shale with near complete dominance by *Ephedra torreyana* (Torrey ephedra) (SWCA 2011; Glisson 2011).

Flowers of *S. wetlandicus* typically open in mid-day and close late in the afternoon for three to five days (Tepedino et al. 2010). A broad assemblage of native, ground-nesting bees, mostly from the family Halictidae (Tepedino et al. 2010), pollinate *S. wetlandicus*. These bees can

5 The latest recovery goals for *Sclerocactus wetlandicus* and all four endangered fish, which provide information on species background, life history, and threats, can be found on the internet at: http://www.fws.gov/mountain-prairie/species/plants/UintaBasinHooklessCactus/index.html and http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-goals.html

travel from 0.4 to 1 km between plants (Tepedino pers. comm. 2010). Other insects, including ants and beetles, may also pollinate *S. wetlandicus* (Service 1990a). Limiting the amount of fragmentation and disturbance within the habitats of *S. wetlandicus* is important to maintain adequate pollinator habitats and healthy cactus populations.

About four to five weeks after flowering, the fruits of *Sclerocactus wetlandicus* reach maturity, each containing approximately 20 seeds (Tepedino et al. 2010). The fruits open and fall away, leaving the seeds on the apex of the plant where they are washed to the ground and dispersed by rain (Tepedino et al. 2010). The life history and population dynamics of these species are poorly known, but they are thought to be long-lived perennials, usually flowering after 3 or 4 years.

In 2010, we developed a potential habitat polygon for *Sclerocactus wetlandicus* to better illustrate the species' distribution and abundance. Although both *Sclerocactus* species' populations can be found outside of these areas, they tend to occur in greater numbers and at higher densities within the polygons. This polygon is updated annually and was last updated in March 2012 (Service 2012).

The total area of potential habitat for *Sclerocactus wetlandicus* is currently 435,379 acres and includes federal, tribal, state, and private lands. Our most current geographic data for *S. wetlandicus* includes over 21,142 points representing approximately 48,048 individual cacti (BLM 2012). These numbers include living and dead plants, but do not include hybrids of *S. wetlandicus* and *S. brevispinus* which occur outside of the action area where these two species overlap. Based on recent survey data (BLM 2012) and extrapolation to unsurveyed, suitable habitat, we predict the total count for *S. wetlandicus* is at least 50,000.

We do not have population trend data for *Sclerocactus wetlandicus*. However, as described below, the high levels of energy development result in the loss and fragmentation of habitat for these species across their range. Thus, we conclude it is likely that this species and its available habitat are declining.

Habitat loss and fragmentation associated with energy development is a major threat to this species across its known range. There are 4,880 oil and gas well locations (not including directional or horizontal wells) within the *Sclerocactus wetlandicus* potential habitat polygon (Utah Division of Oil, Gas, and Mining [UDOGM] 2013). If we estimate 5 acres of disturbance per well site (at 40 acre spacing) and associated roads, then at least 24,400 acres (6 percent) of the *S. wetlandicus* potential habitat polygon is directly impacted by energy development facilities. Indirect disturbances are much greater and can extend 400 meters from the disturbance based on impacts to the species' pollinators and their habitats (Tepedino et al. 2010). We estimate that 35 percent of potential habitat across the range of *S. wetlandicus* is impacted through direct and indirect disturbance due to oil and gas development.

In addition to existing development, approximately two-thirds of the potential habitat polygon for *Sclerocactus wetlandicus* is leased for oil and gas development. At least 17,000 wells are

planned for development in the Uinta Basin in the next 15 years, and thus the amount of surface disturbance across *Sclerocactus* habitat can be expected to increase substantially.

There are two levels at which oil and gas development impact *Sclerocactus wetlandicus*: 1) on a localized level within the immediate proximity of known cactus locations, and 2) on a broader landscape scale. Loss of individual plants and direct impacts are minimized through the incorporation of mitigation measures through the consultation process. For example, we recommend that oil and gas development maintain a 300-foot buffer between surface disturbance and listed plants on federally-managed lands in order to minimize the direct loss and indirect disturbances (e.g., fugitive dust) to individual cacti. However, exceptions to this 300-foot buffer are allowed with the additional commitment to continue to monitor plants that fall within the buffer. As a result, at least 313 wells (not including directional and horizontal wells) are now located within 300 feet of known *Sclerocactus* species locations (UDOGM 2013). Some of these well locations are historical or were developed without section 7 consultation because they were thought to occur outside of the range of the species. We do not have an accurate way to estimate how many cacti were lost or disturbed from development of these wells.

It is more difficult to implement conservation for the species on a broader landscape scale. Substantial energy development already exists within the species' occupied and potential habitat, (we estimate at least 6 percent disturbance; see the paragraph above for more details). Indirect effects such as habitat fragmentation, fugitive dust, and invasive species extend out beyond 300 feet (see, for example, Walker and Everett 1987; Myers-Smith et al. 2006; Farmer 1993), and the commonest pollinators for *Sclerocactus* species can potentially be impacted at a distance of at least 400 meters (1,312 feet) from direct surface disturbances (Tepedino et al. 2010; Tepedino pers. comm. 2011). Thus, at least 51 percent of the known occupied habitat is both directly and indirectly impacted by energy development. Conversely, this means less than half of occupied *Sclerocactus* habitat remains undisturbed (including both direct and indirect effects). Overall, the extensive amount of energy development projects across the Uinta Basin results in increased habitat fragmentation, fugitive dust, invasive species, and hydrologic changes across the landscape, and likely negatively impacts *Sclerocactus* populations.

We believe it is necessary to avoid and minimize additional surface disturbances in the most important *Sclerocactus* habitats so that we can effectively conserve and recover the species. Thus, we have established areas that we refer to as "core conservation areas" for all *Sclerocactus* species, including *S. wetlandicus*. Core conservation areas contain the densest known occupied habitat of *S. wetlandicus*. They are different from the potential habitat polygon in that they are more precise and show distribution within the range, whereas the potential habitat polygon delineates the range of the species. Core conservation areas are consistent with our recovery plan objectives that recommend establishing formal management designations to provide for long-term protection of important populations and habitat (Service 1990a, Service 2010a).

We established two levels of core conservation areas for *S. wetlandicus* based on pollinator travel distance and designed the areas to provide habitat connectivity between populations and individuals. Connectivity between sub-populations is important because *Sclerocactus* species

are out-crossing and require pollen from another plant's flower to produce viable seed (Tepedino et al. 2010). The most common *Sclerocactus* flower visitors are Halictinae bees (a subfamily of bees that pollinate *Sclerocactus*) that can travel from 400 meters to 1,000 meters (Tepedino et al. 2010). These bees also use other native plants as food sources, and protecting overall native plant diversity is important to protect *Sclerocactus* pollinators (Tepedino et al. 2010). Finally, protecting bee nests is critical (Tepedino et al. 2010), but we do not currently have a reliable way to identify bee nests in the field.

Level 1 polygons were developed using a 400-meter buffer around plants to allow for pollinator travel and include the densest concentrations of cactus locations and the most restrictive management recommendations. Level 2 polygons were developed using a 1,000-meter buffer around plants while incorporating less-dense cactus areas and less restrictive management recommendations.

We recommend no additional direct disturbance within level 1 core conservation areas and a direct disturbance cap of 5 percent within level 2 core conservation areas. The 5 percent threshold allows a low to moderate level of disturbance in areas with dense cactus populations while limiting additional disturbance in areas that are already highly disturbed.

Within core conservation areas, we estimate approximately 7 to 8 percent of the land surface contained within level 1 and level 2 core conservation polygons for *Sclerocactus wetlandicus* is already directly disturbed by energy development. This direct disturbance exceeds the 5 percent we recommend in the core areas indicating a need to avoid and minimize further impacts and develop successful reclamation techniques. By applying the same calculations we used for occupied habitat above, we estimate that 67 percent of level 1 and level 2 core conservation areas for *S. wetlandicus* is directly and indirectly disturbed by energy development.

Colorado River Endangered Fishes

The Colorado pikeminnow and humpback chub were listed as endangered on March 11, 1967 (32 FR 4001); the bonytail was listed as endangered on April 23, 1980 (45 FR 27710); and the razorback sucker was listed as endangered on October 23, 1991 (56 FR 54957). Critical habitat was designated for all four fish species on March 21, 1994 (59 FR 13374). Species descriptions, critical habitat information, life history, population dynamics, and the species status, distribution, and recovery goals are described in detail within their respective Recovery Plans and amendments (Service 1990b, Service 1990c, Service 1991a, Service 1991b, Service 1997, Service 2002a, Service 2002b, Service 2002c, Service 2002d). The Colorado pikeminnow, razorback sucker, bonytail, and humpback chub have designated critical habitat within the Green River in Uintah County, just outside of the action area.

III. ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, state, or private actions and other human activities in the

action area, the anticipated impacts of all proposed state or federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation process.

The action area is defined to mean "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The action area also depends on the species being discussed. Because the project alters water quantity in the Green River, we define the action area for the four Colorado River endangered fish and their designated critical habitat to include the Green and Colorado Rivers between Flaming Gorge Dam and Lake Powell for the purposes of this consultation (see Proposed Action, Action Area).

Status of the Species within the Action Area

Sclerocactus wetlandicus

As described above, we delineated a potential habitat polygon for *Sclerocactus wetlandicus* to better understand the species distribution and abundance across its range. Although *S. wetlandicus* populations can be found outside of these areas, they tend to be more isolated and occur in low densities. The total area of potential habitat for *S. wetlandicus* across its range is 435,379 acres. Based on our delineated habitat polygon, we estimate that approximately 16,360[6] acres of *S. wetlandicus* potential habitat (~4 percent) occurs within the action area, and approximately 11,643 acres (~71 percent) of this habitat is on BLM land. The remaining 4,717 acres of potential habitat occur on state and tribal lands.

As previously discussed, we estimate approximately 50,000 *Sclerocactus wetlandicus* rangewide. There are at least 553 *S. wetlandicus* individuals within the action area (approximately 1 percent of the total estimated population) (BLM 2012).

Colorado River Endangered Fishes

All four endangered Colorado River fish species are found in the Green River. Additional detail of these populations is discussed below:

One of three Colorado pikeminnow populations, the Green River subbasin population, will be affected by this project. This population was estimated at 6,000 to 8,000 adults (Nesler et al. 2003, Service 1991a, Service 2002b) and was determined to be declining in 2001-2003 (Bestgen et al. 2005).

The Green River subbasin population of razorback sucker is likely to be impacted by this action, and this population is estimated at 500 to 1,000 fish (Modde, Burnham and Wick 1996, Lanigan and Tyus 1989). The Green River from the confluence with the Yampa River to Sand Wash has

6 The BLM's BA calculated approximately 15,896 acres of potential habitat polygon within the project area. The difference between the two estimates is insubstantial, but we will use our own estimate for consistency of our calculations throughout this BO.

the largest existing riverine population of razorback sucker (Modde et al. 1996, Lanigan and Tyus 1989).

The Desolation/Gray Canyon population of humpback chub is likely to be impacted by this action, and this population is currently estimated at 1,500 fish (Service 2002c). Each population of humpback chub consists of a discrete group of fish, geographically separated from the other populations, but with some exchange of individuals. The fish community in Desolation and Gray Canyons includes age-0, juvenile, and adult *Gila,* including humpback chub, indicating a reproducing population (Chart and Lentsch 1999).

Bonytail were once widespread in the Colorado River Basin (Chamberlain 1904). Surveys from 1964 to 1966 found large numbers of bonytail in the Green River in Dinosaur National Monument downstream of the Yampa River confluence (Vanicek and Kramer 1969). However, few bonytail were captured after 1973, and the last recorded capture in the Green River was in 1985 (Service 2002a). Following this decline, large numbers of bonytail were stocked in the Green River Basin between 1998 and 2009. In 2009, biologists working on the Green River in the Uintah Basin, Utah, captured in excess of 40 bonytail stocked more than a year earlier, indicating some success of recent stocking activities(Service 2010b).

Factors Affecting the Species within the Action Area

Sclerocactus wetlandicus

The action area incorporates the River Bend Unit, an area that has already been developed to some extent. Approximately 369 well pads are developed across the action area within the *Sclerocactus wetlandicus* potential habitat polygon across all landowners (UDOGM 2013). Some of these wells are plugged and abandoned, shut-in, or the location was abandoned, but they may be reopened for future development. We estimate that at least 1,845 acres of land, or ~11 percent of the potential habitat polygon in the action area, is directly disturbed by these well locations.

The action area includes portions of the Middle Green core conservation area for *Sclerocactus wetlandicus*, where substantial disturbance has already occurred (Table 1).

Table 1. Existing disturbance in the Middle Green core conservation areas where it overlaps the action area. Level 2 core conservation areas are inclusive of level 1 areas.

Within action area:	**Level 1**	**Level 2**
percent of core area	4%	7%
estimated number of well pads in core area	4	19
estimated acres direct surface disturbance in core area	20	95
estimated percent direct surface disturbance in core area	8%	8%

Sclerocactus wetlandicus is experiencing direct and indirect impacts from existing oil and gas development within the action area. Direct and indirect impacts include increased mortality, increased illegal collection, habitat fragmentation, further introduction and spread of invasive species, the possible loss of pollinators, increased fugitive dust, and increased erosion.

Mortality occurs when a cactus is accidentally kicked, stepped on, or driven over by humans. As roads and pipelines increase within occupied habitat, the chance for mortality increases. Other factors, such as livestock grazing, may exacerbate this situation by focusing impacts within the remaining interspaces between roads and wells, leading to further cactus mortality.

Illegal collection of *Sclerocactus wetlandicus* historically was one of the primary threats to the conservation and recovery of this species (BLM, 2008a). The increase in the number of access roads within and near occupied habitats allows greater access to rare plant populations and increased illegal collection of the species.

Habitat fragmentation occurs as a result of the increased number of access roads, pipeline and other utility ROWs, and long-term surface disturbance from well pads and associated facilities. The anthropogenic fragmentation of plant habitats can decrease species density (Mustajarvi et al. 2001) and result in isolated, smaller populations that are more prone to extinction (Forman and Alexander 1998). Decreased species density has the potential to adversely impact pollination and reproductive success of *Sclerocactus wetlandicus* (Mustajarvi et al. 2001). Increased habitat fragmentation from roads can also act as a barrier to plant pollination and seed dispersal (Bhattacharya et al. 2003; Ness 2004).

Noxious and invasive plant species directly compete for resources with native species such as *Sclerocactus wetlandicus* and alter habitat making it more difficult for the species to survive and thrive. Seeds from invasive species are often carried by vehicles and spread via vehicle-caused air turbulence (Forman and Alexander 1998). Within the action area, noxious and invasive

species are often present in the soil seed bank, and once an area is disturbed, these species can quickly establish. In addition, competition from noxious and invasive species can further reduce special status species' population size. Invasive plants spread more easily when other land uses such as livestock grazing are concentrated within the remaining interspaces between roads and wells. The cumulative pressures of energy development and grazing can lead to more invasive plants in *Sclerocactus wetlandicus* habitat.

The spread of noxious and invasive plants may change species composition within native plant communities. This may lead to increased livestock grazing on native grasses and shrubs that act as "nurse" plants for immature cacti. Nurse plants create an environment that is more favorable for successful establishment of immature cacti by providing shade, moisture, and protection from trampling.

Pollinators and their nesting sites are directly disturbed by oil and gas activities. Additionally, habitat alteration from invasive species can alter pollinator composition in the area, thereby possibly reducing the effectiveness of pollination within the native community. All of these connected actions reduce the ability of *Sclerocactus wetlandicus* to thrive within its native habitat.

Surface disturbances can lead to increased dust, erosion and storm water runoff that could impact *Sclerocactus wetlandicus*. Construction activities, increased access roads, and increased vehicular traffic within and near occupied habitats will lead to increases in fugitive dust and particulates. Dust accumulation is higher near roads, with fugitive dust depositing up to 984 feet from the source (Everett 1980). Dust accumulation may adversely impact photosynthesis, respiration, transpiration, water use efficiency, leaf conductance, growth rate, gas exchange, and growth (Everett 1980; Thompson et al. 1984; Farmer, 1993; Sharifi et al. 1997; Trombulak and Frissell 2000; Hobbs 2001). Erosion and runoff, though natural events, can have direct impacts to cacti from burying to direct removal of individuals. Erosion and runoff can be altered by human activities—for example, vegetation removal and alteration of stream courses—making these events more catastrophic. These augmented events can lead to greater damage to native ecosystems through additional scour and burial of soils and plants. Increases in dust, erosion, and storm water runoff interact cumulatively with other negative effects to further fragment and disturb *S. wetlandicus* populations.

Colorado River Endangered Fishes

The primary factors affecting the four endangered Colorado River fish are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; and pesticides and pollutants (Service 2002a, Service 2002b, Service 2002c, Service 2002d). The existing habitat, altered by these threats, is modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The primary impacts from oil and gas development, which may lead to the factors listed above, are water depletion and degradation of water quality through sediments and pollutants released to waterways close to or within critical habitat.

IV. EFFECTS OF THE ACTION

The effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action that will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

XTO is proposing to drill 250 new wells from 70 new well pads and 180 existing pads. Disturbance will include associated access roads, construction and production facilities, pipelines, and electrical power lines. The proposed action is estimated to directly disturb an additional 923 acres through these well development and pipeline construction activities. These activities will add approximately 5 percent more direct disturbance to the project area, for a total cumulative disturbance of 14 percent of the project area.

Sclerocactus wetlandicus

As previously described, there are at least 16,360 acres of *Sclecrocactus wetlandicus* potential habitat within the action area (using the potential habitat polygon from 2012). The BLM estimates that 923 acres of surface disturbance will occur with the proposed action, and most of this disturbance falls within *S. wetlandicus* potential habitat. They also estimate that currently over 25,805 acres of habitat within the *S. wetlandicus* potential habitat polygon is currently disturbed by energy development. The proposed action will contribute to this disturbance by less than 1 percent of the total potential habitat for *S. wetlandicus* across its entire range.

Sclerocactus wetlandicus plants will be avoided by 300 feet (see 4.1.1 of the BA), so individual cacti will not be within 300 feet of a work area under the Agency's Preferred Alternative. The Agency's Preferred Alternative does not involve developing with level 1 core conservation areas but does include expanding 3 well pads in level 2 core conservation areas (see map 2.3-1 in the BA). We expect 1.5 acres of additional surface disturbance from expansion of three well pads in level 2 core conservation areas. This will add approximately 1 percent to the existing surface disturbance for a total of 9 percent surface disturbance within level 2 core conservation areas within the action area. We expect a negligible increase in habitat fragmentation with well pad expansion in core conservation areas.

Indirect impacts will occur along approximately 9 miles of new roads within potential habitat under the Agency's Preferred Alternative. Deposition of wind-blown soil onto *Sclerocactus wetlandicus* individuals during construction and use of these roads will negatively impact the cactus through reduced photosynthesis (BLM 2008b). The expanded road network and surface disturbance from project-related construction will increase sediment delivery to the small ephemeral drainages and areas of overland flow associated with *S. wetlandicus*. *S. wetlandicus* is not tolerant of heavy sedimentation (BLM 2008b), and increased sedimentation will increase

the risk of mortality or stress to an unspecified number of *S. wetlandicus* located near disturbed areas.

Additional indirect impacts to *Sclerocactus wetlandicus* include an increased risk of crushing by off-road vehicles due to an expanded road network in the action area, impacts from herbicides used to control invasive plants in the project area, and possible reductions in pollination or seed dispersal due to a larger road network and resulting habitat fragmentation and dust. Because *S. wetlandicus* requires insect pollinators for successful reproduction (Tepedino et al. 2010), impacts to pollinator nesting and foraging habitats will negatively affect the cactus by reducing the diversity and abundance of pollinators and, thereby, the plant's ability to successfully reproduce. The expanded road network also will increase the risk of illegal collecting of *S. wetlandicus*.

Although the conservation measures described in the BA will minimize the impacts of the action to *Sclerocactus wetlandicus*, larger landscape-level changes such as increased habitat fragmentation and habitat loss, pollinator disturbance, changes in erosion and water runoff, and increased weed invasion cannot be entirely negated. These disturbances will continue to negatively impact *S. wetlandicus* throughout the action area.

Colorado River Endangered Fishes

This project will adversely affect Colorado pikeminnow, razorback sucker, bonytail, and humpback chub by reducing the amount of water in the river system upon which they depend by up to 175 acre-feet/year. The effects to all four species primarily result from the effects of the water depletion upon their habitats. The amount of water removed by the proposed action is below the current sufficient progress threshold of 4,500 acre-feet. However, the cumulative effect of water depletions, including from this action, adversely affects the four listed fish by further reducing the amount of water available to them, increasing the likelihood of water quality issues, increasing their vulnerability to predation, and reducing their breeding opportunities by shrinking the amount of breeding habitat within their range. Water depletions also reduce the ability of the river to create and maintain the primary constituent elements that define critical habitats.

Additionally, water intake structures have the potential to harm all life stages of endangered Colorado River fishes through mortality, injury, or displacement. This impact is especially apparent to newly-hatched, young-of-year fish. In fact, immediately after hatching, larval fish have no swimming ability for the first few weeks of life. Even after newly-hatched fish have acquired swimming ability, they lack burst speeds to escape entrainment velocities from many pumping structures. However, placing pump hoses in off-channel infiltration galleries removes the exposure of this impact to fish. In additions, placing hoses in fast velocity areas, installing intake covers (fish screens), and pumping at appropriate times should reduce entrainment.

Development of oil and gas wells requires water for both well drilling and completion. Approximately 2.7 acre-feet of water will be consumed during drilling and completion of each

well. The BLM estimates that 175 acre-feet of water will be consumed in the first 4 years of the project, with 6.3 acre-feet used annually after that for dust abatement for the life of the project (up to 39 years). We estimate that approximately 1,600 acre-feet will be consumed over the lifetime of the project. Peak withdrawals of approximately 175 acre-feet of water will be drawn from sources that feed the Green River in any given year. This equates to approximately 0.4 cfs of withdrawal (assuming that water use occurs evenly over 240 days per year). A 0.4 cfs withdrawal will represent a loss of approximately 0.04% of the approximately 1,000 cfs recorded minimum stream flow of the Green River within the action area (based on stream flow records since 1992 for the Green River (as measured at Jensen, Utah) and the White River (as measured at Watson, Utah). This flow reduction will be considered a long-term (life of the project) impact in terms of reductions in habitat for listed fish species in the Green River.

There is a greater potential for impacts from pollutants, if a pipeline, well pit, or other source were to inadvertently release contaminated fluids into waterways at points near the Green and White Rivers. Through direct or indirect discharge, these pollutants could reach the Green River and negatively impact water quality to the point of affecting native fish populations. Direct impacts will result from a discharge from a pipeline or well pit reaching the Green River in its original form or within a single release event. Indirect effects occur when discharges are released to the ground and are later released to the river after being carried by an erosion event or carried by rain or snowmelt runoff. As more well and pipeline development occurs in the project area the chance of pollutants reaching the Green River increases, thus increasing the potential of harm to native fish populations.

No new surface disturbance is planned within the 100-year floodplain of the green river, which includes wells, pipelines, or roads. Although applicant-committed measures will reduce the chance for spills or leaks of contaminants, accidental releases can and do still occur. According to the National Response Center, there have been at least 219 spills and releases within Carbon, Duchesne, and Uintah Counties from January 1991 through August 2011 due to oil and gas development and related activities affecting water, land and air.

Spill incidences reviewed in Utah include corrosion and leakage of surface and buried pipelines, broken well rods, valve and gasket failures, wellhead pressure buildups, shutoff alarm malfunctions, leakage of trace systems, loss of formation water to the surface during drilling, and vehicular related traffic accidents. Releases have included crude oil, natural gas, hydrochloric acid, condensate, salt water, ethylene glycol, and produced water in various quantities.

Releases of harmful agents into floodplain habitats could result in significant adverse impacts to the endangered fish and their designated critical habitat. One of the constituent elements of the designated critical habitat for the four Colorado River fish is contaminant-free water. Any release of contaminants into the floodplain will result in degradation of critical habitat and could result in take of individual fish, including downstream impacts to larvae and juveniles.

The Green River is a large river with variable dilution factors based on seasonal flows. However, contaminants are likely to accumulate in backwater/depressional areas that have

reduced dilution and less flushing capacity (Woodward et al. 1985). Colorado pikeminnow and razorback sucker use these sites downstream, which provide cover and a food source, for overwinter survival and rearing areas. The Agency's Preferred Alternative includes applicant committed measures to minimize and reduce the potential for contaminants to be released into the natural systems. However, oil and gas related accidents can be severe and have serious consequences to fish and wildlife resources.

Although most incidents are relatively small in size, large scale spills do occur. If large-scale breaks occur in sensitive resource areas, the results can be catastrophic to fish and wildlife resources. The effects of smaller leaks that may cause chronic, sub-lethal effects to fish populations may be more prevalent. While the oil and gas industry has a wide variety of methods available to detect substantial leaks or integrity breeches, the technology for detection of small "pinhole" leaks is not as advanced. This creates a significant problem in that the current available methodology may allow small leaks to go undetected for extended periods of time often evading detection until they are manifested on the surface sediments or water.

Sublethal exposure of fish to contaminants can result in altered behavior and impede necessary life functions such as growth, habitat selection, competition, predator avoidance, feeding, and reproduction (Laurence 1972, Little et al. 1985, Brown et al. 1987, Lemly and Smith 1987, Little et al. 1993). Changes in heart and respiratory rates; gill hyperplasia; enlarged liver; reduced growth; fin erosion; impaired endocrine system; a variety of biochemical, blood, and cellular changes; and behavioral responses may also result. Behavioral and physiological changes generally occur at lower toxicant concentrations than that which cause mortality (Little and Finger 1990). Early life stages of fish are generally more sensitive to environmental contaminants than juveniles or adults (Mayer and Ellersieck 1986).

Disruption of behavioral functions can result in population declines or changes in year-class strength if enough individuals are affected (Little et al. 1993). Links between behavioral alterations and population level effects in the natural environment have been limited to documentation of avoidance responses. More research is needed to determine population-level responses to the effects of environmental contaminants on aquatic communities.

Fish may avoid or be attracted to certain contaminants and this response varies widely with species, habitat conditions, and chemical constituents. While avoidance may provide short-term protection by minimizing exposure, the fish are displaced from preferred habitats into less desirable or already occupied areas (Atchinson et al. 1987). Free-ranging fish have been documented to avoid oil-contaminated water and gas-supersaturate water (Gray 1990).

Contaminant studies associated with oil and gas drilling activities have been conducted in the San Juan River to assess potential impacts to endangered fish species. Concentrations of hydrocarbons in sediments, surface water, and pore water were low; however compounds which have been found to be toxic to aquatic organisms and to have the potential for photoactivation were present. Aquatic organisms exposed to certain hydrocarbons (flouranthene, anthracene, pyrene, and chrysene) and simultaneously or subsequently exposed to sunlight or other sources

of ultraviolet radiation exhibit much greater adverse effects, including deterioration of body tissues, than organisms exposed to hydrocarbons alone. In the presence of ultraviolet light, all the hydrocarbons, except chrysene, were acutely toxic to the fish in the 4 to 15 μg/l. Historical studies of hydrocarbon toxicity did not involve UV light. Increased hydrocarbon toxicity associated with photo-activation elevates concerns regarding environmental hazards of oil and gas developments (Wilson et al. 1995, Service 1995).

The severity of the impacts from larger spills will be dependent on the time of year, the river flows, presence of endangered fish, and the volume of the contaminant plume. Immediate effects of small leaks to fish populations will be difficult to ascertain but will likely become evident in future reproductive or growth issues. Spill attenuation through the applicant-committed measures will reduce the risk of a spill reaching the Green River.

V. Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Declines in the abundance or range of many special status species are attributable to various human activities on federal, state, and private lands, such as human population expansion and associated infrastructure development; construction and operation of dams along major waterways; water retention, diversion, or dewatering of springs, wetlands, or streams; recreation, including off-road vehicle activity; expansion of agricultural or grazing activities, including alteration or clearing of native habitats for domestic animals or crops; and introductions of non-native plant, wildlife, or fish or other aquatic species, which can alter native habitats or out-compete or prey upon native species. Many of these activities are expected to continue on State and private lands within the range of various federally-protected wildlife, fish, and plant species, and could contribute to cumulative effects to the species within the action area. Species with small population sizes, endemic locations, or slow reproductive rates will generally be more susceptible to cumulative effects.

Sclerocactus wetlandicus

Non-federal activities have the potential to cumulatively affect *Sclerocactus wetlandicus*, as a significant portion of this species' range occurs on state, private, and tribal lands without federal mineral leases or federal surface rights. Quantified data on the future extent of these activities are difficult to obtain, but we must assume, for the purposes of this assessment, that some level of these activities are reasonably certain to occur, particularly energy and mineral exploration and development, livestock grazing, stone collecting, off-highway vehicle use, and illegal collecting.

Our data show there are no known individual *Sclerocactus wetlandicus* located on lands in the action area without a federal nexus. There are no private lands located within the action area. The action area does include land managed by the Bureau of Indian Affairs, so development in this area will fall under separate consultation and we will not analyze those impacts here. However, there could potentially be *Sclerocactus* individuals on state lands within the action area, and surveys are not always required or conducted on private, state, and tribal lands. *S. wetlandicus* individuals occurring on non-federal lands will be negatively impacted by landscape-scale factors (habitat fragmentation, increased dust, and so on) due to cumulative impacts in the action area.

Colorado River Endangered Fishes

Reasonably foreseeable future activities that may affect river-related resources in the area include oil and gas exploration and development, fire management, irrigation, recreational activities, Central Utah Project, Colorado River Salinity Control Project, and activities associated with the Upper Colorado River Endangered Fish Recovery Program. Implementation of these projects affects the environment including, but not limited to, water quality, water rights, socioeconomic factors and wildlife resources.

Cumulative effects to this species include the following types of impacts:

- Changes in land use patterns that will further fragment, modify, or destroy potential spawning sites or designated critical habitat;
- Shoreline recreational activities and encroachment of human development that will remove upland or riparian/wetland vegetation and potentially degrade water quality;
- Competition with, and predation by, exotic fish species introduced by anglers or other sources;
- Additional water depletions to the Upper Colorado River Basin.

VI. CONCLUSION

After reviewing the current status of *Sclerocactus wetlandicus* and the four endangered fishes of the Upper Colorado River Basin, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that this project, as described in this biological opinion, is not likely to jeopardize the continued existence of *S. wetlandicus* or the four endangered fishes. The proposed project is also not likely to destroy or adversely modify designated critical habitat. We base our conclusion on the following:

- We expect minimal additional surface disturbance because approximately 73 percent of the proposed new wells will be drilled from existing well pads. No new well pads will be constructed within *Sclerocactus wetlandicus* core conservation areas.

- Applicant committed conservation measures, including avoidance of *Sclerocactus wetlandicus* individuals by 300 feet, and mitigation measures previously stated in this biological opinion will minimize direct impacts to listed species. Less than 1 percent of the known population of *Sclerocactus wetlandicus* occurs in the action area.
- The existence of the Upper Colorado River Endangered Fish Recovery Program has provided sufficient progress of recovery activities to date.
- Adequate pumping guidelines are in place to reduce impacts to young-of-year and juvenile fish.

We recognize that the person who depletes and the amount of water they deplete may vary from year to year. Consequently, water users assume the risk that the future development of senior water rights, including Tribal water rights, may result in shortages of water to junior users. Nothing in this biological opinion precludes any new depletion that results from the exercise of senior water rights within the project area.

VII. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR § 17.3). Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR § 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the BLM so that they become binding conditions of any grant or permit issued to XTO for the exemption in section 7(o)(2) to apply. The BLM has a continuing duty to regulate the activity covered by this incidental take statement. If the BLM (1) fails to assume and implement the terms and conditions or (2) fails to require XTO to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, either BLM or XTO must report the progress of the action and its impact on the species to us as specified in the incidental take statement. [50 CFR § 402.14(i)(3)]

We have developed the following incidental take statement based on the premise that the applicant-committed conservation measures will be implemented.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

We anticipate that all age classes of Colorado pikeminnow, humpback chub, razorback sucker, and bonytail could be taken from within the Upper Colorado River Basin as result of the proposed action. Incidental take is expected to be in the form of harm (death or injury) due to accidental contamination from leaks/spills during project related activities of project area streams and washes that are tributaries to the Green River. Also, water withdrawals associated with this project will follow applicant committed conservation measures (for example, pump screens) that should reduce entrainment to a minimal amount.

Based on surveys conducted by UDWR and the Service of listed fish per river mile from 2006 through 2008, we estimate at least 27 Colorado pikeminnow, humpback chub, razorback sucker, and bonytail could be present within 0.5 river miles downstream of the project area within the Green River (Bestgen et al. 2010).

Juvenile and adult Colorado pikeminnow, razorback sucker, bonytail, and humpback chub could be injured or killed through contact with the intake structure. We believe the current design of the project will minimize impacts to fish occurring in this area. Based on the above information and applicant committed conservation measures, we authorize: a total combined take of 10 percent (3 fish) of individuals for Colorado pikeminnow, humpback chub, razorback sucker, and bonytail greater than 60 millimeter; take of habitat not to exceed 0.5 river miles downstream of the project area; and all take in the form of harm that will occur from the removal of 175 acre-feet of water per year during the first 4 years with a peak depletion of 175 acre-feet.

In addition, entrainment of larval fish will occur as pumps take water from the river. These small individuals cannot be screened out. Measuring larval fish entrained in the pumps would be very difficult, as they are very small and will continually be entrained into pumps. Therefore, we estimate that the number of larval fish impinged on pump screens or entrained into pumps situated in flowing water will be a very small percentage (<0.01 percent) of the annual larval production. We authorize a total lethal take of 0.01% of all larval fish for Colorado pikeminnow, humpback chub, bonytail, and razorback sucker for the pump's operational period.

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal, reduction or possession of federally-listed plants; the malicious damage of such plants on areas under federal jurisdiction; the destruction of federally listed plants on non-federal areas in violation of state law or regulation; or in the course of any violation of a state criminal trespass law.

EFFECT OF THE TAKE

In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to Colorado pikeminnow, humpback chub, razorback sucker, and bonytail, or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

We believe that the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the Colorado pikeminnow, humpback chub, razorback sucker, and bonytail:

1. Conduct all proposed actions in a manner that will minimize all impacts to listed endangered fish species and their designated critical habitat

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, BLM and XTO must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions are assumed to include all previously listed applicant-committed environmental protection measures, but in some cases include more restrictive or more detailed measures. Conservation measures include implementing the Recovery Program (and relevant RIPRAP measures).

For Reasonable and Prudent Measure #1:

1. To ensure proper tracking of water depletions from the Upper Colorado River System, XTO will notify the BLM and/or our office as to what water resources will be used for the project as they are designated, and the amounts that will be withdrawn from each one.
2. Coordinate with our office regarding design and placement of any structures that may need to be placed in washes or tributaries of the Green River.\
3. Coordinate with our office regarding any instream pumping structures that deviate from the approved pumping guidelines described above in the applicant committed conservation measures section.
4. Appropriate erosion control and revegetation measures will be employed. In areas with unstable soils where seeding alone may not adequately control erosion, grading will be used to minimize slopes and water bars will be installed on disturbed slopes. Erosion control efforts will be monitored by the operator and necessary modifications will be made to control erosion.

VIII. REPORTING REQUIREMENTS

In order to be exempt from the prohibitions of section 9 of the Act, the BLM must comply with all Recovery Program activities and the monitoring proposed below.

The implementing regulations for incidental take require that federal agencies must report the progress of the action and its impact on the species (50 CFR 402.14(i)). To meet this mandate, the BLM will monitor and report the progress of their action as follows:

1. The BLM is required to submit to our office an annual report of water depletions associated with oil and gas development, including the following information:

    - Project name and/or applicant name
    - Permit number and/or special use authorization
    - General location and legal description
    - Depletion amount in acre-feet
    - Timing of depletion
    - Identify if new or historic depletion[7]
    - Sub-total water depletion (acre-feet) for each applicant
    - Total depletion for the entire year in acre-feet
    - Total number of APDs approved
    - Total number of wells spudded

Reports shall be due to our office on a yearly basis by October 31. The address for the Utah Fish and Wildlife Service Field Office is:

2369 West Orton Circle, Suite 50
West Valley City, Utah 84119

Any annual cactus monitoring reports associated with the proposed actions must be submitted to us and the BLM by January 31 each year following monitoring.

Upon locating dead, injured, or sick listed species, immediate notification must be made to the Service's Salt Lake City Field Office at (801) 975-3330 and the Service's Division of Law Enforcement, Ogden, Utah, at (801) 625-5570. Pertinent information including the date, time, location, and possible cause of injury or mortality of each species shall be recorded and provided to the Service. Instructions for proper care, handling, transport, and disposition of such specimens will be issued by the Service's Division of Law Enforcement. Care must be taken in handling sick or injured animals to ensure effective treatment and in handling dead specimens to preserve biological material in the best possible state.

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[7] It is important to include information on whether each depletion is new or historic (occurring prior to January 1988), because we addresses new and historic depletions differently under the new section 7 agreement of March 11, 1993. Historic depletions, regardless of size, do not pay a depletion fee.

IX. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The applicant-committed measures and proposed mitigation measures address most of the impacts associated with water withdrawals from the Green River, other impacts to waterways, and impacts to *Sclerocactus wetlandicus*. However, to ensure that federal agencies can meet their requirements under Section 7(a)(1) and work toward recovery of listed species, we recommend the following measures in addition to applicant-committed conservation measures. The conservation recommendations below for *Sclerocactus wetlandicus* were adapted from the recovery outline.

Because the Recovery Program is already working toward recovery of the four Colorado River fish species, the conservation recommendations below are specific to this project and will help further the goals of the Recovery Program.

Sclerocactus wetlandicus

Surveys and Monitoring

- Completion of a comprehensive survey throughout *Sclerocactus wetlandicus'* range, including areas that are not likely to be disturbed. Survey results will provide an accurate population estimate and allow us to refine core population areas so we can more effectively protect the species. This effort will require evaluation of habitat components likely to support *S. wetlandicus*.
- More accurately delineate the range and morphology of *Sclerocactus wetlandicus* and potential varieties, especially in relationship to *S. brevispinus* and particularly in the hybrid zone.
- Locate possible connectivity corridors between *Sclerocactus* populations to better refine core conservation areas.
- All federal agencies and land-owners—including the BIA, Ute Tribe, Bureau of Land Management (BLM) and our office—should work together to implement and fund the range-wide monitoring program for *Sclerocactus wetlandicus*. These data will improve our understanding of trends and allow us to adopt more effective conservation measures if cacti are being adversely impacted despite current conservation measures.

Threats Abatement

- Follow the same applicant-committed conservation measures across the project area regardless of land ownership.
- Identify cacti sites in urgent need of habitat protection, set protection priorities, and implement protective measures and special management considerations. For example, the BLM, BIA, Ute Tribe, and our office should work together to finalize core conservation areas where surface disturbance will be limited in order to preserve intact populations of cacti and open, unoccupied habitat.
- Oil and gas leasing and other mineral extraction activities should avoid occupied sites and other important habitat when possible.
- Implement standard conservation measures to minimize future project and use impacts. For example, proposed projects should use existing surface disturbance and rights-of-way to minimize additional surface disturbance and habitat fragmentation.
- Coordinate with land management agencies, project proponents, and other partners early in the planning process to limit direct and indirect impacts of planned activities.
- Install livestock exclosures for protection and monitoring purposes in locations that will not be prone to illegal collection.
- Prevent the collection of *Sclerocactus wetlandicus* plants from natural populations. With respect to this project, XTO employees should notify us or the BLM immediately if they observe suspicious behavior—such as non-federal or non-project-related personnel looking for plants—in areas with known cactus locations.
- For infrastructure (typically, a pipeline) that crosses through occupied cactus habitat, applicants should ensure that future maintenance activities will not impact cacti. This can be accomplished by some or all of the following:
    - Notify maintenance crews when they will be working in a sensitive cactus area and provide them with GPS information or maps of areas to avoid,
    - Have a botanist on site prior to and during maintenance activities to flag cacti or avoidance areas and remove the flags immediately after work has completed, and
    - Install protective fencing (e.g., silt fencing) around cacti that are downslope or downwind of surface-disturbing maintenance activities during maintenance, and remove the fencing immediately work is completed.
- We recommend that XTO apply the same conservation measures that they practice on federal lands across all of their project areas that contain *S. wetlandicus* habitat.

Research

- Continue research into *Sclerocactus wetlandicus* life history and ecology, including soil requirements and pollinators.
- Study population dynamics and conduct a population viability analysis.
- Encourage investigations that project *Sclerocactus wetlandicus'* vulnerability and response to climate change.

- Coordinate with *Sclerocactus* genetic and taxonomic experts to resolve the genetics of *S. wetlandicus* outlier populations and the boundaries between *S. brevispinus*, *S. wetlandicus*, and *S. parviflorus*.
- Establish effective, science-based reclamation techniques for disturbed habitat.
- Improve our understanding of livestock and native (e.g., rodent) grazing impacts.
- Monitor *Moneilema semipunctatum* (cactus borer beetle) infestations, and study the relationship of episodic infestations with drought and other environmental factors.
- Monitor changes in invasive species prevalence and impacts on *Sclerocactus wetlandicus*. Additionally, continue to explore approaches to minimize the risk posed by invasives and associated remediation actions.

Colorado River Endangered Fishes

Threats Abatement

- Machinery should be fueled outside of all stream channels to prevent spillage into waterways; and
- Removal of nonnative riparian species in the local area, followed by plantings of native species.

Research

- We recommend that the project applicant work with our office to identify and fund contaminant studies related to oil and gas development in the Uinta Basin and its potential effects on aquatic environments. These studies may include but are not limited to:
    - determining presence of polyaromatic hydrocarbons (PAHs) in the system;
    - conducting risk assessment study to determine the need for automatic shut off valves for all pipelines crossing critical habitat or drainages to critical habitat;
    - analyzing fish tissue for presence of mercury; and
    - examining reclaimed reserve pits and their potential to contaminate surrounding soils.
- We recommend that the project applicant assist in funding studies to determine how the habitat conditions of the White River may deviate under continued water depletion impacts. Components of these studies include:
    - Installing permanent thermograph stations in multiple locations in the drainage to determine if stream temperatures are being altered by water depletions; and
    - Conducting water flow modeling to inform the establishment of instream flow guidelines for the White River.

For us to stay informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

X. REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the action outlined in your request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action was retained (or is authorized by law) and if: (1) the average annual water withdrawals out of the Upper Colorado River Drainage System exceed the estimated 175 acre-feet by more than 10 percent; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. If cactus core conservation areas are approved and/or modified in the future by the Service, re-initiation of consultation for the Riverbend Unit Infill project will not be necessary. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

We appreciate your commitment in the conservation of endangered species. If the project changes or it is later determined that the project affects listed species differently than identified above; it may become necessary to reinitiate section 7 consultation. If you require further assistance or have any questions, please contact Jessi Brunson at (435) 781-4448.

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APPENDIX J

Signed Tribal and SHPO Letter for River Bend Unit Infill Development

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District Office
170 South 500 East
Vernal, UT 84078
http://www.blm.gov/ut/st/en/fo/vernal.html

TAKE PRIDE IN AMERICA

September 2, 2010

In Reply Refer To:
8160 (UTG002)

CERTIFIED-RETURN RECEIPT REQUESTED

Ivan Posey
Chairman
Eastern Shoshone
P.O. Box 538
Fort Washakie, WY 82514-0538

RE: Big Pack Area, River Bend Area, and Greater Natural Buttes EIS

Dear Chairman Posey:

The purpose of this letter is to introduce you to the Big Pack area, the River Bend area, the Greater Natural Buttes EIS, and to initiate consultation with your Tribe.

The Big Pack area is a production development area located in T12S, R22E, and T11S, R22E. This is a large area defined for oil and gas production. This project is represented by attached Map 1. We are seeking input from your Tribe on this production area in the event that this area is utilized and placed into production. The NEPA documents for the Big Pack EA were completed in December 2008. To further assist you we have included those NEPA documents on a CD. The project is located within the external boundary of the Uintah and Ouray Indian Reservation as determined by the 10th Circuit Court.

The River Bend area is a production development area located in T9S, R19E, and T9S, R20E. This project is represented by attached Map 2. The project is located within the external boundary of the Uintah and Ouray Indian Reservation as determined by the 10th Circuit Court. This is also a large area defined for oil and gas production. This project is represented by attached Map 2. We are seeking input from your Tribe on this production area in the event this area is utilized and placed into production. The NEPA documents for the River Bend EA were also completed in December 2008. NEPA documents for the River Bend EA are also on the CD for your convenience. The project is located within the external boundary of the Uintah and Ouray Indian Reservation as determined by the 10th Circuit Court.

The Greater Natural Buttes EIS is in the process of being completed. Details and a draft version of this EIS are on the enclosed CD. The Greater Natural Buttes EIS is a production development area located in T9S, R20E; T8S, R20E; T9S, R21E; T9S, R22E; T9S, R23E; T9S R24E; T10S, R20E; T10S, R21E; T10S, R22E; T10S, R23E; T11S, R21E; T11S, R22E. We are seeking input from your Tribe on this production area in the event this area is utilized and placed into production. Attached Map 3 represents the Greater Natural Buttes EIS. The project is located within the external boundary of the Uintah and Ouray Indian Reservation as determined by the 10th Circuit Court.

In accordance with the National Historic Preservation Act of 1966 (as amended) Section 101(d), the BLM Vernal Field Office respectfully inquires if there are any comments or special concerns within the proposed project areas. Please advise us whether there are any individuals, such as traditional cultural leaders or religious practitioners, who the BLM should contact in regards to these matters.

Please note that coordination will be completed with the Utah State Historic Preservation Office prior to the implementation of the project outlined in this letter. If you have any questions regarding the proposed project, please contact Fire Program Archaeologist Kathie Davies at (435)781-4460.

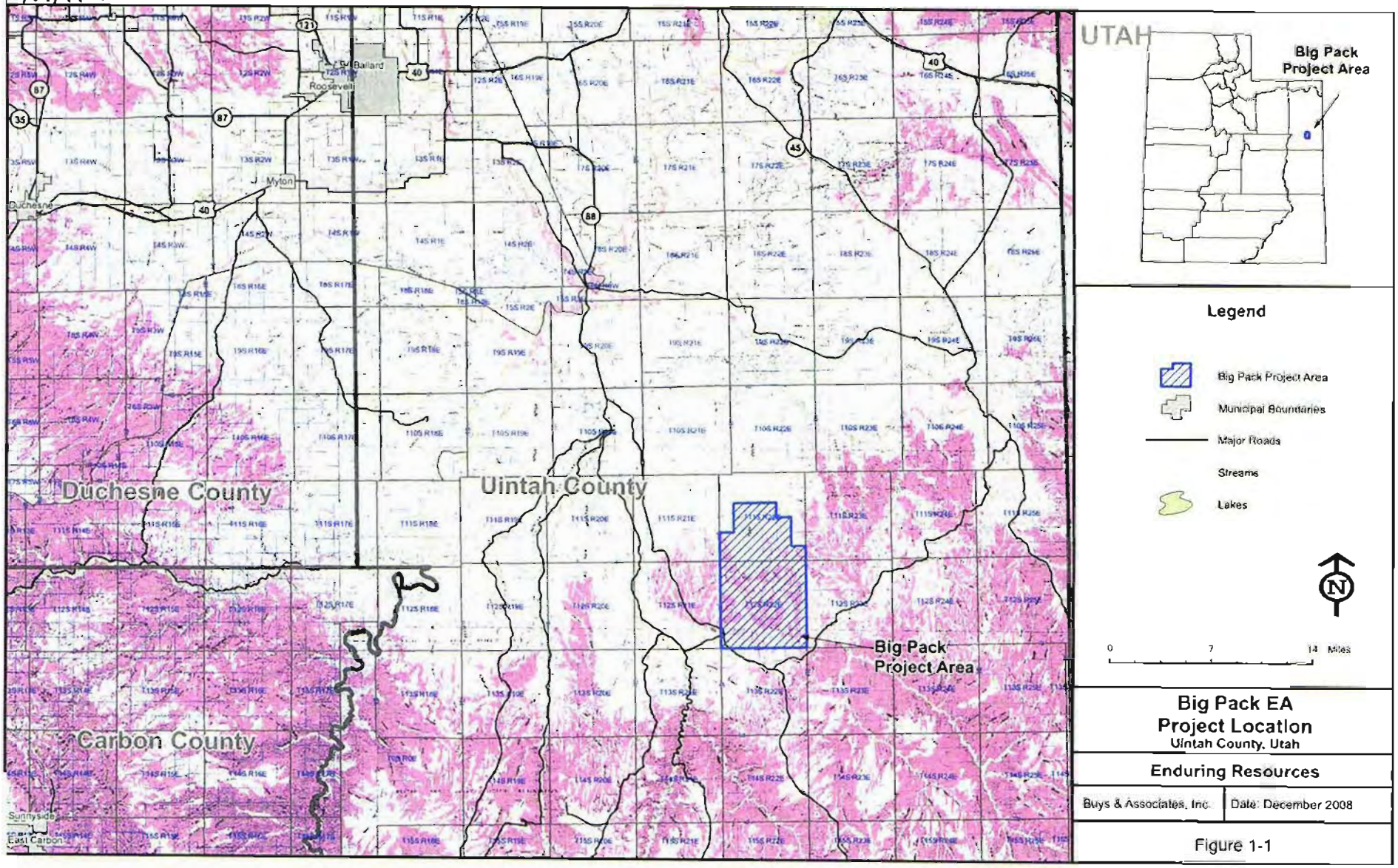
Sincerely,

James H. Sparger
Acting Assistant Field Manager
Lands and Minerals

Enclosure

MS/kad/smd

MAP1



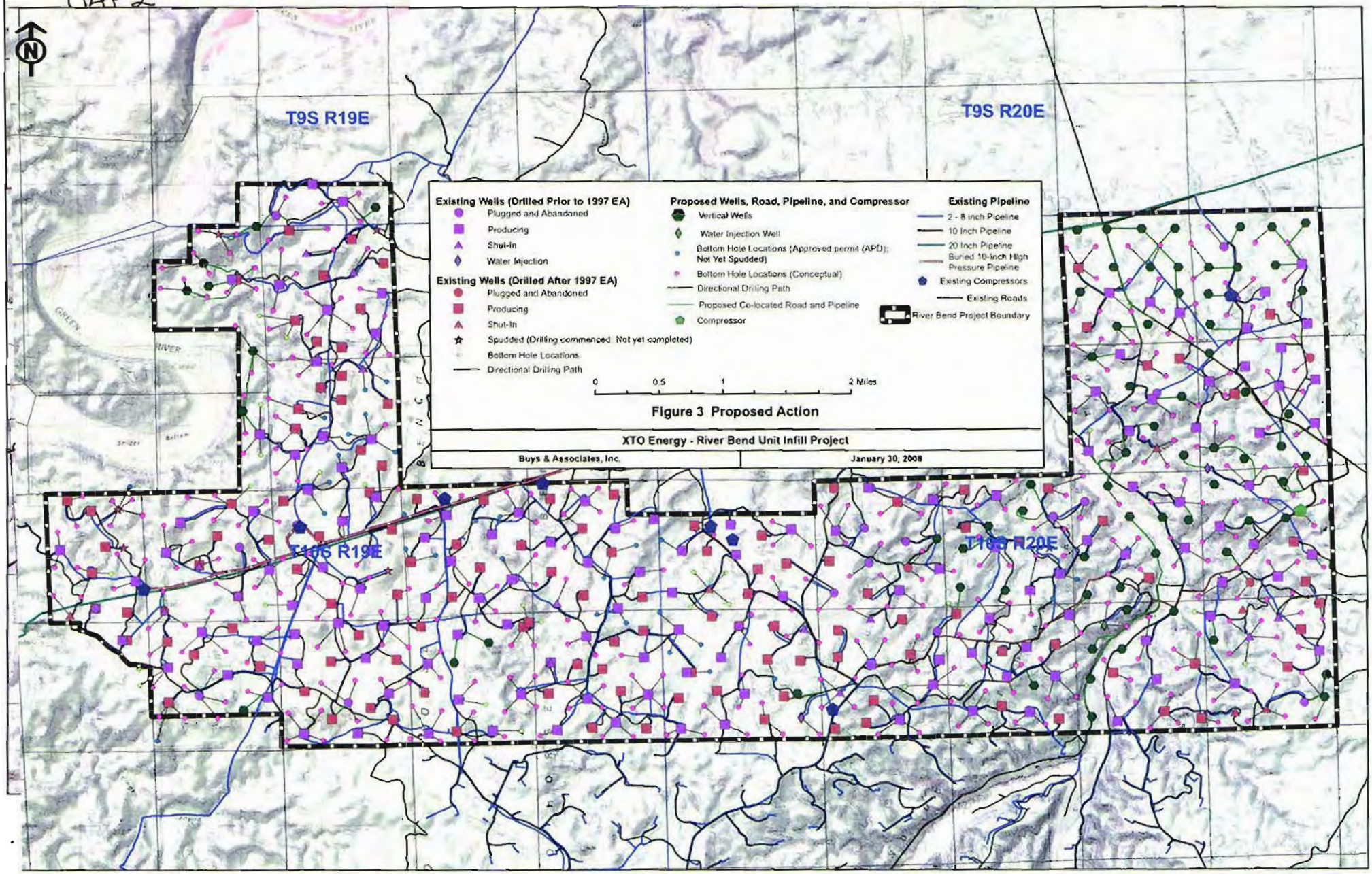
Big Pack EA
Project Location
Uintah County, Utah

Enduring Resources

Buys & Associates, Inc.	Date: December 2008

Figure 1-1

MAP 2


N
T9S R19E
T9S R20E
T10S R19E
T10S R20E
GREEN
RIVER
Existing Wells (Drilled Prior to 1997 EA)
Plugged and Abandoned
Producing
Shut-In
Water Injection
Existing Wells (Drilled After 1997 EA)
Plugged and Abandoned
Producing
Shut-In
Spudded (Drilling commenced. Not yet completed)
Bottom Hole Locations
Directional Drilling Path
Proposed Wells, Road, Pipeline, and Compressor
Vertical Wells
Water Injection Well
Bottom Hole Locations (Approved permit (APD); Not Yet Spudded)
Bottom Hole Locations (Conceptual)
Directional Drilling Path
Proposed Co-located Road and Pipeline
Compressor
Existing Pipeline
2 - 8 inch Pipeline
10 Inch Pipeline
20 Inch Pipeline
Buried 10-inch High Pressure Pipeline
Existing Compressors
Existing Roads
River Bend Project Boundary
0
0.5
1
2 Miles
Figure 3 Proposed Action
XTO Energy - River Bend Unit Infill Project
Buys & Associates, Inc.
January 30, 2008

Big Pack, River Bend, + Greater Natural Buttes EIS
+ Kerr McGee Greater Natural Buttes Blocks
(U-09-MQ-0068bp)

JT: 9/7/10

te Mountain Ute Tribe
ttn: Ernest House, Sr., Chairman
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owaoc, CO 81334-0188
010 1670 0001 2223 4358

oshute Indian Tribe
ttn: Rupert Steele, Chairman
O Box 6104
papah, UT 84034-6104
010 1670 0001 2223 4341

hite Mesa Ute Tribe
ttn: Leona Eyetoo, Councilwoman
O Box 7096
landing, UT 84511-7096
010 1670 0001 2223 4372

aguna Pueblo Tribe
ttn: John E. Antonio, Sr., Governor
O Box 194
aguna, NM 87026-0194
010 1670 0001 2223 4389

outhern Ute Tribe
ttn: Matthew Box, Chairman
O Box 737
gnacio, CO 81137-0737
010 1670 0001 2223 4365

te Indian Tribe
ttn: Curtis Cesspooch, Chairman
O Box 190
ort Duchesne, UT 84026-0190
01670 0001 2223 4334

anta Clara Pueblo Tribe
ttn: Walter Dasheno, Governor
O Box 580
spanola, NM 87532-0580
7010 1670 0001 2223 4396

Hopi Tribe
Attn: Leroy Ned Shingoitewa, Chairman
PO Box 123
Kykotsmovi, AZ 86039-0123
7010 1670 0001 2223 4402

Zia Pueblo Tribe
Attn: Ivan R. Pino, Governor
135 Capitol Square Dr.
Zia Pueblo, NM 87053-6013
7010 1670 0001 2223 4419

Navajo Nation
Attn: Joe Shirley, President
PO Box 7440
Window Rock, AZ 86515-7440
7010 1670 0001 2223 4426

Northwest Band of Shoshone Tribe
Attn: Bruce Perry, Chairman
707 N Main St.
Brigham City, UT 84302-1449
~~7010 1670 0001 2223 4419~~
7010 1670 0001 2223 4464

Eastern Shoshone Tribe
Attn: Ivan Posey, Chairman
PO Box 538
Fort Washakie, WY 82514-0538
7010 1670 0001 2223 4457

Eastern Shoshone Tribe
Attn: Wilred Ferris
Tribal Historic Preservation Office
PO Box 538
Fort Washakie, WY 82514-0538
7010 1670 0001 2223 4433

Ute Mountain Ute Tribe
Terry Knight
Tribal Historic Preservation Officer
P.O. Box JJ
Towaoc, CO 81334-0188
7010 1670 0001 2223 4440

PUEBLO OF LAGUNA
P.O. BOX 194
LAGUNA, NEW MEXICO 87026

(505) 552-6598
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(505) 552-6655

Office of:
The Governor
The Secretary
The Treasurer

RECEIVED
OCT 18 2010
BLM VERNAL, UTAH

October 13, 2010

Mr. James H. Sparger
Acting Assistant Field Manager
Bureau of Land Management
Green River District
170 South 500 East
Vernal, Utah 84078

Dear Mr. Sparger:

RE: 8160 (UTG002) Big Pack Area, River Bend Area, and Greater Natural Buttes EIS

The Pueblo of Laguna appreciates your consideration to comment on the possible interests your projects may have on any traditional or cultural properties.

The Pueblo of Laguna has determined that the undertaking WILL NOT have a significant impact at this time. However, in the event that any new archaeological sites are discovered and any new artifacts are removed, we request to be notified to review items. We also request photographs of items. According to our unpublished migration history, our ancestors journeyed from the north through that area and settled for periods of time before traveling to our present location. Therefore, the possibilities of some findings may exist.

Sincerely,

John E. Antonio, Sr.
Governor
Pueblo of Laguna

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District Office
170 South 500 East
Vernal, UT 84078
http://www.blm.gov/ut/st/en/fo/vernal.html

OCT 10 2012

IN REPLY REFER TO:
8160 (UTG011)

Lori Hunsaker
Deputy State Historic Preservation Officer
Utah Division of State History
300 Rio Grande
Salt Lake City, UT 84101

RE: XTO Energy's River Bend Unit Infill Development

Dear Ms. Hunsaker:

The Bureau of Land Management Vernal Field Office (BLM) is initiating the Section 106 process regarding XTO Energy's (XTO) River Bend Unit (RBU) Infill Development.

XTO Energy has proposed a natural gas infill development project on its Federal leases located within the River Bend Unit Project Area, approximately 34 miles south of Vernal, Utah. XTO proposes 484 new vertical and directionally drilled wells in their plan to expand and fully develop gas production in the existing RBU Project Area.

The RBU Project Area consists of approximately 16,719 acres including parts of Township 9 South, Range 19 East; Township 10 South, Range 19 East; and Township 10 South, Range 20 East; Salt Lake Meridian, Uintah County, Utah. Surface ownership in the RBU Project Area consists of BLM land, administered by the Vernal Field Office (VFO) (12,002 acres); Uintah and Ouray Indian Reservation, administered by the Bureau of Indian Affairs (BIA) (4,075 acres); and State land administered by the School and Institutional Trust Lands Administration (SITLA) (642 acres).

Surface disturbance for well pads, access roads, pipeline ROWs, and other surface facilities would equal approximately 1,075 acres. Vertical drilling of up to 74 natural gas wells from 74 new well pads; Directional drilling of up to 32 wells from the 74 new well pads; Directional drilling of up to 378 natural gas wells from existing well pads (well pads would be expanded by up to 0.5 acre per well); Construction of 12 miles of new co-located road, gas lines, and produced water lines; installation of up to 99 miles of replacement gas lines that would transport gas produced from both existing and proposed wells to the main gathering lines, and; Construction of one new compressor station and expansion of eight existing compressor stations.

Most of the RBU Project Area is currently developed, with the majority of proposed development in areas where cultural resource inventories have been conducted.

The Class I cultural resource review identified 284 previous cultural resource inventories that have been conducted in the RBU Project Area. Most of the inventories were conducted during the permitting process for oil and gas exploration and development, including seismic operations, and well pad and pipeline construction. Of the 284 previous inventories, 251 (88 percent) resulted in a finding of no cultural resources. Thirty-three (12 percent) of these previous cultural resource inventories identified a total of 51 archaeological sites within the RBU Project Area. Of the 51 known archaeological sites, located within the RBU Project Area, 31 (61 percent) were evaluated to be eligible for listing on the NRHP, 18 (35 percent) were evaluated to be ineligible for listing on the NRHP, and two (0.04 percent) were not evaluated. These known archeological resources in the RBU Project Area are dominated by prehistoric sites (67 percent of the sites identified). Prehistoric site types within the RBU Project Area consist of lithic scatters, rock art, open camps, and rock shelters. Historic site types within the RBU Project Area consist of temporary camps, rock art, cairns, and Gilsonite mining sites. Based on the results of the Class I data review, predictions about site density, location, type, and sensitivity within the RBU Project Area can be made tentatively. Because inventories in the RBU Project Area have been done mostly in response to cultural resource clearances required for individual projects, their findings may not be representative of the entire RBU Project Area. However, given the available information, we can anticipate that sites would most likely be associated with temporary use of the area during the prehistoric time period. The available documentation indicates that sensitive sites (eligible to the NRHP) having additional research potential may be common in the immediate study area.

Prior to the initiation of construction activities, a Class III inventory will be conducted in all areas of proposed surface disturbance.

In order to avoid, or mitigate adverse effects on historic properties, XTO has committed to the following measures:

- A Class III inventory will be conducted in all areas proposed for surface disturbance. The inventories will be conducted on a site-specific basis prior to the initiation of construction activities. At each proposed well and compressor station location, a 10-acre square parcel would be defined, and centered on the well pad center stake. The 10-acre parcel would be examined for cultural resources by an archaeologist, walking parallel transects spaced no more than 30 feet apart. All access, gas line, and water line routes would be surveyed to a width of 200 feet.

- Whenever feasible, prehistoric and historic sites documented during the Class III inventory as eligible for listing on the National Register of Historic Places (NRHP), as well as areas identified as having a high probability of significant subsurface materials, would be avoided by development. Specifically, well pad locations and access/gas and

water line routes would be altered or rerouted as necessary to avoid impacting NRHP-eligible sites.

• If avoidance is not feasible, or does not provide the required protection, adverse effects would be mitigated (e.g., data recovery through excavation).

• If cultural resources are uncovered during surface-disturbing activities, XTO would suspend operations at the site and immediately contact the AO, who would arrange for a determination of eligibility in consultation with the SHPO, and, if necessary, recommend a recovery or avoidance plan.

• XTO would inform their employees, contractors, and subcontractors about relevant Federal regulations intended to protect archaeological and cultural resources. All personnel would be informed that collecting artifacts is a violation of Federal law and that employees engaged in this activity would be subject to disciplinary action.

With the consideration of the applicant committed measures listed above, the BLM has made a determination of No Adverse Effect 36 CFR 800.5(b) for the undertaking.

We request your comment on our effect determination for this undertaking. If you have any questions, please contact Cameron Cox, Archaeologist at (435)781-3411.

Sincerely,

Jerry Kenczka
Assistant Field Manager
Lands and Minerals

cc: Kristine Curry, Archaeologist, State of Utah School and Institutional Trust Lands Administration
Garry Cantley, Archaeologist, Bureau of Indian Affairs, Western Regional Office

Enclosures: Surface Disturbance Table
Known Archaeological Sites
RBU Project Area Map

MW/cc
Central File

CCOX;4October2012

State of Utah

GARY R. HERBERT
Governor

GREG BELL
Lieutenant Governor

Department of Heritage and Arts

Julie Fisher
Executive Director

State History

Wilson G. Martin
Director

RECEIVED
OCT 25 2012
BLM, Vernal Utah

October 22, 2012

Jerry Kenczka, Assistant Field Manager
Lands and Minerals
Bureau of Land Management
Green River District Office
170 South 500 East
Vernal Utah 84078

RE: XTO Energy's River Bend Unit Infill Development

For future correspondence please reference Case No. 12-2026

Dear Mr. Kenczka:

The Utah State Historic Preservation Office received your request for our comment on the above referenced undertaking on October 16, 2012.

We concur with your determinations of eligibility and effect for this undertaking.

This letter serves as our comment on the determinations you have made, within the consultation process specified in §36CFR800.4. If you have questions, please contact me at 801-245-7241 or Jim Dykmann at 801-245-7234.

Sincerely,

Jim Dykmann
Archaeologist
USHPO
for Lori Hunsaker
Lori Hunsaker
Deputy State Historic Preservation Officer
Archaeology

APPENDIX K

XTO Energy's River Bend Unit Infill Development Environmental Assessment Response to Comments

XTO Energy's
River Bend Unit Infill Development
Environmental Assessment Response to Comments

Respondent	Comment Number	Comment	Agency Response
XTO	1	BLM has provided no basis for selection of Alternative C over Alternative A; Both Alternatives would have Insignificant Impacts to surface resources when added to existing development in the area and to air resources when compared to existing emissions, and given the Clean Air Act Subpart OOOO which will result in substantial VOC reductions.	The U.S. Environmental Protection Agency (EPA) submitted a comment letter encompassing the XTO Riverbend EA, the Enduring Resources Southam Canyon EA, and the XTO Big Pack (Little Canyon) EA that raised questions regarding the adequacy of the air quality analysis in the initial EA that was prepared for the project. To determine the relative impact of this project's alternatives, the BLM agreed to create two reduced development alternatives (250 wells and 150 wells), and conduct an Emissions Inventory comparison. These alternatives were developed to illustrate the difference with regard to air quality impacts between the Proposed Action and alternatives the Proposed Action and alternatives. It was determined that Alternative C was the agency preferred alternative due to its proportionally fewer impacts compared to those impacts anticipated under the proposed action. Specifically, given the modeled 24-hour $PM_{2.5}$ NAAQS exceedances under the proposed action, Alternative C was selected as the agency preferred alternative because it would result in proportionally fewer $PM_{2.5}$ emissions. In addition, under Alternative C, no new surface disturbance would occur within: USFWS designated Level 1 core conservation areas for Uinta Basin hookless cactus, mapped 100-year floodplains, the Lower Green River suitable WSR; and Visual Resource Management (VRM) Class II areas, all of which would be impacted by the proposed action.
XTO	2	Under XTO's federal leases XTO has a contractual right, and an obligation, to produce commercial quantities of hydrocarbons. Based upon the plain language of XTO's leases, and BLM's statutory requirements under FLPMA, it is not appropriate to base NEPA alternatives upon scaled-down recovery of mineral resources, particularly for an infill project within a long existing active gas field. Accordingly, Alternatives C and D should be re-named and dismissed as not meeting the purpose and need of the Project.	The NEPA directs lead agencies to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal that involves unresolved conflicts concerning alternative uses of available resources;…" (NEPA Sec. 102(2)(E)). Alternatives must be analyzed as necessary so as to provide a reasoned choice (40 CFR 1502.14). NEPA requires lead agencies to develop and assess reasonable alternatives that meet the purpose and need for agency action. In determining the alternatives to be considered, the emphasis is on what is "reasonable" rather than on whether the proponent or applicant likes or is itself capable of implementing an alternative.

Respondent	Comment Number	Comment	Agency Response
			"Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant." BLM has identified a number of resources that would be protected by the adoption of either Alternative C or D. These resources include air quality, USFWS designated Level 1 core conservation areas for Uinta Basin hookless cactus, mapped 100-year floodplains, the Lower Green River suitable WSR, and Visual Resource Management (VRM) Class II areas. See also the response to XTO 1. None of the environmental protection measures described under Alternative C or D would disallow lawful access to develop a lease, but they may require relocation of well pads, roads, or ancillary facilities within the lease, or require special construction or operational methods to reduce potential environmental impacts. Both alternatives meet the purpose and need as described in Section 1.2. None of the alternatives preclude future proposals for further development of the leases, though any such future proposal would have to be analyzed under the NEPA process.
XTO	3	The Draft EA needs to be revised to clarify and put into proper context the background concentrations of zone. The Draft EA needs to be revised to explain the difference between "background values" and "design values" for purposes of air quality analysis The Draft EA should be updated to reflect background concentrations based upon all of the monitors now operating in the Basin, and include the new monitoring data for winter ozone from the winter of 2012	The highest value from a monitor in the airshed was used to define the background value. As XTO alludes to, more recent monitoring has shown lower values, and the majority of observed ozone concentrations in the region are less than 75 ppb. However this data was not publically available at the time the draft EA was written. BLM updated the EA to include more recent monitoring results and what they mean; however the background concentration as reported remains the same.
XTO	4	As drafted, it is not clear whether the additional ozone mitigation measures would be required if there is a single exceedance of the 75ppb ozone NAAQS standard, or whether it is based upon the three year average of the fourth-highest daily maximum 8-hour concentration. BLM needs to revise and clarify this section.	This requirement was rewritten for clarity. BLM will review, in consultation with EPA and UDEQ, any monitored exceedances in the Uinta Basin in the future to determine whether the enhanced mitigation defined in the EA should be required as a result of the monitored exceedance. There are other potential reasons and sources that may lead to a monitored exceedance (e.g. wildfires) and it is not reasonable to automatically require enhanced mitigation without prior review. The exceedance trigger is however based on a single exceedance of the standard.
XTO	5	On page 4-19 of the Draft EA, Section 4.2.5.1, BLM needs to	The reference to the GASCO ROD is an error and has been removed.

Respondent	Comment Number	Comment	Agency Response
		revise and clarify regarding the Gasco ROD and EIS. As currently drafted, it is not clear whether this requirement is a trigger point for XTO or whether this is just an error by including out-of-date language from the Gasco Draft EIS (BLM issued the Gasco ROD in June 2012).	However, the BLM will be taking future actions to update air quality ozone modeling analyses and, as justified by the updated ozone modeling, to reduce the potential for exceedances of the ozone NAAQS.
XTO	6	The Draft EA needs to be updated to include the monitored ozone values from the winter of 2011-2012, and a brief discussion of the on-going Uinta Basin Winter Ozone Study. At a minimum, to place the winter ozone phenomenon into context, the Draft EA should provide an overview of this study, and explain that further research is being conducted to determine what measures, if any, can be examined to address potential emissions that contribute to winter ozone formation.	The monitored ozone values for 2011 to 2012 have been updated. However, the final report of the 2012 Uinta Basin Winter Ozone Study was not publically available at the time the EA was developed. After review of the draft 2012 Uinta Basin Winter Ozone Study it does not appear that any of the recommendations or requirements contained in the draft EA will be modified as a result of this new information with the exception of the items already mentioned in these comment responses.
XTO	7	BLM should keep this infill project within the context of XTO's valid existing lease rights. Under BLM's regulations for oil and gas, XTO, as lessee, shall have the right to use <u>so much of the leased lands as is necessary</u> to explore for, drill for, mine, extract, remove and dispose of all the leased resource in a leasehold . . . .. 43 C.F.R. § 3101.1-2 (emphasis added). Under FLPMA, BLM is obligated to recognize valid existing lease rights. 43 U.S.C. § 1701 note (h) ("[a]ll actions by the Secretary concerned under this Act shall be subject to valid existing rights."); see also 43 C.F.R. § 1610.5-3(b).	As described in Section 1.2 of the EA, BLM's need for the project is to fulfill its responsibilities under federal laws for oil and gas leases to allow leaseholders to develop mineral resources to meet continuing national energy needs. The MLA, as amended and its implementing regulations allow, and essentially encourage, lessees or potential lessees to explore for oil and gas or other mineral reserves on Federally-administered lands. The FLPMA of 1976, mandates that the BLM manage public lands on the basis of multiple use [43 U.S.C. § 1701(a)(7)]. Minerals are identified as one of the principal uses of public lands in Section 103 of FLPMA [43 U.S.C. § 1702(c)]. The BLM is responsible for administering activities consistent with rights associated with valid existing leases. As a part of the multiple use mandate, the BLM also has a FLPMA obligation to manage for multiple uses and comply with laws designed to protect the environment. See also the response to XTO Comments #1 and 2.
XTO	8	Contrary to BLM's statement in Appendix A: (a) there are no wilderness characteristics in the Project area; (b) no new wilderness characteristics inventory is necessary; and (c) no analysis of the impacts on the Project on non-existent lands with wilderness characteristics is necessary.	The wrong ID team checklist (outdated) was inadvertently attached to the draft EA. The correct checklist has been attached.
XTO	9	NEPA does not mandate that BLM prioritize protection of other resources over XTO's exercise of its rights in its valid existing lease rights. The XTO leases do not contain any lease restrictions for the protection of the Pronghorn Antelope.	Based on this comment, the pronghorn timing restriction has been removed from the applicant committed environmental protection measures in Section 2.1.12.3 of the EA.

Respondent	Comment Number	Comment	Agency Response
		Further, BLM does not even consider the Pronghorn Antelope to be a sensitive species. Given that XTO's leases do not contain any Pronghorn stipulations, and that Pronghorn are not a sensitive species, the proposed restrictions should be removed from the EA.	
XTO	10	BLM's purpose and need detailed in Chapter 1 of the Draft EA is insufficient. BLM is required not only to consider the purpose and need of the agency, but must also include the purpose and need of XTO. To be legally sufficient, the River Bend EA needs to be revised to include not only the purpose and need of BLM, but also the purpose and need of XTO, the project proponent.	BLM Handbook H1790-1 states that the purpose and need of the project is federal and that the proponent's purpose and need is important background information. The proponent's purpose and need of developing leases and meeting contractual obligations is discussed in Section 1.1.
U.S. EPA, Region 8	1	Near-field air quality modeling performed for the project resulted in values that exceed the 24-hour $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). In order to support a FONSI, the EPA recommends that the EA also identify and discuss mitigation the BLM will require for these exceedances. Any exceedances of the $PM_{2.5}$ NAAQS should be avoided to prevent adverse impacts associated with short-term exposure. We recommend that the EA acknowledge this predicted adverse impact and discuss the mitigation measures that will be implemented to prevent a $PM_{2.5}$ exceedance Regarding the need to mitigate predicted adverse impacts to the $PM_{2.5}$ NAAQS, it is possible that the impacts predicted by modeling may already be mitigated by selection of the Preferred Alternative because the rate of development for the Preferred Alternative is lower than the Proposed Action. If this is the case, the EPA recommends that the EA/FONSI explain the basis for the BLM's conclusion.	As explained in the footnote to Table 4.2-4, the modeled impact shown is the maximum value, not the 98th percentile. In addition, the background quoted (from the Ouray station as noted in Table 3.2-2 of the EA) is a maximum of two nearby monitoring stations and not representative of the regional 98th percentile 3-year average. The significance criterion for $PM_{2.5}$ is defined by the NAAQS which is designed to protect the public health and welfare. The PM2.5 NAAQS is both a numerical value (i.e., 35) and the form of that value (3-year average 98th percentile). The potential $PM_{2.5}$ impact is roughly proportional to the emissions and the emissions are roughly proportional to the number of wells developed per year and the total number of wells. Since Alternatives B through D have fewer wells than the Proposed Action (Alternative A), the potential $PM_{2.5}$ impact will be roughly proportionally less than shown for the Proposed Action (Alternative A). BLM is confident the dust controls used in the modeling analysis together with other practical dust control measures and the reduced rate of development under the agency preferred alternative will also ensure no violations of the $PM_{2.5}$ NAAQS.
U.S. EPA, Region 8	2	The EA incorrectly states that the Greater Natural Buttes (GNB) EIS showed a "maximum single hour modeled impacts" greater than the 1-hour NO_2 NAAQS. The GNB EIS showed modeled 1-hour NO_2 that did not exceed the NAAQS.	The comment is correct as the Final EIS for Greater Natural Buttes showed that the 1-hour NO_2 NAAQS would not be exceeded. The EA has been corrected.
U.S. EPA, Region 8	3	Move the discussion regarding sensitive Class II areas currently appearing in Chapter 5 (the cumulative impacts chapter) to	The discussion regarding sensitive Class II areas for the Proposed Action alone currently appearing in Chapter 5 has been moved to

Respondent	Comment Number	Comment	Agency Response
		Chapter 4 (the project impacts chapter), because this discussion appears to be more focused on project-specific impacts than cumulative impacts.	Chapter 4 as requested.
U.S. EPA, Region 8	4	Revise Chapter 5 to include a summary of cumulative visibility impacts to Class I and sensitive Class II areas predicted in the Greater Natural Buttes EIS. The EPA believes this is an important piece of disclosure since cumulative impacts were projected to be high in the GNB analysis area.	Chapter 5 will be revised to include a summary of cumulative visibility impacts to Class I and sensitive Class II areas predicted in the Greater Natural Buttes EIS as requested.
U.S. EPA, Region 8	5	It is unclear what the BLM means by the commitment to control emissions from glycol dehydrators "based on emissions values". We assume this means XTO will install low emission glycol dehydrators at all existing and new compressor stations and production wells, similar to the commitment in the recent GASCO and GNB Records of Decision. We recommend that the FONSI clarify this point.	The mitigation measure for glycol dehydrators has been clarified to say: Installation of low emission glycol dehydrators at all existing and new compressor stations and production wells where uncontrolled emissions are over five tons per year. Due to various well production rates (especially for existing wells) and various sizes of compressor stations, it will be more important to install low emitting dehydrators at locations with relatively high uncontrolled emissions than at sites with relatively low emissions.
Ken Kreckel	1	Surface impacts under all drilling alternatives could be reduced by drilling all of the proposed wells from existing well pads. The EA states that vertical drilling depths through the prospective portions of the Mesaverde are less than 9000'. An examination of the State of Utah files for wells in the immediate area shows that the Mesaverde is found at approximately 7500'. Other productive zones in the Wasatch are at about 6000'. Using these numbers, I arrived at the parameters required to drill the proposed directional wells. A 40 acre surface spacing unit can be thought of a square with sides of 1320'. Assuming the surface well pad is placed at the center of this square, it follows by simple geometry that the maximum horizontal reach for a directional well on a down hole spacing of 5 acres would be no longer than about 933. This represents the directional wells that would be drilled from existing well pads. The directional parameters required to do this are straightforward and well understood. The required build rates and inclination angles to drill an S-curve well meeting these requirements under the same geological conditions have been achieved in numerous locations in Utah, including the Peter's Point area of West Tavaputs.	The below was summarized by the BLM from a response provided by XTO. The BLM has reviewed the response for adequacy and accuracy. Where technically and economically feasible, XTO is committed to minimizing surface disturbance in the RBU area. XTO recognizes from our past experience in the area that there can be benefits from drilling directional wells in a pad development and has even made this the cornerstone of the RBU development plan (84.7% of wells proposed in Plan A are directional wells). Mr. Kreckel's reference to 5-acre or 10-acre spacing is not relevant to the development plan in the RBU EA. Infill wells for this project are proposed on a 20-acre spacing basis. Development on a 20 acre spacing basis would require ~1319' of lateral distance to achieve the

Respondent	Comment Number	Comment	Agency Response
		Directional wells of much longer reach have already been successfully demonstrated by XTO in an adjacent section to the Riverbend project area. The Evans Federal 15-25E, drilled in 2004 in the NWSE of section 25 T10S, R19E achieved a horizontal reach of just over 1300'. Directional parameters for this well were a build and drop rate of 3 degrees per 100' and an inclination angle of 34 degrees. This well was perforated and fracked across a gross interval of 5386' to 8306' in the Wasatch and Mesaverde.	bottom hole location, ~40% longer than Mr Kreckel calculated for a proposed directional well in this unit. In addition, some of the original wells within the RBU were not drilled in the center of the quarter section due to topography limitations or due to environmental concerns such as local vegetation or wildlife activity. These scenarios extend the lateral reach required to achieve the 20 acre bottom hole location. Mr. Kreckel's comment fails to account for all technical and economic considerations of drilling these types of directional wells. As the deviation of a well increases, tool conveyance (such as plugs, packers, etc…) used in completion and workover operations become much more difficult to run into the wellbore and set without failure, adding incremental risk to most jobs performed on deviated wells. Increasing angle of deviation in a directional wellbore also reduces the effectiveness of artificial lift methods due to increased wear on down-hole tools and decreased efficiency of wellbore hydraulics (liquid unloading). All wells in this project area require artificial lift, and any decrease in effectiveness of these methods will decrease reserve recovery, increase operating costs, and increase surface activities for repair and maintenance. For example, one of the primary methods of artificial lift for XTO and other operators in the area is rod pumping. This method includes a downhole pump with steel rods to surface and a reciprocating unit to stroke the pump to remove fluids from the wellbore. XTO has experienced operation difficulty with rod pumps in deviated wells because the high angle in the wellbore tends to increase friction and rod wear, ultimately leading to premature failure of the pumping system. The only remedy fix this is to move a workover rig on location to replace the string. This increased failure frequency drives up operating costs and decreases the efficiency of reserve capture.
Ken Kreckel	2	The Table on page 2-27 show 0 directional wells to be drilled from new vertical well pads under Alternatives C and D, yet the maps show many such wells to be drilled from new well pads.	Alternatives C and D would both employ the use of directional drilling. Alternative C would involve approximately 180 wells that would be drilled from existing pads, and Alternative D would involve approximately 108 wells drilled from existing pads. The referenced table has been clarified.

Respondent	Comment Number	Comment	Agency Response
NPS	1	Ensure that the ozone action strategies associated with this infill proposal identify in detail how and when additional air quality mitigation will be implemented, should regional modeling or monitoring demonstrate this step is necessary.	Section 4.2.5 details how and when air quality mitigation will be implemented.
NPS	2	It is not appropriate to extrapolate VISCREEN results at 50 km distance from the project area to represent impacts at the NPS Class I areas, which are in excess of 100 km from the River Bend unit. The closest boundary of Dinosaur NM is approximately 50km away from the project area. The only appropriate models to evaluate visibility impairment in the Class I areas, and portions of the Class II area that are greater than 50 km from the project are CALPUFF or photochemical grid model, as these assess multi plume impacts. As described in the FLAG document, the VISCREEN model is a near-field steady state plume blight assessment, appropriate for applications where the emission sources is less than 50 km from the receptor area (e.g., NPS unit). In a near field situation (i.e., approximate steady state conditions), visibility impairment from a discrete plume is calculated using contrast and color difference as compared with a viewed background.	It is recognized that the CALPUFF model is a more refined method to assess potential visibility impacts. It is also understood, and it was explained in the EA, that the VISCREEN model uses different parameters than the CALPUFF model to assess visual air quality, and that the VISCREEN model is limited to 50 km. However, potential visual air quality impacts at 50 km from a source will always be greater than at distances greater than 50 km. Also, screening modeling techniques, such as VISCREEN, by design yield greater calculated impacts than more refined models. If the coherent plume assumed by VISCREEN does not cause a significant visual air quality impact at 50 km, then there would not be a significant impact when an actual, diffuse plume were modeled at the greater distances for the Class I and II areas of interest. Accordingly, if CALPUFF was used at distances greater than 50 km, the modeled visual air quality impacts would be less than calculated by VISCREEN and presented in the EA. The screening analysis in the EA is combined with the more refined analysis from the GNB project (which used CALPUFF and the more refined techniques). The combination of RBU-specific screening and tiering off other analyses is consistent with the National Air Quality MOU and is sufficient to determine whether RBU project emissions will significantly contribute to visual air quality both alone and cumulatively. Refer also to EPA comment #8.
NPS	3	The EA discussed the VISCREEN results in terms of the change in deciview metric. This does not conform to recommendations in the FLAG document or the VISCREEN manual, which uses a change in color threshold of less than or equal to 2.0 and the absolute value of the change in contrast of less than or equal to 0.05. Please revise the text accordingly.	The comment is correct. VISCREEN uses different significance criteria than CALPUFF. However, as explained in the EA Section 4.2.1.4, those parameters are less stringent that the "just noticeable change" significance criterion used for regional haze impact assessments. That is why the significance criterion was changed to a contrast of 0.02 instead of 0.05 as explained in the EA.
NPS	4	The VISCREEN analysis used an incorrect background visual range of 170 km. The analysis should have used the annual average estimated natural background visual range value for Arches NP, reported in Table 10 of the FLAG 2012 document, which is approximately 274 km.	If a more refined CALPUFF model were to be used, then a more refined background visual range could be used. However, it is not appropriate to mix VISCREEN methodologies with refined methodologies. The refined background visual range was used in the CALPUFF modeling of GNB.

Respondent	Comment Number	Comment	Agency Response
NPS	5	We cannot assess from the information provided in the EA, and the air analysis appendices if the NPS recommended "virtual point source" method was applied when evaluating near-field visibility impacts from oil and gas activities in the VISCREEN assessment.	It is recognized that when running VISCREEN for an area source at distances less than 50 km, a virtual source methodology is appropriate. For the EA, however, the distances are greater than 50 km, so using a virtual source methodology will not yield a different result (i.e., the distance is still 50 km, even at A stability). To be conservative (i.e., over-state the impacts), the VISCREEN model was run as if all of the emissions came from a single point 50 km away from the Class I or II area of interest.
NPS	6	Although the UBAQS-based modeling for this study used updated, project-specific emissions and showed relatively modest impacts with regard to ozone, it is not clear that a more advanced modeling platform would predict the same results. In addition, the model simulations employ spatial resolutions of 4 km while the results presented used a 12 km UBAQS model domain. The NPS questions the continued reliance on these modeling results to conclude that cumulative ozone impacts are not anticipated.	BLM is developing a more refined ozone analysis, including using a more resolved modeling domain of 4 km as recommend by NPS, and expects this analysis to be available for use by early 2013. This is one of the reasons for the BLM ARMS Adaptive Management Strategy and modeling studies committed to in the EA. The ozone modeling conducted for the RBU EA was conducted by the BLM's contractor for the EA. It has been included in the RBU EA as relevant data since it is available, and based on a BLM review of the modeling assumptions (particularly emissions) that went into the calculations it is a conservative analysis.
NPS	7	Due to no regional ozone action plan, the NPS is greatly concerned about the cumulative air quality impacts of oil and gas development in this region and recommend rigorous mitigation of emissions for all area projects.	The Uinta Basin is not currently in non-attainment and there is no requirement for a regional ozone action plan. BLM has recently conducted numerous ozone analyses and determined that under the mitigation strategy employed in this EA and across the field, BLM has complied with its duties under NEPA to disclose the impacts to air quality in the EA. As discussed in Comment NPS #1, the EA details specific actions, including mitigation that will be taken as the result of new studies with respect to cumulative ozone impacts.
NPS	8	The NPS believes that immediate enhanced mitigation measures are appropriate due to the recent monitored exceedances of the ozone standard at multiple locations in the Uinta Basin as well as the lack of an AQRV assessment in the analysis.	The controls and mitigation defined in the EA represents BLM's determination of presumptive-BACT (Best Available Control Technology) and is consistent with the controls and mitigation in other recent oil and gas development projects in the Uinta Basin. Enhanced mitigation options are included in the EA to recognize that an understanding of winter ozone formation is currently in its early stages, and informed and effective control strategies cannot at this time be realistically evaluated. Intensive studies are currently underway in the Uinta Basin to resolve this issue, and the adaptive management

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			components in the EA insures that once a comprehensive control strategy is developed activities authorized by this EA will be included. It is premature at this time to require controls beyond BACT that cannot be adequately demonstrated as effective. The BLM does however support the selection of a reduced development alternative to minimize any potential adverse air quality impacts that could result from this decision, as is consistent with NEPA guidelines.
Southern Utah Wilderness Alliance (SUWA)	1	This project will exceed limits on ozone; the BLM cannot approve project that will lead to exceedances of federal air quality standards. FLPMA also requires the BLM to ensure that its approval of oil and gas development complies with all applicable air quality standards. The BLM is obligated, by FLPMA, to comply with the environmental standards established in the Clean Air Act. This means that the BLM may not permit development that will result in exceedances of NAAQS, PSD increments, or air quality related values. The River Bend EA indicates that this project will likely increase ozone levels in the Uinta Basin in 2018 by nearly one part per billion (ppb). The BLM then only focuses on summertime values of ozone pollution and says that ozone levels in the region will meet federal air quality standards. However, this ignores two major problems. First, wintertime ozone levels are well above federal standards. Although BLM cannot yet model such exceedances, it knows that this project will increase ozone pollution levels in the Uinta Basin. Therefore, it knows that this project is likely to exacerbate levels already well in excess of federal standards. Second, the BLM totally ignores the likelihood that the Environmental Protection Agency is likely to revise ozone limits down within the future. In that case, the BLM will likely violate federal limits in the summer as well.	SUWA is making the argument that BLM is not complying with "federal air quality standards" by authorizing projects with air emissions in an area that has monitored exceedances of these standards. The National Ambient Air Quality Standards (NAAQS) are ambient concentrations of specific air pollutants which EPA has established by regulation that trigger specific regulatory responses by state, tribal, and/or federal agencies. The NAAQS does not nor is it intended to define how sources of air pollution will be controlled or regulated to achieve these standards. The Clean Air Act defines the process by which an area is first classified as nonattainment (or not meeting the standards) and also defines how approvable and enforceable plans (i.e. state implementation plans) will be developed to address nonattainment. As the project area is still considered unclassifiable, and regulated as an attainment area, and no relevant SIP is in place to guide control of new sources of air emissions, SUWA's assertion that BLM is not complying with federal air standards is not correct. There are no federal air standards that will be violated by BLM's authorization of new sources of air emissions in the project area. FLPMA contains a requirement that "the public lands be managed in a manner that will protect the quality of …air and atmospheric, …values". BLM recognizes this affirmative responsibility, and through this analysis, the use of applicant committed control measures and identified mitigation, and the proactive adaptive management strategy outlined in the draft EA, is pursuing both the aggressive application of presumptive best available control technologies and the ongoing and comprehensive analysis of the existing air resource issues identified in the project area. To that end BLM is conducting a regional modeling exercise to evaluate air quality conditions in the Uinta Basin and identify concrete and scientifically defensible control strategies. BLM

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			has evaluated the proposed RBU project using the best available science, has applied controls and mitigation consistent with existing regulatory and management practices, and is undertaking and directing subsequent analysis to further refine and improve air quality management in the project area to fulfill its commitment under FLPMA related to both this specific project and to its overall public lands responsibilities. BLM firmly believes these actions are managing the public lands in a manner that will protect their air resource values while ensuring continued and responsible multiple use on these lands. Comprehensive and widespread ozone monitoring in the Uinta Basin for the 2011/2012 winter period has not recorded any exceedances of the ozone NAAQS. While it is possible that there will be future winter ozone issues in the Basin this is not a given and SUWA is jumping the gun on declaring the basin in nonattainment. It is entirely possible that current management actions may be effective in addressing this problem. BLM, EPA, and the State of Utah are working diligently on this problem. A comprehensive and collaborative air quality study, partially funded by BLM, has been ongoing the past two years to try to answer these questions, however there is still no accepted basis on which to make control determinations, nor, as SUWA points out, are we able to model winter ozone formation yet. The adaptive management components of the EA will ensure that once effective and scientifically valid control measures are determined they can be applied to the RBU and other oil and gas development projects in the Uinta Basin.
SUWA	2	The EA rejects the need to perform analysis on whether NO_2 standards will be exceeded on the basis that the activity in a given area would occur for less than the three-year period. FLPMA requires the BLM to ensure, or require, that its approval of oil and gas development complies with all applicable air quality standards. The BLM's discussion shows that clearly there is a possibility that rigs could come back to the same region three years in a row. BLM must therefore require that rigs not be located in a similar area for three consecutive years or for any combination that will result in levels of NO_2 above 188 micrograms per cubic meter ($\mu g/m^3$), such as two consecutive years of drilling in a region.	The EA has been revised to make it clear that the 1-hour NO_2 NAAQS will not be exceeded. Refer to comment EPA 1.

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SUWA	3	The EA's surface water quality section should be updated to reflect the most current information regarding Willow Creek, the only perennial stream in the project area. This would include 2010 Utah Division of Water Quality intensive assessment data and results for Willow Creek.	Section 3.2.3.1 (Surface Water) in the EA has been updated to include water quality data through May 2009 for Willow Creek monitoring station 4933500. The EPA STORET database does not contain data that is more current than 2009. Therefore, the EA includes the most current data that is available.
SUWA	4	The Riverbend EA violates 43 C.F.R. § 2920.7(b) which requires that "[e]ach land use authorization shall contain terms and conditions which shall… [r]equire compliance with air and water quality standards established pursuant to applicable Federal and State law." Each of the action alternatives would increase sedimentation and negatively impact Willow Creek, a 303d listed stream. The EA also violate state water quality standards in violation of FLPMA. See 43 U.S.C. § 1712(c)(8); 43 C.F.R. § 1610.3-2.	This regulation does not pertain to permitting of oil and gas operations which are covered by 43 C.F.R. Part 3160. There is nothing in the EA that suggests that the project, as proposed, would violate water quality standards pursuant to applicable Federal and State law. Regardless, BLM recognizes that erosion and sedimentation are serious issues. XTO has committed to specific Environmental Protection Measures which will prevent sedimentation resulting from erosion, Section 2.1.12.4, and to prevent pollutant discharges to Willow Creek, Section 2.1.12.6. Additionally, the BLM has recommended specific mitigation measures that will decrease sedimentation discharge, including the implementation of various widely-accepted best management practices, seeding, revegetation, and berms to prevent stormwater runoff, Section 4.3.5.
SUWA	5	The EA also violates NEPA because it did not indicate that XTO will need to obtain permits for the discharge of storm water from culverts or diversion ditches that would be built as a result of the project. Also, because the Riverbend EA authorizes exceedances of water quality standards it violates the Clean Water Act, 33 U.S.C. § 1323(a)	The Ninth Circuit Court of Appeals vacated the EPA's 2006 oil and gas construction storm water regulation. However, the Energy Policy Act's clarification of the activities included in the Clean Water Act 402(i)(2) still apply. Under the Energy Policy Act's clarification, only activities (industrial or construction) that result in a discharge of a reportable quantity release or that contribute pollutants to a violation of water quality standard are subject to permit coverage. As noted in the EA, a storm water permit or other appropriate permits may be needed under some circumstances, but these would be determined on a site-specific basis.
SUWA	6	NEPA further requires the BLM to consult with and/or request comments from the Utah Division of Water Quality, the state entity that develops and enforces state water quality standards. 40 C.F.R. § 1503.1(2)(a)(i). The Riverbend EA does not indicate that this consultation has occurred.	Consultation with the Utah Division of Water Quality is not required because the project will not result in violations of water quality standards. The draft EA was provided to the Utah Public Lands Policy and Coordination office for comment, and no comments were received.
SUWA	7	The BLM did not discuss the method used to calculate three of the six greenhouse gases (CO_2, CH_4, N_2O). The EA did not discuss how the various greenhouse gasses contribute to climate	The methodology for calculating all emissions, including greenhouse gas emissions, is detailed in Appendices F-1 through F-4 of the EA. The Appendices show the emission factors, equations, and assumptions

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		change in different degrees.	used to calculate the emissions. The total GWP has been added to the emissions totals in the EA.
SUWA	8	The EA omits data from the referenced USGS study.	The comment references a USGS summary publication (4 pages), *Impacts of Climate Change on Water and Ecosystems in the Upper Colorado River Basin,* that discusses the potential impact of climate change on the Upper Colorado River Basin. The publication does not discuss the causes of climate change, does not discuss how or if individual projects contribute to climate change, or even if climate change is related to emissions of CO_2 or other greenhouse gases. It is simply a report that discusses potential feedback mechanisms related to changes in precipitation and temperature. The comment also references a BLM report, *Climate Change: Supplementary Information Report, Montana, North Dakota and South Dakota*. This report is much more comprehensive than the USGS publication, and describes data and methodologies used to estimate greenhouse gas (GHG) emissions for the BLM planning areas of Billings, Butte, Dillon, Hi-Line Planning Area (Malta, Glasgow, and Havre Field Offices), Lewiston, Miles City, North Dakota and South Dakota. However, since the location of the project area is not within the planning areas analyzed in the report, the BLM will not include its analysis or conclusions in this EA. Neither of these studies provide a methodology for assessing the impacts of a specific project on global warming, because global warming is a global, not regional, phenomenon and the emissions from individual projects are an infinitesimally small portion of global emissions. The understanding and prediction of potential impacts related to climate change are neither well enough understood nor applicable to project level planning to require the sorts of restrictions and mitigation proposed by this comment. Requiring project level restrictions based on speculative landscape level suppositions about potential climate change impacts for the project area is arbitrary and capricious, and unlikely to survive legal challenge. BLM does and will continue to comply with federal, state, and agency requirements regarding climate change disclosure and mitigation. "Anticipatory planning" is neither a recognized NEPA requirement, nor is it applicable to project level NEPA analysis. BLM does and will

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			continue to require emission reduction and control based on recognized air quality issues associated with oil and gas projects, which also have benefits related to GHG reduction, and will continue to encourage reductions of GHG's consistent with federal, state, and agency guidance. A qualitative discussion of GHG, climate change and potential impacts on climate change has been incorporated into the analysis. BLM has elected to incorporate project design and control measures that reduce GHG emissions into the alternatives, rather than consider a separate alternative. Additionally, the newly proposed NSPS, NESHAPS and Tribal NSR regulations will require emissions controls that will lower the amount of methane emitted from specific sources.
SUWA	9	The RBU EA does not mention emissions from other project in the area.	The comment again references the BLM report for North and South Dakota, which is not applicable for the Proposed Project area. Nevertheless, a discussion of cumulative greenhouse gas emissions as reported by the Greater Natural Buttes EIS has been added to the EA for reference. See Chapter 5 of the EA for a discussion of cumulative impacts and analyses.
SUWA	10	Request to explain how methane emissions were calculated.	The methodology for calculating emissions, including greenhouse gas emissions, is detailed in Appendices F-1 through F-4 of the EA. The tables of emissions in the EA (e.g., Tables 4.2-1 and 4.2-2) show that methane emissions from construction equipment, drilling engines, well completions, interim reclamation, pumping unit engines, production heaters, stock tanks, dehydrators, operational vehicles (increased traffic), pneumatics, and compressor engines were all included in the totals.
SUWA	11	The BLM fails to account for increased nitrous oxide emissions from vehicles operating within the RBU. The BLM's estimate that there will be zero increase in nitrous oxide during the development stage and very little during the production stage of the proposed plan, disregards the emissions that will necessarily result from increased construction and equipment associated with the project.	Nitrous oxide (N_2O) emissions from operating vehicles were not shown in the EA as the emissions of N_2O are much, much less than other greenhouse gas emissions. On a gram per mile basis, emissions of N_2O are on the order of 0.0002 percent of CO_2 emissions. Even accounting for GWP, N_2O emissions are less than 0.06 percent of the GWP per mile. A footnote has been added to the emissions tables explaining why the N_2O emissions appear as zero.
SUWA	12	BLM must reconsider the carbon dioxide emissions from construction activities as they are integral to the overall project and the project would not be able to move forward without them.	The emissions of CO_2 from construction and interim reclamation are an extremely small percentage of the total CO_2 emissions from development. That is why the emissions appear as zero. A footnote has been added to the emissions tables explaining why the CO_2

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			emissions appear as zero.
SUWA	13	The BLM does not describe why leaving the pit liner in the ground is a better alternative than removing the liner.	Regulatory standards for reserve pit structure and reserve pit reclamation practices and timelines vary widely by state. Generally, pit materials must be dried or solidified prior to backfilling. Although oil and gas wastes are exempt from hazardous materials regulation by RCRA, some nonexempt materials do exist and must not exceed standards set forth in CERCLA prior to backfilling and reclamation. The determination of whether to bury the contents of the reserve pit along with the pit liner depends on the environmental sensitivity of the site, the contamination potential of the pit contents, and the time limit set for closing of the pit. The pit liner and contents would only be buried if it can be demonstrated that the contents are non-hazardous wastes that are exempt from RCRA hazardous waste management requirements. If any wastes test positive for nonexempt hazardous materials, they will be disposed of in the appropriate licensed site. Reserve pit contents that are buried and covered over are mixed with pit liners because no reasonable amount of excavating and cleaning can completely separate the liner from the pit contents after the pit has been used. The standard practice in Utah is to encapsulate the pit liner and contents in the pit which is then covered with at least four feet of backfill and topsoil and the surface sloped, when practical, so as to promote surface drainage away from the reclaimed pit area.
SUWA	14	The EA does not address the level of safety or the magnitude of earthquakes that the pipelines are designed for. The BLM must inform the public and themselves about the serious risk of a spill and subsequent contamination.	Geology was not discussed in the EA because it was not considered an issue as documented in Appendix A. While instances of induced seismic activity have been documented at oil fields, and other sites, such cases are relatively rare. Induced seismic activity may be prevented through proper siting, installation, operation, and monitoring. Induced seismic activity usually occurs along previously faulted rocks and may be investigated by analyzing the stress conditions at depth. In the case of injection wells, seismic events are unlikely to occur due to injection in porous rocks unless very high injection pressures cause hydraulic fracturing. The development of oil and gas wells in the State of Utah is regulated by UDOGM and injection wells in the State are regulated through the Underground Injection Control (UIC) program. UDOGM and UIC guidance require an extensive characterization, testing, and monitoring of each well to

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			be performed. See section 2.1.9 Spill Procedures for a discussion on how spills would be handled onsite. See section 4.3.1.2 Soil Contamination, 4.4.1.1 Surface Water, 4.4.1.3 Floodplains, 4.9.1.5 Special-status Fish and Wildlife Species, 5.2.2 Soil Resources, and 5.2.3 Water Resources for text regarding the risks for spills and contamination.
SUWA	15	The River Bend EA fails to evaluate the potential contributions of the activities in the River Bend Unit on soil disturbance, which leads to early snowmelt in nearby mountains when transported in windstorms.	The effect of dust on mountain snow cover is an emerging research area that is too speculative to address in, and beyond the scope of, the RBU EA. Section 3.2., 4.2 and 5.2.1 of the draft EA include a discussion of impacts from GHGs on climate, and resulting environmental impacts of climate change.
SUWA	16	BLM should make proper estimations of the amount of land able to be reclaimed based on their own statements that reclamation of these soils is generally poor.	The Green River District (GRD) Reclamation Guidelines apply to all surface disturbing activities on BLM administered surface lands. The guidelines mandate a reclamation plan be developed for all surface disturbing activities. The guidelines stipulate an acceptable level of revegetation prior to accepting the disturbance for final abandonment. According to the GRD guidelines, successful revegetation is attained when there is approximately 75% basal cover as compared to similar undisturbed adjacent native vegetative communities, and the reclaimed area is comprised of desired species and/or seeded species within 5 years of the initial reclamation action. However if after three (3) growing seasons there is less than 30% of the basal cover based on similar undisturbed native vegetative community, then the Authorized Officer may require additional seeding efforts.
SUWA	17	In order to comply with the mandates of NEPA, BLM should conduct a soil inventory to identify the location of biological soils in the River Bend Unit. BLM should also develop mitigation measures tailored toward the protection of biological soils. In order for the hard look test to be met, BLM must conduct both an inventory and develop specific mitigation measures tailored toward protection of biological soils.	In accordance with CEQ regulations (CFR 1502.22), the EA includes the potential impacts of the Proposed Action and alternatives on biological soil crust within the RBU Project Area. In the absence of site-specific data, the best available information has been used to predict the impacts on biological soil crust which could occur under the Proposed Action (see Section 4.3.1.3). The project area is an existing gas field with over 800 wells and related infrastructure. The types and location of soils in the project area are included in Section 4.3.1.1.
SUWA	18	BLM should discuss the fracing chemicals to be used in the project area and any human or environmental impacts that could potentially occur if these chemicals were to enter the	It's important to note that water accounts for about 90 percent of the fracturing mixture and sand accounts for about 9.5 percent. Chemicals account for the remaining one half of one percent of the mixture. There

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		environment or come in to contact with humans. XTO has disclosed some of chemicals found in their fracing fluids so BLM can at least begin with that information.	are several ways oil and natural gas companies manage the use of fracturing fluids, depending on what specifically is in them, the presence of usable groundwater or surface waters, geography, and local, state, and federal regulations. Spent or used fracturing fluids are normally recovered at the initial stage of well production and recycled in a closed system for future use or disposed of under regulation, either by surface discharge where authorized under the Clean Water Act or by injection into Class II wells as authorized under the Safe Drinking Water Act. Regulation may also allow recovered fracturing fluids to be disposed of at appropriate commercial facilities. Not all fracturing fluid returns to the surface. Over the life of the well, some is left behind and confined by thousands of feet of rock layers. Studies by the Ground Water Protection Council (GWPC), an association of state regulators, and the Environmental Protection Agency (EPA) have clearly demonstrated the effectiveness of current state regulations in protecting water resources. When the GWPC studied the environmental risk of hydraulic fracturing, they found one complaint in the more than 10,000 coalbed methane wells reviewed – an Alabama well where problems were not related to fracturing according to the EPA. The EPA initiated its own study of environmental risks from coalbed methane hydraulic fracturing and, again, no significant environmental risks as a result of proper hydraulic fracturing were identified. Presently, there is no federal rule regarding the disclosure of fracturing fluids. UDOGM currently requires the disclosure of chemicals used in the fracturing process.
SUWA	19	Despite these predicted acreage and AUM losses, BLM does not suggest mitigation measures of proportionately reducing grazing in the area.	Mitigating impacts to vegetation by reducing grazing is beyond the scope of this EA.
SUWA	20	BLM does not consider the effects on wildlife of the combined grazing acreage loss and habitat loss.	Please refer to Section 5.2.8 for an analysis of the impacts to grazing, wildlife and resource competition.
SUWA	21	BLM should discuss how the potential mitigation measures for Uinta Basin hookless cactus would affect the proposed action and whether or not the mitigation measures would be applied here.	Alternative A (Section 2.1.12.5) discusses in detail the applicant committed environmental protection measures for Uinta Basin hookless cactus. Alternatives C and D incorporate these measures and add the avoidance of new surface disturbance within level 1 core conservation areas. These measures are integral to the alternatives and

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			as such are basic assumptions for the impacts analysis in Chapter 4 of the EA. Further conservation measures may be developed during Section 7 consultation under the Endangered Species Act. The results of that consultation will be included in the FONSI and/or DR.
SUWA	22	The proposed activity and the alternatives will lead to direct habitat loss for pronghorns. Under the proposed action and the alternatives, disturbed areas will be reclaimed. However, the River Bend EA notes that "7-10 years would be required for shrub establishment and production of useable forage.	While much of the RBU Project Area in designated as Crucial Value Year-Long Fawning Habitat for pronghorn, it is important to note that the majority (77 percent) of the surface disturbance under the Proposed Action would only occur as expansion of existing infrastructure and in habitats that are already fragmented by past oil and gas activity. In fact, the RBU Project Area already contains some 324 well pads, 108 miles of road, and 137 miles of pipelines and associated central facilities. It is also important to note that numbers of pronghorn within the Project Area and surrounding region are exceeding low, as the number of antelope within the entire Book Cliffs herd unit (Herd Unit #10) is estimated at approximately 244 animals. This translates to an estimated average density of one pronghorn per 10.7 square miles. While the EA does maintain that surface-disturbing activities that remove vegetation in crucial value, year-long fawning habitat for pronghorn could affect pronghorn fawn activities in the RBU Project Area at least to some degree, it does not acknowledge that these impacts would be significant.
SUWA	23	The BLM concludes that the impact to pronghorns will be minimal because XTO will limit construction and development activity during the fawning period. BLM should explain more clearly how this conclusion was reached. There is no evidence to indicate that XTO will be required to cease operations between May 15-June 20 as indicated by the fact that only one of the leases in the area contains this stipulation. If XTO is voluntarily undertaking this requirement, will BLM oversee the cessation? BLM should more fully explain its conclusions on pronghorn antelope.	The timing restriction is a lease notice, not a stipulation. In addition, in their comment letter, XTO indicated that the timing restriction was not an applicant committed measure. Refer to comment XTO 9. However, the impact analysis for pronghorn has been clarified based on XTO's and SUWA's comment (see section 4.9.1.2).

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		activity during the fawning period. BLM should explain more clearly how this conclusion was reached. There is no evidence to indicate that XTO will be required to cease operations between May 15-June 20 as indicated by the fact that only one of the leases in the area contains this stipulation. If XTO is voluntarily undertaking this requirement, will BLM oversee the cessation? BLM should more fully explain its conclusions on pronghorn antelope.	an applicant committed measure. Refer to comment XTO 9. However, the impact analysis for pronghorn has been clarified based on XTO's and SUWA's comment (see section 4.9.1.2).